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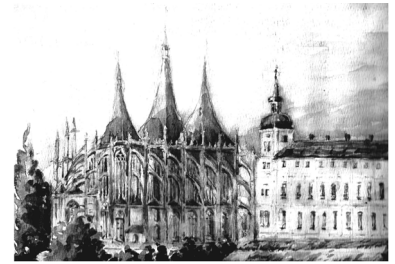
Kutná Hora © J. Chroust

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**Schriftenreihe
Informatik**

50

Doucek Petr ■ Chroust Gerhard ■
Oškrdal Václav (Editors)

IDIMT-2021
Pandemics: Impacts, Strategies and Responses

**29th Interdisciplinary Information
Management Talks**
Sept. 1–3, 2021
Kutná Hora, Czech Republic

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Schriftenreihe Informatik

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Pandemics: Impacts, Strategies
and Responses
29th Interdisciplinary Information Management Talks

The Conference IDIMT-2021
took place September 1st – 3rd, 2021
in Kutná Hora, Czech Republic

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ANNEX

A Hearty Welcome to IDIMT 2021!

Fig 1: Kutná Hora, Czech Republic

Fig. 2: AIT office, Vienna

The COVID-19-Virus has considerably changed the landscape of scientific conferences and it has not been overwhelmed yet. The virus has demonstrated the vulnerability and fragility of our high-tech society with respect to human health and the resulting economic and social situation. At the same time modern technology has enabled us to find relatively quick responses to medical threats by testing, vaccinating and overcoming of personal distancing due to electronic communication.

We are happy to be able to hold the 29th conference in a way that is compatible to previous conferences but that has also been adapted to safety requirements, requiring a hybrid - mixed real and virtual - conference. We are therefore holding the anchor conference in Kutná Hora, as in the previous 4 years. Additionally, a virtual mirror conference has been established in Vienna and several participants will connect from their home offices.

The historic town of Kutná Hora reminds us of resilience and preservation of old values and perspectives while the Viennese mirror conference, taking place on the premises of the AIT Austrian Institute of Technology, a leading research company in digitalization, reminds us of modern communication technology. The Prague University of Economics and Business bridges these two worlds and symbolizes the cross-fertilization the between them.

The world-wide challenges posed by the COVID-19 virus have demonstrated the importance of interdisciplinary approaches and the need for management of information – two topics which have characterized the IDIMT conferences since their beginning in 1993[1]

The impressive history of the IDIMT conferences has been separately documented in a hard cover book plus its e-book version[2]. IDIMT conferences have always reflected the up-to-date challenges of interdisciplinary cooperation and information management. Consequently the 2021 conference explicitly addresses COVID-19, crises and pandemics, and their impact on all aspects of life.

This year we have accepted 54 submitted papers plus 11 keynote papers and 2 invited papers with a total of more than 110 co-authors. The submissions have been reviewed in a two-step double blind

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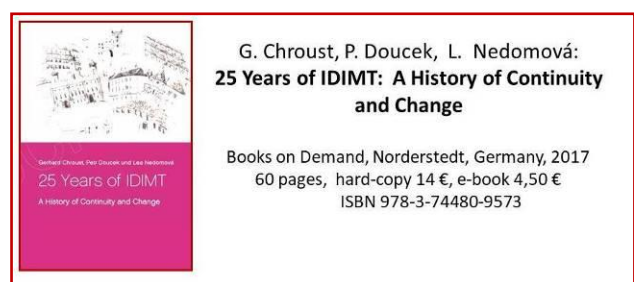
[1] Chroust, G. and Doucek, P., editors (1993). Information Management Workshop 93, Kubova Hut, Czech Republic. Univ. of Economics, Prague & J. Kepler University Linz, Austria 1993, ISBN 3-902457-06-6

[2] G. Chroust, P. Doucek, L. Nedomová: 25 Years of IDIMT: A History of Continuity and Change, Books on Demand, Norderstedt, Germany, 2017 (hard copy and e-book).

review process in order to judge and to evaluate the acceptability of the papers. The authors have received extensive comments and were required to improve their papers accordingly by a second submission. The authors have come from 12 different countries: Austria, Czech Republic, Estonia, Germany, India, Kazakhstan, Lithuania, Netherlands, Poland, Russia, Slovakia and Ukraine.

The programme will offer two parallel streams for in-person attendance and virtual participation by off-site participants. We expect approximately 90 participants.

For 2021 we have chosen the following topics:

- Digitalization and Industry 4.0 - Changes in Concepts Caused by COVID-19?

- Innovations and Strategies in a Pandemic Era.

- Digital Transformation in Crisis Management.

- Social Media, Fake News, Myths and Ethics.

- Digital Health - Emergency Support for Victims and First Responders.

- Smart Supply Chain.

- Cyber Security in a Digital World.

- Performance and Sustainability Management and Corporate Social Responsibility.

- Trust in Smart Robotics and Autonomous Systems - Resilient Technology, Economy and Society.

- COVID-19's Impact on Enterprise Software Development.

- COVID-19's Influence on Learning and Teaching.

The distribution of the papers sheds some light on the current interests of our participants.

Each session is organized by a Session Chairperson and traditionally starts with a keynote, followed by papers providing additional points of view. At the end of each session there is a 20 minute, often heated, discussion.

Loesch, C.W. and Chroust G. (ed.):
**Technologies Changing Our World
- 21 Perspectives 2000 bis 2020**

Books on Demand, Norderstedt, Germany, 2020
292 pages, hard-copy 20 €, e-book 8 €
ISBN 978-3- 7519 6769 3

This extensive interdisciplinary exchange of thoughts is one of the unique selling points of the IDIMT-Conferences. Since 2000 Christian Loesch has always offered an overview of technical, economic and/or business developments in the global world collected in a special book[3]. This year's title is 'Mutual Impact of the COVID-Pandemic and ICT'.

IDIMT 2021 would not have been possible without the support of many organizations and persons. We would like to express our thanks to:

- the Prague University of Economics and Business for the project IGA 409021,

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[3] C. Loesch and G. Chroust (ed.): Technologies Changing Our World 21 Perspectives 2000 – 2020, Books on Demand, Norderstedt, Germany, 2020 (hard copy and e-book).

- the Faculty of Informatics and Statistics of the Prague University of Economicsand Business,
- the Johannes Kepler University Linz, Institute of Telecooperation, and
- the AIT Austrian Institute of Technology for providing room for the mirror conference.

Our further thanks go to:

- Petr Doucek for chairing the Organizing Committee, for arranging the conference location and the hotels,
- Gerhard Chroust for chairing the Programme Committee,
- Antonin Pavlíček and Lea Nedomová, for organizing the program, the reviews, keeping contact with all involved speakers, and reminding forgetful authors and session chairs,
- Václav Oškrdal for arranging and assembling the accepted papers for the proceedings,
- Lea Nedomová, for her support in performing the necessary administrative tasks,
- all keynote speakers, speakers and contributors of papers,
- all members of the Programme Committee and the Session Chairpersons for soliciting contributors and creating an interesting and compact program,
- all reviewers providing critical remarks for improving the papers,
- the Trauner Verlag as the publisher of our conference, and
- all other unnamed persons contributing to the success of this conference.

Looking forward to a successful and interesting conference!

Gerhard Chroust   July 2021   Petr Doucek

The Nine Locations of IDIMT Conferences 1993 – 2021
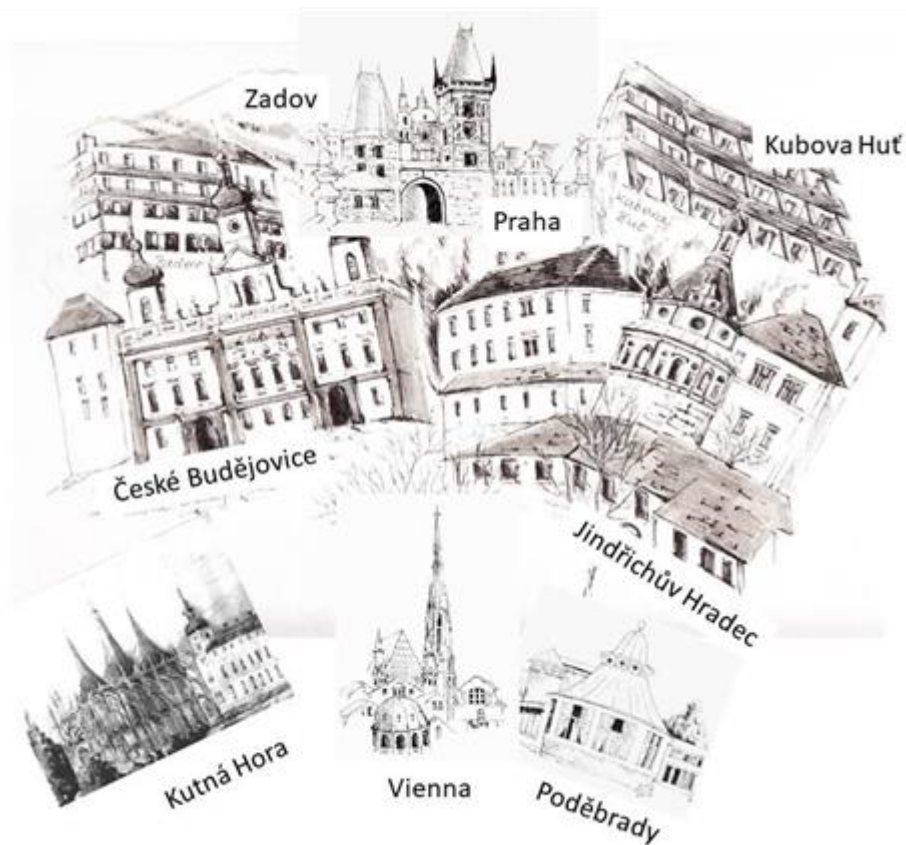
Kubova Huť	1993, 1994
Zadov	1995 – 2002
České Budějovice	2003 – 2007
Jindřichův Hradec	2008 – 2012
Praha	2013
Poděbrady	2014 – 2017
Kutná Hora	2018 – 2020
Kutná Hora, Vienna	2021

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Anniversary Gerhard Chroust 2021

The 80th anniversary of Univ. Prof. Dipl. Ing. Dr. techn. Gerhard Chroust MS. is certainly a good occasion to take stock some of the career, personal life, professional and scientific achievements, having had the privilege to witness.

He started his career at the Technical University in Vienna but doubled his achievement by adding the Master of Science at the University of Pennsylvania to his Dipl. Ing. degree within a year. In 1965 this was remarkable, showing both the academic qualification as well his international broad-minded personality.

He had returned to the Technical University of Vienna when IBM asked the Austrian Computing pioneer Prof. H. Zemanek to establish a Computer Science laboratory in Vienna for IBM. Prof. Zemanek chose the best of his postgraduate students for this and of course Gerhard Chroust was one of the few.

Even his full-time work at the laboratory could not exhaust the energies of Gerhard Chroust and he paralleled his work for the IBM Laboratory with his academic career up to his habilitation. This was not easy, it took a lot of strength, stamina and will to fulfill simultaneously the requirements of the IBM Laboratory, his beloved family near Vienna and the Johannes Kepler University in Linz. He did it with great bravery and outstanding support of his wife Janie.

Just becoming tenured professor at the Johannes Kepler Univ. of Linz for in 1992 he immediately stretched his hand across the fallen iron curtain. One of his first endeavors was a seminar for Czech students at the Univ. of Linz already in 1992. The young professor wanted more and found in an outstanding student named Petr Doucek a congenial partner. This was the birth of IDIMT.

Newly established at the University he built a well-organized institute with a family-like atmosphere and branched out of academia to government and industry. It would be incomplete not to mention his intellectual creativity producing nearly around the clock new ideas and endeavors, as well publications encompassing of a dozen books and hundreds of publications. Implementing all these activities with a sense of social empathy for the people around him, from colleges to students.

These activities did not only result in outside appreciation of his institute but also in numerous honorable personal recognitions reaching from Secretary General of the International Federation for System Research to board member of the Austrian Society of Computing to mention some.

Later he broadened his engagement into cultural diversity, systemic aspects and disaster management, long before Covid 19, complementing his diverse interests and competences reaching from archaeology to history. He is living the first two letters of IDIMT (**I**nter**D**isciplinary **I**nformation **M**anagement **T**alks).

For many the 80th birthday is used to look backwards but in the case of the jubilee it is just looking at a locomotive in full motion with no sign to slow down.

Ad multos annos!

Christian Loesch

INVITED CONTRIBUTION

MUTUAL IMPACT OF COVID AND ICT

Christian W. Loesch

IBM ret.

CWL001@gmx.net

Abstract

Covid and ICT presents a complex and differentiated perspective, contrasting the mainstream and presenting a different picture.

The economic scenario displays the impact and how the key players of the ICT scenario fared in this turbulent environment. Contrary to the general negative picture it displays a complex scenario of many positive trends and achievements with emphasis and acceleration of developments and their social acceptance, attaining even extraordinary growth in areas as e.g. the digital health sector and potential future medical applications.

While the general public focus is concentrating on the threats of Covid, we will also peruse the evolution of ICT in the shadow of Covid challenge, showing impressive inventiveness in adapting to the new scenario additional and handling the end of Moore and beyond Moore scenario.

A fertile symbiosis of evolution and revolutionary technologies is emerging on the horizon or progressing further. Technologies expected in the future as exascale computing, with its bandwidth and storage challenges are not just future, they are already going to be realized now at spearheading projects as Argonne, Lawrence Livermore or CERN.

We will survey developments, technologies progressing at accelerated speed in the shadow of Covid, ranging from quantum computing, photonics, molecular electronics, and spintronics.

Finally we will look at two-dimensional materials, PCM (phase change materials), as well as AI and neuromorphic computing and collaterally reemerging technologies as UWBG (ultra-wide band gap) with the potential to push the limits of spatial, temporal energy solutions that may be crucial in the coming decennium as well as new materials and devices.

This short review should give a glimpse on the plethora of ongoing developments their key protagonists, collateral phenomena and emerging challenges which may impact the world we are going to live in.

1. Economic Scenario and Covid

A short survey how some of the key players coped with the scenario.

How did they fare
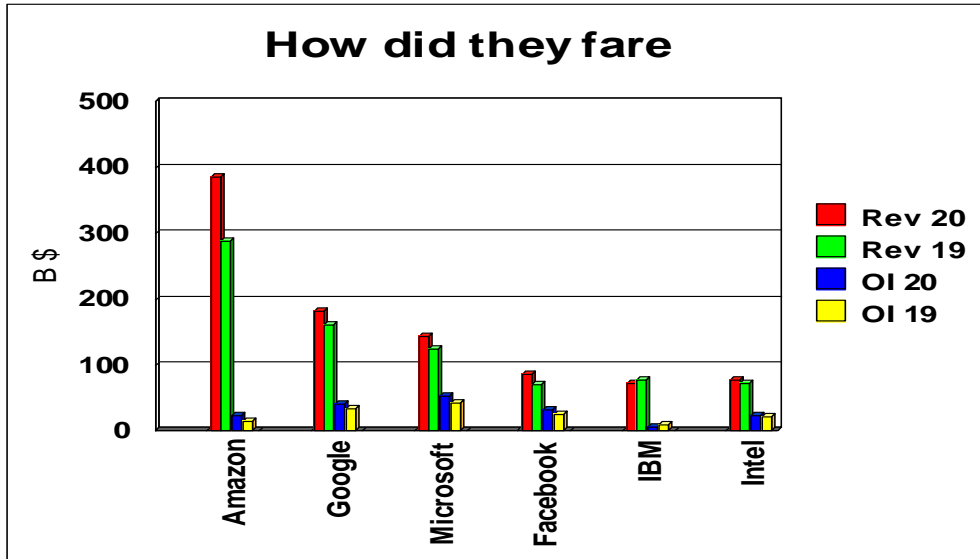
Expressed in figures of revenue and operating income:

	Rev	OI
Amazon	+34%	+6%
Alphabet/Google	+13%	+22%
Microsoft	+14%	+37%
Facebook	+21%	+38%
IBM	-5%	+8%
Intel	+8%	+31%

The damaging impact on individuals as well as regional/global economies was evident early on. But contradictory to doomsday prognosis the IC industry largely intelligently prevaricated the decline impacting many industries. Global IC sales increased 10% in 2020 fueled by demand for portable computers and powerful large-screen smartphones, used to access the Internet and cloud computing when furthermore Covid- crisis investments in data-centers gave IC sales an additional boost.

Computing has long been the growth engine for the IC industry, but emerging applications in communication, consumer, automotive, and industrial/medical systems are fueling development of new complex, high-speed, and/or low-power ICs. Cloud computing, 5G technology, artificial intelligence, virtual reality, the Internet of Things, autonomous vehicles, robotics, and many other technologies are rapidly advancing and will change the way consumers live and businesses operate, Electronic system sales are expected to rise 8%, while the 2021 IC market is forecasted to rise and set a new all-time high sales level of 441 B$, which would surpass the previous high marks of 2018.

	2020	2021	(in B$)
Electronic systems sales	1650	1,780	4,8%
IC Market	395	441	8,0%
Semicond. Cap Exp.	109	125	15%

IT Industry - some key figures

Optimistic forecast expect even a three-year wave of double-digit growth for the IC industry. This is based on the 15% surge in semiconductor industry capital spending, expected for this year as TSMC and Samsung are expanding their 7nm and 5nm manufacturing capacity. TSMC furthermore expects production of 3nm devices by the end of the year. The recent IBM announcement of its 2nm technology will be addressed especially later.

Compared to many other industries, the IT industry expects an enormous market boom in the next five years until 2025. Additionally supported by the increased demand for software and social media platforms such as Google Hangouts, WhatsApp, Video, Zoom, and Microsoft Teams a.s.o.

Total Microprocessor Market History and Forecast
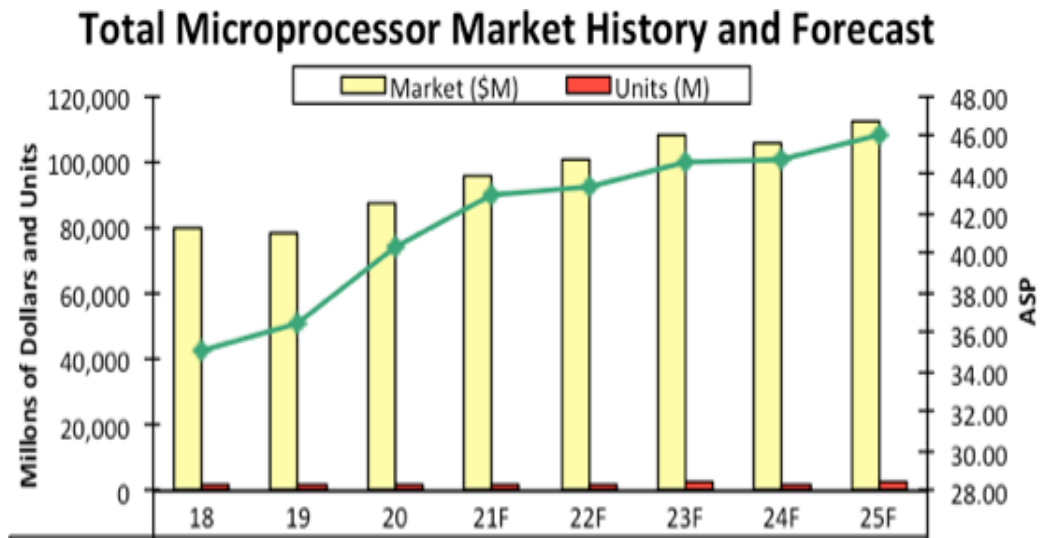
1.1. **Disguised impacts**

Apart from the above mentioned fact and figures, disguised amplifiers for opportunities and concerns have ascended or intensified:

- Amplifiers:
  - AI adoption
  - Full acceptance of robots
  - Data sharing practices
  - Switch to online in ed, gov, commerce, e-learning
  - Video conferencing on demand and streaming platforms
  - Interest to learn IT and as job requirement
  - Cloud bases services
  - Big Data and analysis
  - AR and VR
- Concerns
  - Misuse of data collected
  - Growth of organized campaigns
  - Dependence on non- EU platforms etc. and material resources
  - Lock downs consequences for education, skill growth, inequalities
  - Censorship w/o democratic legitimization, freedom of speech
  - Saturation of some hardware in large markets (tablets, smartphones, PCs)
  - Difference in speeds of recovery

2. ICT technologies and spearheading applications

2.1. ICT visions for the digital health sector

Consider the extraordinary time we live in: There has never been a period in history of such rapid advances in medical knowledge and technology, sinking their roots in the now and becoming a leading edge user of ICT.

The pandemic gave rise to explosive growth in the digital health sector. Venture funding shot up 66% over 2019, with a record $14.8 billion raised globally in 637 deals. A special effect of the COVID-19 pandemic was its "demystifying" telemedicine and digital medicine. Many physicians got a slight taste of the technology for the first time, and not multiplying their administrative burdens.

Some promising technologies assisting the future of medicine emerge on the horizon.

- New (even brain) computer interfaces bring hope for the paralyzed
- and augment human features, as e.g. prosthetic limbs
- Voice as diagnostic and medical support tool
- Patient empowerment as a consequence of the tech revolution
- Health sensors, portable diagnostics
- Biohackers, (sensors in clothing, tooth or implanted)
- Artificial Intelligence in Decision-Making
- Fading out of human experiments
- DIY Biotechnology e.g. direct-to-consumer genomics
- Surgical Robots
- Nano robots in our bloodstream
- 3D printing bones by design, organs on demand
- Genetic testing -> Genetic Medicare
- AR and mixed reality based for medical education

After a difficult initial period advanced diagnostics as e.g. IBM´s Watson is expected to exceed the diagnostic success rate of ordinary mortals, (in the U.S., approximately 1 in 5 diagnoses are suspected to be wrong or incomplete, and about 1,5 million people are injured by medication errors each year).

Although some of these advances are already having an impact, most are still at their early stages and will not reach the market in foreseeable future, but due to advances in AI, the falling cost of gene sequencing and personalized medicine, they may fast become parts of diagnostics, drug development and patient care.

A study assessed the potential medical technologies ranked in descending order by the criteria:

- Chances to be realized
- Potential impact and
- Accessibility show

o Health Sensors & Telehealth

o Direct to customer genetic testing

o AI

o 5G

o Robots

o 3D Printing

o MR

o QC

Brain computer interfaces

3. Technology in the shadow of Covid

Architecture

Two developments accelerated computing to reach a crossroad requiring extraordinary attention.

The first is the many times prognosticated and delayed dooming end of Moore's Law, i.e. we cannot longer depend on the doubling in performance and density at the same cost. The second is the explosive growth of data and the emergence of artificial intelligence (AI). This is ill-suited to the current von Neumann computing architecture that, while effective for high-precision calculations, is excessive in energy consumption and wasteful in AI applications. New computing models and architectures beyond the von Neumann approach are needed. There is need and opportunity to reshape computing as we know it, making it orders of magnitude more energy efficient and powerful as today.

This will not be a short term process but rather a symbiotic multistage approach.

Processors

This spring IBM´s 2nm processor prototyping was presented, (it's a feasibility announcement which will have to make the long way into consumer devices, as announcing 2nm chips and building them at scale are different challenges. To put this into perspective (2nm is thinner than a DNA strand), IBM plans to release its first commercial 7nm processors this year in its Power Systems servers. Although 2nm processors are probably at least a few years away from coming to laptops and phones, it's at least good to know which more powerful and efficient technologies are in the pipeline.
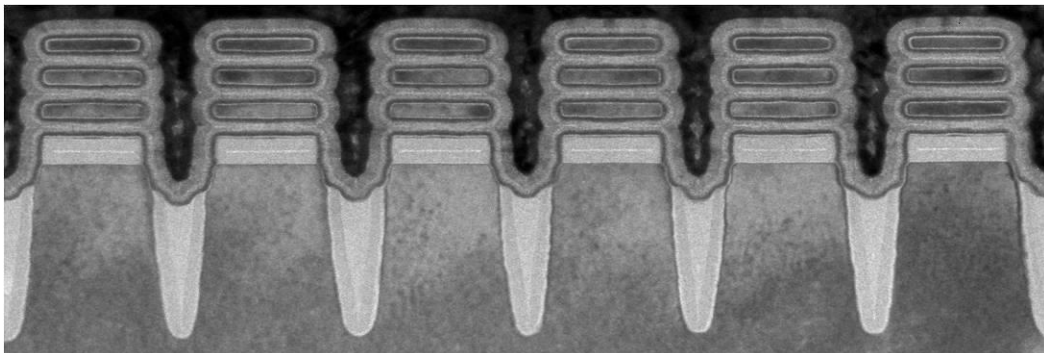
The potential benefits of the 2 nm chips could include:

- 45 percent higher performance

- 75 percent lower energy use, than today's most advanced 7 nm chips.

- Quadrupling cell phone battery life

- Drastically speeding up a laptop's functions.

- Contributing to faster object detection and reaction time in autonomous vehicles

- The big jump is in transistor count. IBMs 2nm chip features ~ 333M transistors /mm^2 comparing to TSMC's most advanced ~173 MTr /mm2, or Samsung's ~ 127 MTr/mm^2.

For the technology interested some details. The technological advances behind IBM´s 2nm technology are new bottom dielectric isolation i.e. reduction in leakage current, extreme ultraviolet (EUV) lithography enabling front-end to production of variable nanosheet widths from 15nm - 70nm and last but not least, all the critical layers for IBM´s 2nm technology will use single exposure EUV, with benefit in terms of cycle time and defect reduction a.s.o. The transistor has three layers of nanosheet, and each sheet has a width of ~40nm and a height of ~5nm. The pitch is ~44nm, and gate length ~12nm.

The 2nm node number does not refer to a specific physical feature on the die. In past decades, a semiconductor node name related to a given feature of the chip. The current naming convention refers to "a metric that's a combination of many parameters, as power, performance and density, to enabling value and function that you can put on the chip every two and a half years.

Data

All forecasts agree on an explosive growth of data and the associated requirements on storage as well as on bandwidth. These challenges are not future dreams but already addressed in leading edge exascale computing facilities pushing the present technologies to and beyond their limits.

The upcoming computing technology is embodied in the world's exascale machines of laboratories as Argonne, Lawrence Livermore, Oak Ridge or CERN. It is used by researchers at CERNs ATLAS (A Toroidal LHC ApparatuS) and CMS (Compact Muon Solenoid) particle detectors in the LHC (Large Hadron Collider). These are facilities continually updating with sensing and measurement capabilities pushing the limits. The demands on data storage and data processing multiply, representing increases over next years by factors of 20-24 from today, and these data handling needs will multiply further on. The experiments at CERN result in extreme data volumes, in spite of being filtered at acquisition to less than 10% (LHC will have a luminosity of 3000 fb−1, corresponding to ~1012 proton-proton collisions).

As example some ATLAS figures:
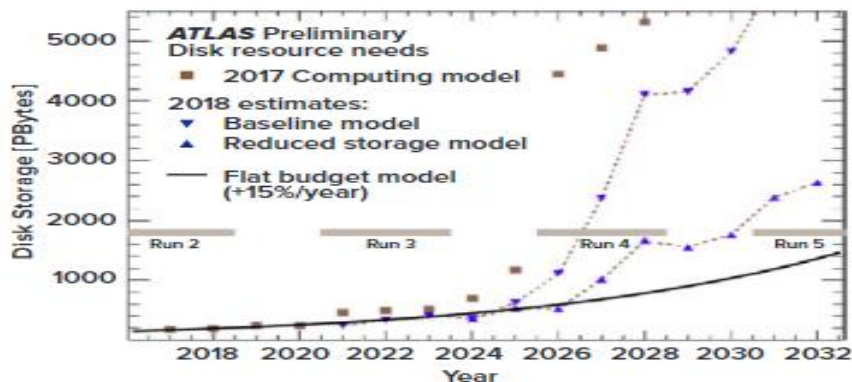
Scaling of storage device capacity has outpaced bandwidth scaling in the past and is likely to do so in the future. The gap between storage capacity and bandwidth renders efficient utilization of high-density storage devices challenging. The main limitation for device bandwidth scaling is the high energy cost of data movement, which has led to the idea of moving computation closer to storage.

3.1. More Moore and Beyond the Horizon

The common believe of Moore's Law death, is basically driven by the seemingly insurmountable problem of keeping spiraling energy density and chip temperatures under control. In the absence of a solution to this 'root cause' issue, other solutions are being evaluated how to remove excess heat generated by racks full of hundreds of thousands of chips, operating in multiple thousands of data centers on the globe. One such solution to the temperature overload problem can be found in Microsoft's deep-sea cloud project, which in 2015 placed a data center in a hermetically sealed, nitrogen-filled shipping container on the seabed off the coast of Scotland to take advantage of 'cost free' cooling by the cold waters in the North Sea. While the project has demonstrated some promising results, not least improved component failure rates, but this can also be attributed to the inert nitrogen environment, clearly moving all datacenters underwater cannot be considered to be a final solution.

These approaches address the symptom, not the cause.

3.2. Optical/Photonic Computing ("the shot in the arm for Moore's Law ")

A solution may be in the form of a paradigm shift in semiconductor chips to a new way to compute and connect chips using photonics, in conjunction with electronics. Using photons, instead of electrons to compute has given birth to ultra-low power, high performance photonic computers that outperform state of the art conventional devices by a factor of up to 100x at one-tenth of the power. When integrated with a new generation photonic communication fabric that enables heterogeneous chip-to-chip communication, rack-scale compute systems become possible. This innovative, yet proven, new processor and communications capability powered by photons, not electrons, could propel chip innovation and performance, providing thus the opportunity for innovation and AI compute performance to get back on track with Moore's Law.

Photonic computing is set to provide the revival Moore's Law needs. It has become possible only in the last few years because of the maturing of the manufacturing for integrated photonics, needed to make photonic chips for communications. What was done on an optical bench 30 years ago, can be put on a chip today.
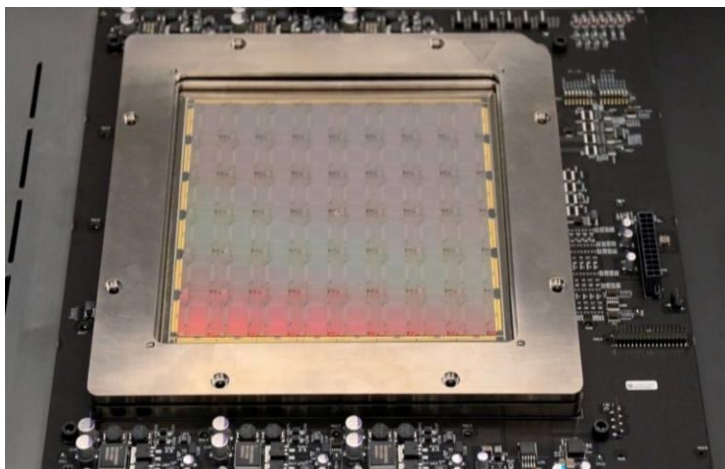
Photo: Lightmatter

23

Lightmatter, an US company, is developing next generation processors that use light rather than electricity, based on the principle of the Mach-Zehnder inferometer.

An advantage of light-based circuits over their electronic counterparts is also never-before-seen speed. Leveraging optical physics, the technology developed can run complex operations in parallel in a single core, using different optical wavelengths for each calculation. Combined with in-memory computing, IBM's scientists achieved ultra-low latency that is yet to be matched by electrical circuits. For applications that require very low latency, therefore, the speed of photonic processing could make a big difference, the speed of photonic-based systems is several orders of magnitude better than electrical approaches. Experiments were showing the potential of the technology, the potential realization of an entire convolution processor, which could maybe use as part of a deep neural network.

It has been argued that Moore's law does not apply to photonics because of the large differences between microelectronics and photonic integration technologies. But applying the methodology of microelectronics to photonics may lead to a dramatic reduction of the costs for R&D and manufacturing of photonic ICs and a widening of application fields in telecommunications and data communications, as well as but also for application as in sensors, medical equipment, metrology and consumer photonics. Thus it will accelerate the development of more advanced integration technologies that bring us VLSI Photonic ICs to continue the pace of innovation in AI.

Digital Photonics is receiving increasing interest. In particular, digital photonics based on coupled micro or nanolasers is a promising candidate for integrating large numbers of digital circuits. The recent breakthrough in plasmonic lasers, which are no larger than modern transistors and can operate with low switching energies at very high switching speeds, holds the promise that digital photonic circuits with more than 100,000 lasers operating at THz clock rate will become reality. Such circuits can avoid a lot of power intensive electro-optic conversions in high speed internet routers and they may be used in ultrafast digital photonic signal processors.

Spintronics

Spintronic memories are emerging as one of future generation storage technologies to replace hard disk drives and current solid state memories. Most conventional solid state memories require one or more transistors or switches per data bit, to a large extent, by the size of a single transistor, the number of transistors needed per memory cell, and the cell layout and architecture, the target market of the domain wall-motion.

Compared with conventional MRAM, including spin transfer torque MRAM, the main advantage of DW-motion MRAM is the separation of the writing and read-out circuits and thus, the larger margin for the read-out levels.

The racetrack memory is conceptually very different from MRAM.

"RaceTrack "memory [IBM Almaden Research Centre]
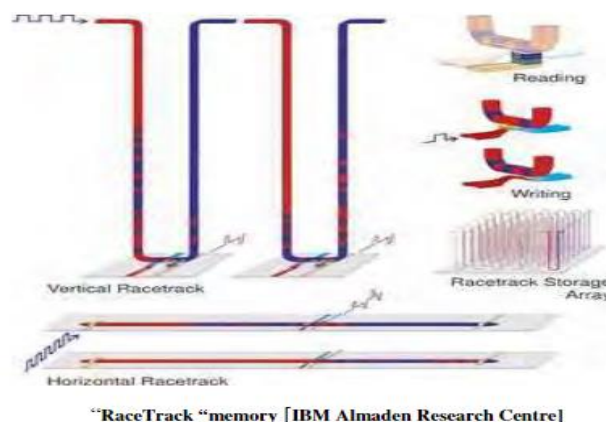
3.3. **On at Over the Horizon**

Questions are being asked about the future as the number of critical compute intensive applications evolve at a faster rate than chip scaling. This discrepancy in rate and scale threatens the continued swift development of important and increasingly foundational pillars of innovations like AI. Since 2010 AI compute requirement has grown at 5x the rate of Moore's Law, doubling approximately every 3.5 months. Given the growing number of life altering applications built on top of AI engines finding a solution to this performance scaling mismatch is high on fabless and chip manufacturing companies priority list. Training a single neural network using today's most advanced chip generates emissions equivalent to that of five cars over their entire lifetime.

New logic devices on the horizon are, the tunnel FET, the spin transistor, and the negative capacitance FET (NCFET). None of these devices has been introduced as commercial products or introduced within processor chips for evaluation, though the NCFET is being actively investigated in industrial R&D today. New devices for digital memory are more advanced, with versions of magnetic RAM (MRAM), resistive RAM (RRAM), ferroelectric RAM (FeRAM), and phase change memory (PCM) in various stages of commercialization. Synchronously we may be witnessing the emergence of a second major architecture for computing, driven by the explosive growth of machine learning algorithms and applications.

The future plethora is rich, with devices operating on electronic, mechanical, magnetic, and biochemical principles, reaching from current CMOS transistors, bio-molecular machines such as mitochondria and ribosomes, ionic and memristive devices, spintronics, photonics, superconducting Josephson junctions, carbon nanotubes, nano/micro-electro-mechanical systems, DNA, and systems of neurons.

We may anticipate that future computing in non-von Neumann architectures will be in one of two classes: (1) those that are Turing complete or (2) those that are used as accelerators for specific computations in conjunction with a von Neumann system.

3.3.1. Neurocomputing – The Renaissance of the Memristor

Memristors, or memory resistors, a low-power and non-volatile technology, are a kind of building block for electronic circuits that scientists predicted roughly 50 years ago but only created for the first time a little more than a decade ago. These components, also known as resistive random access memory (RRAM) devices, are essentially electric switches that remember whether they were toggled on or off after their power is turned off. As such, they resemble synapses, the links between neurons in the human brain, whose electrical conductivity strengthens or weakens depending on how much electrical charge has passed through them in the past. According to new research, memristors could efficiently tackle AI medical diagnosis problems, a development that suggests additional applications in other fields, as low-power or network "edge" applications. A potential application for memristors would be devices capable of learning, adapting and operating at the far ends of a network (a.k.a. its "edge"), where low-power devices like embedded systems, smart home gear and IoT nodes sometimes reside. The memristors could even make edge learning devices a reality.

In theory memristors can act like artificial neurons capable of both computing and storing data. As such, memristors could potentially greatly reduce the energy and time lost in conventional computers shuttling data back and forth between processors and memory. The researchers' memristor arrays achieved a stunning five order of magnitude reduction in energy over conventional digital CMOS electronics. A challenge in developing applications for memristors is the randomness. The level of electrical resistance or conductivity seen in memristors depends on a

handful of atoms linking up two electrodes, making it difficult to control their electrical properties from the outset.
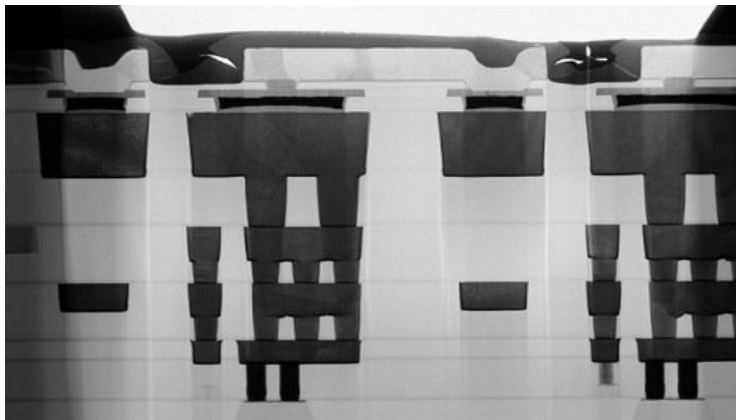
Picture: CEA-Let

The memristors (the top grey-and-black sandwich structures) in a new array can exploit randomness to perform machine-learning tasks.

3.3.2. QC (Quantum Computing)

We are witnessing a highly publicized quest for "quantum supremacy" and a plethora of competing approaches. This invites an update to the QC sessions of previous IDIMTs.

When Google unveiled its demonstration of quantum computational advantage over classical computing in late 2019, soon afterwards Chinese researchers reported progress by the second known demonstration of quantum computational advantage, also called "quantum supremacy".

The Chinese team has shown a different but no less exciting path forward for quantum computing. The Chinese research differs from the Google team's claim in several notably, Google's 2019 demonstration with the 54-qubit quantum computer completely different architecture based on superconducting metal loops as Google, IBM, and Intel.

Other companies such as Honeywell and IonQ have been developing alternative quantum computing architectures based on trapped ions, and in Australia, Silicon Quantum Computing has been developing quantum computers based on spin-based silicon qubits. It now appears also possible to achieve computational achievements with lasers and nonlinear crystals.

One of the challenges with all these great demonstration is: it's not programmable.

EU Commission launched a 10-year quantum flagship in 2018, which, with a €1 billion € budget, described as one of the most ambitious research initiatives. Since then, individual member states have started their own quantum programs in parallel.

In spite of the general optimism there are many challenges or roadblocks ahead as for example the need to build quantum machines that compute without errors. Theories first estimated that to get there would need machines with tens of millions of qubits on a single cooled-down chip, corresponding to requirement as to cool down quantum chips the size of football fields. Luckily, some of the latest results show that it's possible to reduce the number of qubits needed to implement error-correcting codes significantly.

But even if we achieve this, we will have to overcome another hurdle: linking quantum processors, Solutions in this area must unite disparate technologies like superconducting qubits and fiber optics, while solving outstanding challenges in materials science and quantum communications.

4. Robotics

Since this subject has been addressed in several previous sessions, just an update with some key figures. Robot technology has in many ways surpassed the vision since the time when the word "robot" has been coined a century ago. According to the nonprofit International Federation of Robotics in 2019 the number of industrial robots reached 373 000 robots and the total employed worldwide 2.7million. Meanwhile, 173,000 professional service robots were sold and installed in 2019, a number expected to climb to 537,000 units annually by 2023

5. New materials and Structures

5.1. Metasurfaces

The fields of microelectronics and photonics have experienced a remarkable evolution in the last decades. By using metallic and dielectric nanostructures precisely sculpted into two- and three-dimensional nano-architectures electrons and photons can now be manipulated, confined, and processed in ways impossible to achieve with conventional materials and geometries. The introduction of optical metasurfaces has revolutionized the ways in which electromagnetic waves can be controlled, and thus, the prospect of planar, lightweight, and ultra-compact optical devices is becoming a reality. Metasurfaces consist of planar arrays of sub-wavelength structures that locally modify the electromagnetic properties. They are fabricated as used to manufacture microelectronics circuits, offering seamless integration with electronic components. Monolithic fabrication of metasurfaces integrated within electronic circuitry may offer advantages related to data-intensive applications, advanced sensing, and hardware security. For instance, squeezing light to nanoscale dimensions can enable dense optical integrated circuits, overcoming fundamental challenges related to bandwidth and energy dissipation.

The picture below shows three examples as: a) Planar array of subwavelength structures, b) Bielectric structures using TiO2 resonators and c) Plasmonics antennas.
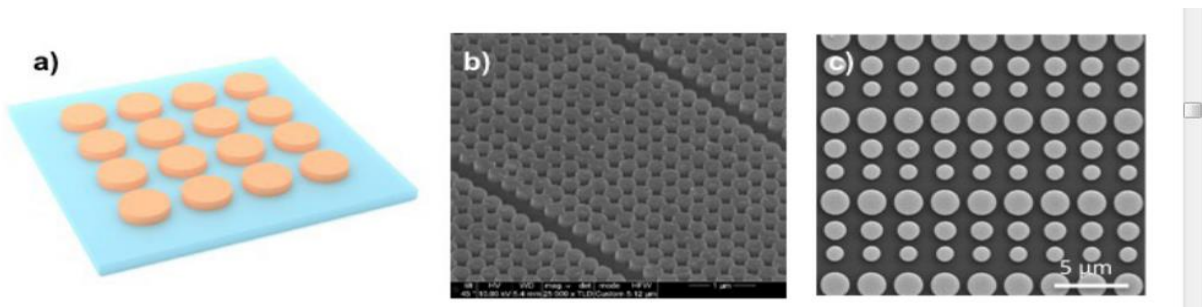
Applied Physics Letters of photonics 3, 021302

5.2. New two-dimensional materials for FETs

The impressive properties of graphene instigates the search for new materials. Swiss scientists made a computational look at two-dimensional materials, like graphene, to see which will make the best transistors.
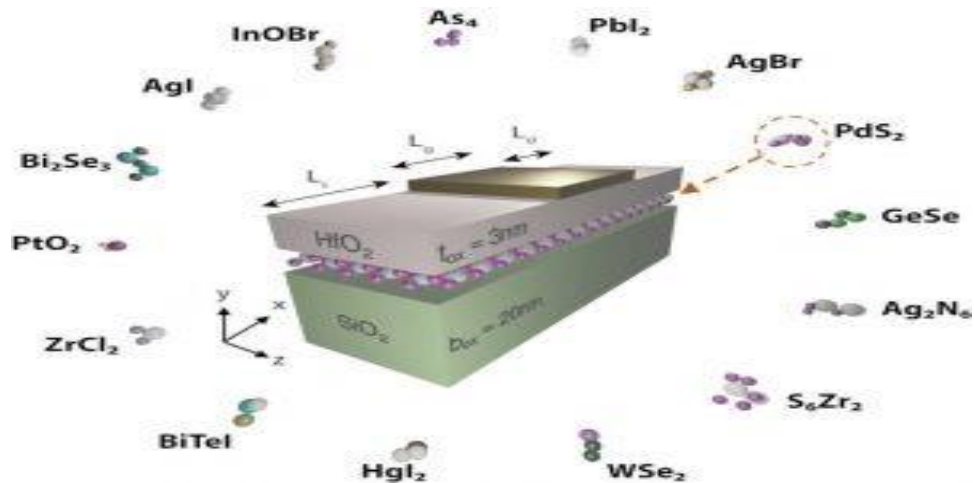
A team, from ETH Zurich and EPFL (École Polytechnique Fédérale de Lausanne), modelled first-principles on a supercomputer, combining density functional theory and quantum transport theory on devices with gate lengths from 5nm to 15nm. Hundred candidates were picked by the EPFL team in 2018, sifting through 100,000 materials to find 1,825 from which 2-D layers of material could be obtained. A further selection from 1,800 to 100 was based on which mono-layers of atoms were most likely to build into Fets. From 100 candidate compounds, 13 show promise, in some cases more promise than the predicted trend of silicon FinFets. Although all 2-D materials have this property, not all of them lend themselves to logic applications. Limiting the selection to those having a large enough band gap between the valence band and conduction band.

While graphene has some amazing physical, optical and mechanical properties, its lack of a natural bandgap limits its use in electronics.

To understand the potential of the research endeavors better, let's recall the basic physics of the band model.
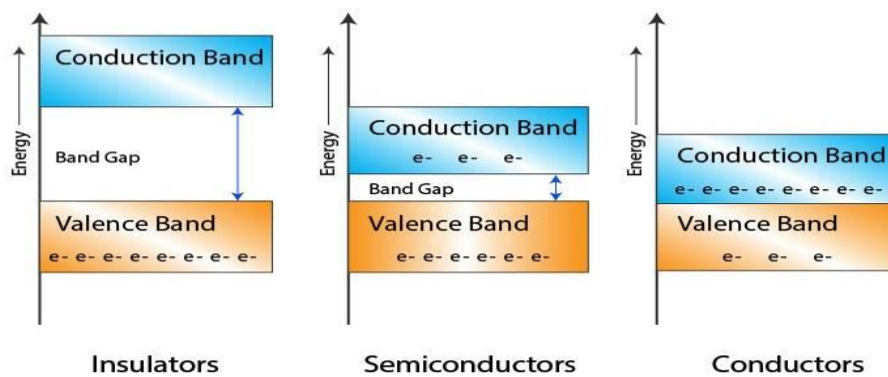
5.3. Wide and Ultra-Wide Band Gap Semiconductors

Silicon and other common materials have a bandgap in the order of 1 to 1.5 eV, which implies that such semiconductor devices can be controlled by relatively low voltages. However, they are as well more readily activated by thermal energy, which interferes with their proper operation. This limits silicon-based devices to operational temperatures below 100 °C. Wide-bandgap materials typically have bandgaps on the order of 2 to 4 eV, allowing them to operate at temperatures in the order of 300 °C. Melting temperatures, thermal expansion coefficients, and thermal conductivity are essential in processing, and these properties are related to the bonding in wide-bandgap materials.

Even as the WBG semiconductor materials continue to mature, on the horizon are the UWBG (ultra-wide-bandgap) semiconductor materials. These include AlGaN/AlN, diamond, Ga2O3 and others perhaps even not yet discovered, having bandgaps significantly wider than the 3.4 eV of GaN in the case of AlN as wide as ~6.0 eV. These UWBG materials have the potential for further far superior performance.

The high breakdown voltage of wide-bandgap semiconductors is a useful property in high-power applications that require large electric fields. Its robustness and ease of manufacture, silicon carbide semiconductors are expected to be creating simpler and higher efficiency charging for hybrid and all-electric vehicles, reducing energy loss, constructing longer-lasting solar and wind energy power converters, and eliminating bulky grid substation transformers. They have the potential to reinvent the electricity grid through new materials, devices, and architectures i.e. improve the manner in which electrical power is generated, transmitted, and consumed. Applications that are driving innovation in solid-state power conversion and control (i.e., power electronics) reach from transportation, renewable energy generation, energy storage, grid modernization (solid-state transformers and DC distribution), to electronic loads. The future electric grid must be adaptive, resilient, and reliable. A key for this is the substation-scale solid-state transformer, replacing today's traditional transformers, but also enable important additional functionality.

It is anticipated that employing UWBG semiconductor materials and devices, along with new magnetic and dielectric materials coupled through an electro-thermo-mechanical co-design approach, will allow compact and efficient solid-state transformers that can be integrated into a "substation in a suitcase", the key component enabling the next-generation flexible and resilient electric grid.

6. Communications

Having discussed this subject already in previous IDIMT sessions let us refrain to a short look at on recent developments in two prevailing technologies: fiber and wireless.

Fiber:

For the first time, an 800 Gigabit per second connection has been made over through a single optical fiber on a live fiber optic link. Using megahertz frequencies, current DSL technologies can achieve downstream transmission rates of up to 100 Mb/sec at a range of 500 meters, and more than 1 Gb/sec at shorter distances. (DSL signal quality often decreases over distance because of the limitations of phone lines; telephone companies can boost voice signals with small amplifiers called loading coils).The 800G should not be confused with the commonly-known 5G cellular service, where the "G" refers to the current generation of wireless technology. In fiber optics, the "G" indicates how many gigabits per second an individual cable can carry. For most long-haul routes today, 100G is standard.

Wireless:

The picture of satellites in space, with many of them used for wireless and soon using laser communication, or other purposes demonstrates an explosive development.

SciAm, Nov 2020

The picture also stress the need to cope with this wild growth and prevent a littering of the satellites space prevent the obvious upcoming problems.

7. Summary

We tried to peruse the impact of the Covid 19 pandemic on ICT and related areas as well as some of the correlated effects ranging from the economic management of the crises to the resilience of the ICT industry to enhancing effect on the acceptance and penetration of IT technology. The vision on emerging technologies and applications should have assisted to complete our tour d´horizon.

Presuing the Covid - ICT scenarion we cover a scenario reaching from

- Economic impact of Covid
- ICT industry and research in the pandemic period
- Emerging ICT technology enhanced applications
- Technology from more Moore to beyond Moore and over the horizon as
- (Photonics, Spintronics, new materials and metasurfaces)
- Colleteral developments as UWBG and
- New paradigms of computations Neuorocomputing / Memristor/Quantum

We addressed the requirement for response by administration and politics to the challenges in areas as "Tech-Giant´s monopolies", data protection, censorship and freedom of speech and ICT in space additionally to the challenges ICT existing before the COVID-19 crisis.

There has never been a period in history of such rapid advances in technological knowledge and thus resulting into a faszinating multifaceted scenario of the world we are going to live in.

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DIGITALIZATION AND INDUSTRY 4.0 – CHANGES IN CONCEPTS CAUSED BY COVID-19

INDUSTRY 4.0 - SELECTED TRENDS IN DIGITAL TRANSFORMATION

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Keywords

Information security threats, Digitalization, ICT penetration into business, ransomware

Abstract

The application of the Industry 4.0 concept in manufacturing companies as well as the gradual digitization of entire society come with new requirements both for the qualification of workers in the ICT sector and for the ICT knowledge and skills of others working in economies. In our article, we focused on trends in the informatization of society as well as on anticipated security threats. We used Eurostat databases as our data source and we analyzed the time series from 2009–2018. The data covered the V4 countries, along with Austria, Germany and Slovenia. The analysis was performed in the MS Excel environment. The results show that the number/share of workers in the ICT sector was growing during the analyzed time period, as was the contribution of the ICT sector to the GDP of individual countries. The analyzed technical trends show that artificial intelligence elements and the Internet of Things are being implemented in the economy relatively slowly. The main identified security risks mainly include the ability to purchase an attack on the data of a selected organization as a service on the dark net market.

1. Introduction

The globalization of society and the economy has various effects on the daily life of people as well as on the operation of companies and multinational corporations. One of the most prominent features, apart from the constant call for innovations (Weiß, Koelmel, Bulander 2016), is the penetration of information and communication technologies (ICT) into common processes (Basl, Doucek, 2012). We come across such terms as the fourth industrial revolution, known as Industry 4.0, quite regularly (Marik, 2016). Its concepts and implementation are the engine of today's ICT sector. In the Czech Republic in particular, we can see this trend in the automotive industry as well as in the production and distribution of different energies, i.e. utilities (Basl, 2019; Keidanren Japan Business Federation, 2018; Dutta, 2018; Suri et al., 2017). The building and implementation of the Industry 4.0 concept comes with a host of partial changes that significantly impact the actual switch to this concept (Maryska et al., 2019). One of them is the current Covid-19 pandemic. With the onset and so-far constant spread of the epidemic, the use of robots in risky places is gaining prominence in order to protect people's health (Basl, Doucek, 2021; Zgodavova, 2005). Robotization brings new unthought-of possibilities, but also a relatively significant risk of social instability. Social instability can manifest itself in two ways - a lower demand for less skilled workers (Webster, 1994) and thus a higher unemployment rate, which has an impact on the state's social nature as understood by the European Union, and in a higher demand for highly qualified

workers able to work with such robotic devices, to keep them running and to repair them, if necessary, as well as for professionals able to design, program and manufacture robotic devices. It will be necessary to start systematically training such professionals both at technical universities and at technical high schools. These are new challenges for the education system and the question is whether or not the education system is able to respond to such demands in the form of online learning.

To present the results of our research on the information society and its relationship to Industry 4.0, we focused mainly on selected trends concerning the following main topics:

- The penetration of ICT into the economy of the V4 countries;

- Security threats in 2021 and beyond.

Based on broader research on this issue, we have formulated slightly narrower research questions, which we will present in our article:

RQ1: What is the trend of penetration of information and communication technologies into the economy and society in the V4 countries, Austria and Germany?

RQ2: What are the major security threats in 2021?

The analyzed group of countries included the V4 countries (Visegrad Four), Austria, Germany and Slovenia.

2.   Data Collection and Methodology

For the two research questions, we used two different strategies of data collection and evaluation. To answer RQ1, we mainly used the databases of Eurostat and the Czech Statistical Office. To answer RQ2, we consulted literature focused on the latest IT security incidents, which also included monthly Situation Reports issued by the National Cyber and Information Security Agency (NCISA), which however cannot be cited because they are not a public source, as well as foreign sources that are cited in the article.

2.1.   Data collection and processing

To collect data for the first RQ, we mainly used the following Eurostat databases. For Paragraph 3.1.1 - the number of workers in the ICT sector, we used the database Eurostat, (2021a) i.e. its tables showing the number (share) of workers in the ICT sectors of the individual analyzed countries. The data concerning ICT Professionals can be found in two separate analyzed groups. The first group is the one we mention; the second group is the number of ICT Professionals in all sectors of the economy. However, the data for this group provided by some statistical offices of the countries and in Eurostat databases differ significantly (even by 10 percentage points in one year). Therefore, in this phase of our research, we did not use the classification of ICT Professionals based on ISCO codes due to inconsistency. We used it only for the Czech Republic because it provides a more accurate picture of the actual representation of ICT Professionals in the economy.

For Paragraph 3.1.2., i.e. the share of the ICT sector on total GDP, we used the database Eurostat (2021b).

For more information about the use of the Internet of Things, we used Eurostat's official sources and data from the end of January 2021. For the "Use of the Internet of Things" (IoT), we used the database Eurostat (2021c) and for the identification of obstacles to using the Internet of Things by individuals, we used the database Eurostat (2021d). Other data are not currently available; therefore, we cannot analyze the trend of the time series. The data we obtained from the aforesaid

databases concern companies with more than 10 employees outside the financial sector of the economy. The data show the situation in 2020.

The standard statistical and analytical functions (Kuncova, Sekničkova 2018) of MS Excel were used to analyze, to evaluate and to present the obtained data.

3. Results

The penetration of ICT into the economy is very closely connected with changes in the qualification structure of entire society. It in fact depends on the development of the ICT sector as one of the sectors of the economy as well as on the development of ICT knowledge, skills and education in other sectors of the economy. In our trend analysis, we focused mainly on:

- The share of workers in the ICT sector on the total employment of the analyzed countries;
- The share of the ICT sector on the GDP of each country;
- The share of use of artificial intelligence in companies;
- The share of use of 3 D printing;
- The share of use of IoT technology by individuals and the identification of the main obstacles to using this technology;
- Security trends and the expected trends of security threats in 2021 and 2022.

As we have already mentioned in the methodological section, we analyzed the V4 countries (Visegrad Four), Austria, Germany and Slovenia.

3.1. Penetration of IT into the Business

RQ1: What is the trend of penetration of information and communication technologies into the economy and society in the V4 countries, Austria and Germany?

In this section, we present the results that mainly concern the following indicators:

- The share of workers in the ICT sector on the total employment of the analyzed countries;
- The share of the ICT sector on the GDP of each country;
- The share of use of artificial intelligence in companies;
- The share of use of 3D printing;
- The share of use of IoT technology by individuals and the identification of the main obstacles to using this technology.

3.1.1. Percentage of the ICT Sector on Total Employment

Fig. 1 shows the trend of the share of workers in the ICT sectors of the analyzed countries.
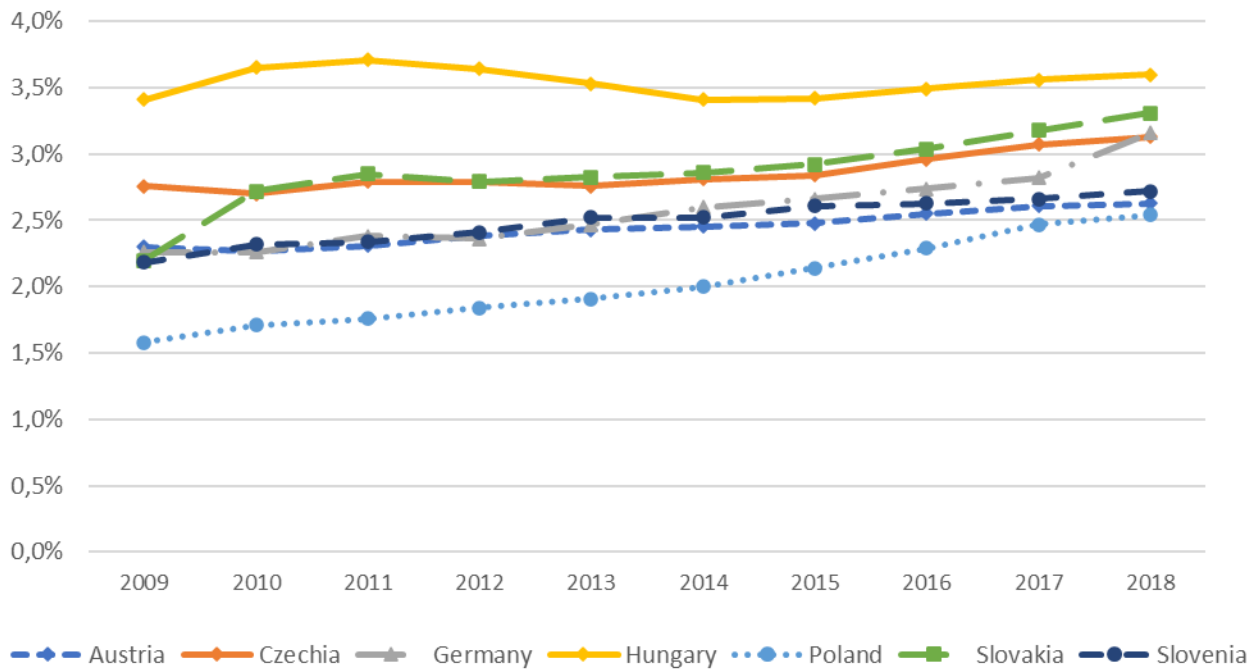
Fig. 1: Percentage of the ICT Sector on Total Employment, (Eurostat, 2021a)

Fig. 1 clearly shows that Hungary had the largest share of workers in the ICT sector on total employment during the entire analyzed time period - it oscillates around 3.5% during the entire analyzed time period (it was 3.6% in 2018). Other countries do not show such a large share of the ICT sector on total employment, yet they show a constant upward trend. In particular, Poland is very successful in this respect; its share of workers in the ICT sector on total employment went up by almost one percentage point during the analyzed decade - from about 1.58% to 2.54%. This trend clearly indicates a growing share of the number of workers in the ICT sector. In addition to analyzing the number/share of workers in the ICT sector, it is also useful to look at its structure. By this we mean that the ICT industry consists of three basic parts - production, services and trade. Due to the limited scope of this article, we do not provide this analysis here, but it will be presented at conferences.

3.1.2. Impact on GDP

Another relatively important indicator is the impact of the ICT sector on the GDP of individual countries, i.e. the contribution of the ICT sector to GDP. The trend of this indicator is shown in Fig. 2.

Here again we can see that the largest contribution of the ICT sector to GDP was in Hungary - about 6% in 2018 (5.95%). The other countries then split into two groups. The first group includes the Czech Republic, Germany and Slovakia. The contribution of the ICT sector of these countries to GDP exceeds 4% (Czech Republic 4.56%, Germany 4.40% and Slovakia 4.12%). The second group includes Austria, Poland and Slovenia; they all show a 3.6% contribution of their ICT sector to GDP in 2018. Austria and especially Poland are showing a growing trend.
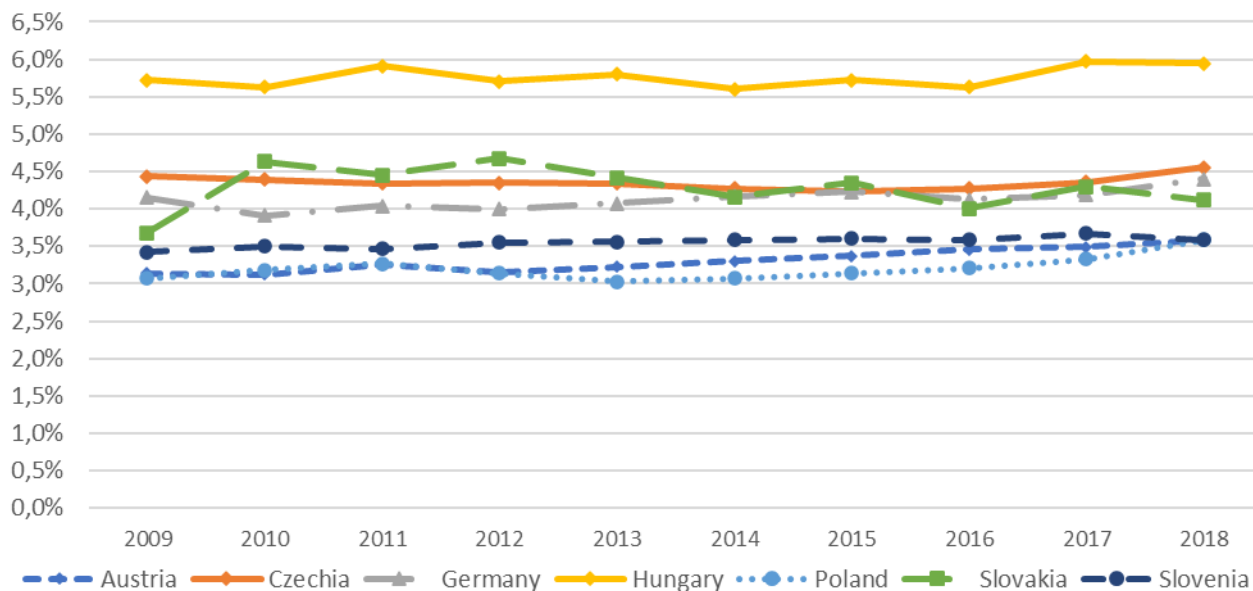
Fig. 2. Percentage of the ICT Sector on GDP, (Eurostat, 2021b)

3.1.3. Areas of further implementation of modern technologies

We chose two technologies and analyzed their implementation. First, we focused on the implementation of artificial intelligence elements in industrial enterprises.

Artificial Intelligence

Although visionaries have been talking about Industry 4.0 for almost a decade, its actual implementation in the form of artificial intelligence is relatively slow and the progress between 2018 and 2020 is rather negligible. We also made a similar comparison with the implementation of robots in the manufacturing industry (Basl, Doucek, 2021). Here, too, the results were rather sad (they will be presented at a conference).

Tab. 1: Using of Artificial Intelligence (% of companies)

Country	2018	2020
Austria	2	2
Czechia	1	2
Germany	2	2
Hungary	1	1
Poland	2	2
Slovakia	2	3
Slovenia	1	1

(Eurostat, 2021e)

The Internet of Things and its application by regular users in households and for home use is another area that we focused on.

3D Printing

The data we have in the field of 3D printing are according to a Eurostat source (Eurostat, 2021f) and are for companies that have more than 10 employees and are not included in the financial sector. Table 2 shows a really marginal increase in this technology and its use last two years. Surprisingly, in 2020 in the Czech Republic, there was a massive development in the printing of protective equipment (especially protective shields) in connection with the Covid 19 epidemic.

Tab. 2: 3D printing (% of companies)

TIME	2018	2020
Austria	4	5
Czechia	4	6
Germany	5	7
Hungary	2	3
Poland	2	3
Slovakia	3	4
Slovenia	4	5

(Eurostat, 2021f)

The real reason for the very small increase in this statistical category may be the fact that universities have been significantly involved in the production of protective equipment, especially technical universities with 3D Print laboratories or very small companies with very low number of employees. I will present the details of this sector in my presentation at conferences, because there is a very limited space in proceeding book.

Internet of Things

The Internet of Things and its conceptual implementation in practice, together with the possibilities of transferring data to private or public databases, the processing of Big Data and other services associated with its operation, has been known for many years. However, the actual implementation is rather low as shown in Tab. 3.

Analysis of Internet of Things

Applications that remotely control household appliances are the most frequently used; in the Czech Republic, it is mostly the tracking of the movement of cars, products and shipments. The share in the Czech Republic is significantly influenced by the automotive industry and related deliveries using the Kanban method. Austria, on the other hand, has the most users of IoT applications in their household. Apps in mobile phones are helping to increase the use of IoT applications, especially for tracking objects.

However, new IoT applications actually come with some obstacles to their use. The reasons why individuals did not use new IoT technologies are listed in Tab. 4.

<div align="center">Tab. 3: The use of the Internet of Things by individuals (% in population)</div>

	Use interconnected devices or systems that can be monitored or remotely controlled via the internet (Internet of Things)	Use smart meters, smart lamps, smart thermostats to optimize energy consumption in the enterprise's premises	Use sensors, RFID or IP tags or internet-controlled cameras to improve customer service, monitor customers' activities or offer them a personalized shopping experience	Use movement or maintenance sensors to track the movement of vehicles or products, to offer condition-based maintenance of vehicles	Use sensors or RFID tags to monitor or automate production processes, to manage logistics, to track the movement of products	Use other Internet of Things devices or systems (than E_IOTDEC, E_IOTDCUS, E_IOTDMTN, E_IOTDPRD)	Use two or more Internet of Things devices or systems
Austria	32	19	5	11	6	6	28
Czechia	N/A:	12	3	22	19	2	11
Germany	N/A:	N/A:	N/A:	N/A:	N/A:	N/A:	N/A:
Hungary	14	3	6	8	1	3	5
Poland	17	5	4	13	2	4	6
Slovakia	17	6	8	9	3	5	8
Slovenia	17	8	0	5	7	6	6

<div align="center">**Eurostat (2021c)**</div>

Note to Tab. 3: Data for Germany are not available.

<div align="center">Tab. 4: Reasons for not using IoT by individuals (% in population)</div>

	Didn't know such devices or systems exist	No need to use those connected devices or systems	Costs too high	Lack of compatibility with other devices or systems	Lack of skills to use those devices or systems	Concerns about the privacy and protection of personal data generated by those devices or systems	Concerns about security	Concerns about safety or health	Other reasons
Austria	4	53	8	10	11	31	27	8	4
Czechia	5	60	9	1	4	1	2	0	5
Germany	1	60	12	1	11	25	20	6	1
Hungary	3	62	5	3	4	2	2	1	3
Poland	5	56	8	5	4	1	1	1	6
Slovakia	11	28	14	6	8	4	3	2	23
Slovenia	25	26	6	1	2	3	2	1	3

<div align="center">**Eurostat (2021d)**</div>

This table is very interesting in terms of evaluation. In essence, it divides the countries into more conservative and innovative based on various criteria. Awareness of IoT-type technologies is an obstacle to their proliferation in Slovenia and Slovakia, yet the population in these two countries feels the need to use such applications. The cost of IoT solutions in households is the biggest obstacle in Slovakia and Germany. Compatibility with other devices and lack of knowledge of how

to operate these devices is not a significant obstacle in any country. The protection of personal data, privacy and health is a very interesting aspect. In this respect, the population of Austria and Germany is highly cautious and conservative, while the population of other analyzed countries is not too bothered by this aspect. One of the factors leading to this conclusion is a low security awareness of the average population of the countries such as the Czech Republic, Hungary, Poland, Slovakia and Slovenia. Another factor may be enthusiasm for IoT applications among people who are optimistic and do not anticipate any security and privacy protection problems.

And now we are getting to the next main topic, i.e. information security trends and how security threats work today.

3.2. **Identified Security Trends**

The penetration of information and communication technologies into economic life is one of the stable features, and the Covid-19 epidemic has significantly accelerated this trend. But the satisfaction with the use of ICT in our everyday life also has its downside, which is the trustworthiness of operations that take place in cyberspace. How can we be sure that someone is not modifying information or is not sending us only some selected part of it? In this respect, we need to think about ICT security and the implementation of security countermeasures.

While reading the NCISA's materials, we came across a very interesting conclusion, which is that as the penetration of ICT into different sectors is increasing, so is the motivation of hackers to attack their information systems. Hackers are recruited from groups that are directly supported by state structures as well as from organized groups of hackers who are hired to attack selected information systems, based on the requests of their clients or the profitability of such an attack. Hacking has thus become a service, a well-paid service.

Business model of attacks

The trend of computer system attacks, both directly in organizations or in cyberspace, has recently changed in terms of the actual hackers and the choice of their targets. In the last decade, we could see groups of more or less advanced hackers who used their own tools and favorite methods, thanks to which it was possible to partly link the attacks to their perpetrators. As an example, we could use FireEye's report identifying the ATP41 (FireEye, Inc., 2021) group, also known as "Double Dragon." This group had or used specific software tools to overcome and use organizations' security measures. This left a unique digital footprint behind.

Ransomware

However, the current trend of attacks on organizations and their assets reveals a new business model, which in fact is the same as the sale of regular ICT services. It is possible to purchase ransomware frameworks on the dark net market in the form of software as a service (SaaS). Currently the most popular SaaS ransomware tools include the "REvil" tool, also known as "Sodinokibi." The group that developed this software is known for recruiting partners who, either alone or in collaboration with the group, carry out attacks on organizations. Once the ransom is paid, the hackers split the profit (Schwartz, 2021). This framework can be used for mass phishing attacks and also as part of exploitation tools that exploit known vulnerabilities to promote a malicious code, e.g. CVE-2019-2725 Oracle's WebLogic remote code execution (Oracle, 2021). "REvil" was first intercepted in April 2019 and analyzed by the security solution and service provider McAfee (McAfee Labs., 2019). Using a reverse analysis of the malicious code, the researchers discovered the link between the REvil group and the GandCrab group that operated Ransomware-as-a-Service portal from January 2018 to June 2019 and ceased its activity after having extorted about 150 million USD (Bradbury, 2019). For its needs, "REvil" adopted the Maze

ransomware group's tactic of exfiltrating data and threatening to publish them unless the victim pays a ransom.

Simplified market access to the tools specifically designed for cybercrime thus opens an imaginary door to criminal groups without major technical knowledge or expensive technical equipment to create good-quality tools and necessary infrastructure. They focus on so-called soft - less protected - targets. Ransomware groups target organizations where they expect the level of information infrastructure security to be lower than that in global technological or business-oriented large/multinational corporations. These soft targets for cyber-attacks include, in particular, healthcare organizations and educational institutions.

The first mass ransomware attack on hospitals was recorded in 2017 during the WannaCry (Brandom, 2017) infection. However, in this case, it was probably not a targeted attack, but rather a poorly handled vulnerability of CVE-2017-0144 (NIST, 2018). However, the same cannot be said about a series of attacks on Czech hospitals between 2019 and 2020, when the hospital in Benešov was infected with "Ryuk" and the University Hospital in Brno-Bohunice with the crypto-virus "Defray." On the other hand, the hospitals in Ostrava and Olomouc were able to successfully protect themselves against similar attacks.

The academic world and its organizations have been infected with ransomware practically all over the world, e.g. Universität Giessen (Ryuk) and the Dutch Universität Maastricht (Clop). This university paid 30 BTC to regain access to its data (Bannister, 2020). The attacks did not spare American universities either. Michigan State University was attacked in June 2020 by NetWalker ransomware.

Supply Chain Compromise

While ransomware attacks organizations' vulnerable infrastructures or, through phishing, end users, "Supply Chain Compromise" attacks use legitimate software to promote a malicious code modified by the hacker once the hacker has successfully compromised the infrastructure of the application development team.

The logic of this attack is that the organization developing a particular application is hacked and the malicious code is integrated in, and distributed together with, the application. The maliciousness of this type of attack lies in the fact that the hacked organization buys and installs the infected application as part of routine updates or installation of already used software.

Such a modified application communicates with the hacker's control infrastructure and waits after the basic identification of the organization where it parasitizes until the hacker decides to continue with the attack or decides that the organization is not attractive enough in terms of know-how, finances or data.

In this category of attacks, the most discussed attack on service providers was the attack that compromised the American company SolarWinds and modified its IT infrastructure monitoring and cataloging tools that are used by more than 300,000 clients worldwide, including government agencies and organizations.

4. Conclusions

Based on our findings, we have reached the following answers resulting from the aforesaid facts.

RQ1: What is the trend of penetration of information and communication technologies into the economy?

The identified trends are divided into two main areas. The first of them is the impact of the ICT sector on the economies of the analyzed countries. We can say that the number/share of workers in the ICT sector on total workforce is growing in the vast majority of the analyzed countries and so is the contribution of the ICT sector to GDP.

Technological trends of applying the most promoted technologies, such as artificial intelligence and IoT solutions, do not show such results. There is no detailed time series that could be analyzed. We could only use data from 2020 because statistical offices are relatively inflexible in their surveys and it is not easy to start a new survey in EU Member States, although the applications have already been used for some time. It turns out that artificial intelligence has been hardly used in the analyzed EU Member States. The expansion of IoT applications, the concept of which has been known for a very long time, is rather insignificant as well. It mainly concerns sensor-based remote control of devices. The fact that users in the majority of the analyzed countries do not feel the need for such solutions represents one of the main obstacles to using IoT. The protection of personal data, the protection of privacy and the protection of health against exposure to radio frequency is very interesting. Austria and Germany are significantly conservative countries in this case, while other countries have a more optimistic approach to IoT applications. They do not pay much attention to this issue and therefore do not consider it a threat to the development of IoT applications.

RQ2: What are the major security threats in 2021?

The hacking of ordinary commercial organizations and public administration organizations have lately become the line of "business" of hacker groups. On the dark net, we can see hackers or hacker groups offer an attack of a specific firm or company in order to enrich themselves by the "sale" or reconstruction of destroyed or encrypted data.

In addition, there are other groups of hacker attacks that are organized for the purposes of industrial espionage. These groups are sometimes organized on the basis of state institutions or work for competing businesses.

In 2021 and 2022, hackers will attack organizations that, in their opinion, have no professional protection. These are mainly organizations such as hospitals, universities, small companies, etc., which, however, represent an attractive target because hackers hope to extort and transfer money to their account.

Large companies will also be attacked in order to compromise their security and to gain a competitive advantage. A typical example is an attempted attack of Pfizer at the beginning of 2021 to obtain information about the Covid-19 vaccine.

5. Acknowledgement

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THE IMPACT OF ICT ON THE CZECH ECONOMY IN THE TIME OF COVID-19: FLASH ESTIMATE FOR 2020

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ICT impact, covid-19, gross value added, employment, index decomposition

Abstract

Our paper aims to analyse the direct ICT impact on the most important economic indicators in time of covid-19 pandemia. We present a very early and preliminary estimate of ICT impact, based on the data available just three and half months after the reference year. Despite the data constraints, there are some relevant results. The ICT industry reduced the fall in gross value added and employment, the share of the ICT industry on employment increased by 0.3 p.p. (i. e. 10%). The average hourly wage of employees increased similarly in ICT compared to the whole economy, while the average monthly wage increase differs between ICT and the whole economy. The results should be verified and improved using additional data sources available in the following months and years.

1. Introduction

Several papers examined the impact of the Information and Communication (ICT) sector on the economy. Fischer and Vltavská (2011) analysed the direct impact of the ICT sector using the data from national accounts and compared some critical indicators of the ICT sector to the indicators of the total economy. They strongly recommended distinguishing between ICT Manufacturing and ICT Services. Direct impact measures the contribution of ICT to production, gross value added and employment. It is a simplification of reality. For complex evaluation of ICT impact, it is also necessary to consider an indirect impact (Pilat and Wölfl, 2004, Fischer and Vltavská, 2012), which expresses the role of ICT goods and services as intermediaries. Nevertheless, the direct impact could be estimated much earlier than the indirect impact: the indirect impact estimate; we need the detailed structure of the economic flows.

Indeed, many more complex papers use a more complex approach to the ICT impact analysis, especially the advanced econometric approach (Hančlová et al., 2015). From another point of view, the impact of ICT could be considered within the context of Industry 4.0, with the analysis on economic, social and environmental aspects (Doucek and Hološka, 2019). Furthermore, Maryška et al. (2012) analysed the broader ICT impact, taking into account the effects on education.

The definition of the ICT sector (Fischer, Vltavská 2011) is sophisticated. ICT sector consists of several industries defined at the detailed (3-digit) level of the classification NACE, both from the manufacturing and services.

This paper aims to analyse the direct impact of the ICT industry on the Czech economy in the first calendar year of covid-19 pandemia (2020). The analysis is instead a flash estimate. As we estimate the impact of ICT for the calendar year 2020 already in spring 2021, we use very preliminary data not recommended for deep analyses. Furthermore, these preliminary data are not available in a detailed structure by the 3-digit level of the NACE classification. Thus, we consider the ICT industry in this paper as a J section of NACE. It means that we do not include ICT Manufacturing (Computer machinery, etc.), and we consider ICT services. Due to the data availability constraints, we analyse the ICT impact on gross value added, employment, labour productivity and average wage.

There are some obstacles if we compare the ICT impact on economy among countries. Colecchia and Schreyer (2002) and van Ark et al. (2002) recommend to take into account different approaches to price adjustments. According to OECD (2004), countries which use hedonic price indices for computer equipment tend to show faster declines in ICT prices and more rapid growth in real terms[4].

The paper is divided as follows. Chapter 2 explains data that are available four months after the end of the reference year. In the same chapter, we also present the methodology based on the index decomposition. Chapter 3 brings the key results, which are briefly discussed in chapter 4.

2. Data and Methodology

2.1. Data

In spring 2021, about 110 calendar days after the reference period, limited data sources from the national accounts are available for the last reference year. We do not have data from annual surveys but just the data from quarterly national accounts. Using quarterly data implies limited interpretation strength of the results.

For our analysis, we use the data from quarterly time series[5]: supply side of GDP, nominal wages and salaries and different data on employment. One can see a selection from the original data in tables 1 to 4.

In table 1, we present data on gross value added (GVA). This indicator is close to the gross domestic product (GDP), but it is better for an industrial analysis as indirect taxes like VAT do not influence it. GVA decreased by 5.4% year-on-year (hereafter: y-o-y) based, while the GVA in the ICT industry increased by 1.5%.

Employment can be measured as a number of persons or as a number of hours worked. The first approach is more accurate; the second one is more reliable. Furthermore, we can estimate total employment (employees + self-employed) or just the employees. For the analysis of labour productivity, we use total employment (self-employed persons also contribute to the economic output like GVA). We use just employees (self-employed do not receive wages, but the so-called mixed-income) for the wage analysis. In table 2, we can see the total employment in the whole economy (y-o-y decrease of 5.8%) and the ICT (3.4% increase). Y-o-y change in the number of employees (table 3) is not so sharp due to the labour rigidities and the job support from the government.

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[4] OECD (2004), p 48.

[5] https://www.czso.cz/csu/czso/hdp_ts

Table 1 Gross value added, chain-linked volumes (constant prices) of 2015, millions of CZK

	GVA Total 2019	GVA Total 2020	GVA 2020/2019	GVA ICT 2019	GVA ICT 2020	GVA ICT 2020/2019
Q1	1,121,157	1,110,132	**99.0**	67,385	69,176	**102.7**
Q2	1,197,792	1,068,127	**89.2**	66,195	67,928	**102.6**
Q3	1,210,698	1,149,612	**95.0**	65,320	65,513	**100.3**
Q4	1,215,652	1,162,375	**95.6**	78,372	78,944	**100.7**
Total	**4,745,299**	**4,490,246**	**94.6**	**277,272**	**281,561**	**101.5**

Source: CZSO. Table hdpcr040121_z.

Table 2 Total employment (thousand hours worked HW)

	HW Total 2019	HW Total 2020	HW Total 2020/2019	HW ICT 2019	HW ICT 2020	HW ICT 2020/2019
Q1	2,498,797	2,401,579	**96.1**	76,236	80,634	**105.8**
Q2	2,512,835	2,245,338	**89.4**	75,867	77,071	**101.6**
Q3	2,310,618	2,276,437	**98.5**	69,637	73,727	**105.9**
Q4	2,365,775	2,198,072	**92.9**	75,175	75,725	**100.7**
Total	**9,688,025**	**9,121,426**	**94.2**	**296,915**	**307,157**	**103.4**

Source: CZSO. Table hdpcr040121_h.

Table 3 Number of employees (E)

	E Total 2019	E Total 2020	E Total 2020/2019	E ICT 2019	E ICT 2020	E ICT 2020/2019
Q1	4,663,496	4,644,741	**99.6**	139,359	143,735	**103.1**
Q2	4,660,014	4,566,351	**98.0**	139,067	140,687	**101.2**
Q3	4,679,580	4,608,962	**98.5**	141,588	143,662	**101.5**
Q4	4,689,702	4,589,719	**97.9**	146,745	147,272	**100.4**
Average	**4,673,198**	**4,602,443**	**98.5**	**141,690**	**143,839**	**101.5**

Source: CZSO. Table hdpcr040121_p.

The total amount of wages and salaries (table 4) paid to the employees remained unchanged in 2020 compared to the previous year. In ICT, one can see an 8.1% y-o-y increase.

Table 4 Total amount of wages and salaries (WS), CZK millions

	WS Total 2019	WS Total 2020	WS Total 2020/2019	WS ICT 2019	WS ICT 2020	WS ICT 2020/2019
Q1	468,242	487,100	**104.0**	25,567	28,200	**110.3**
Q2	489,807	458,473	**93.6**	25,084	26,293	**104.8**
Q3	486,129	492,421	**101.3**	24,961	27,187	**108.9**
Q4	521,150	528,107	**101.3**	26,221	28,395	**108.3**
Total	**1,965,328**	**1,966,101**	**100.0**	**101,833**	**110,075**	**108.1**

Source: CZSO. Table hdpcr040121_m

2.2. Methodology

Firstly, we can compute the valuable but straightforward indicators:

- labour productivity as the GVA in constant prices to the total number of hours worked,
- average hourly wages as a ratio of nominal wages and salaries to the hours worked of employees,

- average monthly wages as a ratio of nominal wages and salaries to the number of employees,
- share of hours worked by employees on the total hours worked,
- share of ICT on total gross value added and total hours worked.

Secondly, we will move to the more advanced indicators that could be used to examine ICT impact. For different types of statistical indicators, there is a different approach to the analysis. **For indicators of quantity**, we use the simple analysis of the contribution to growth: we can compute the direct impact of ICT to the change of the gross value added according to equation.

$$CTG_{ICT} = \left(\frac{GVA_{ICT,t} - GVA_{ICT,t-1}}{\sum GVA_{t-1}} - 1 \right) \cdot 100$$

A similar equation is used for computing contribution to the growth of employment.

For level indicators (indicators of intensity), we have to compute the contribution more sophisticatedly. It is necessary to decompose the effect of a given industry between the level effect and the substitution effect. Detailed methodology of level effect and substitution effect decomposition is described in detail by Fischer, Flusková and Vltavská (2020), comparing the approaches of Datt-Ravallion (1992) and Shorrocks (2013).

3. Results

One can see that the hourly labour productivity is almost twice in ICT comparing to the total economy (table 5). We have to remind you that we use just ICT services due to data availability. ICT manufacturing has much lower labour productivity comparing to ICT services (Fischer and Vltavská, 2011). On the other hand, there was a slight y-o-y decrease in ICT labour productivity (–1.8%) while the total labour productivity remained unchanged (+0.5%).

Table 5 Hourly labour productivity (GVA per total employment of hours worked), CZK

	LP Total 2019	LP Total 2020	LP Total 2020/2019	LP ICT 2019	LP ICT 2020	LP ICT 2020/2019
Q1	449	462	**103.0**	884	858	**97.1**
Q2	477	476	**99.8**	873	881	**101.0**
Q3	524	505	**96.4**	938	889	**94.7**
Q4	514	529	**102.9**	1,043	1,043	**100.0**
Total	**490**	**492**	**100.5**	**934**	**917**	**98.2**

Source: Own computations from Table 1 and Table 2.

It is not possible to directly compare labour productivity to the average hourly wages. As we said, labour productivity is based on the GVA and the total employment, while the average wage is based on the employees only. Nevertheless, wages in ICT are significantly higher compared to the total economy (see table 6). Although covid-19 influenced some industries, the development of the average hourly wage is similar (+6.2% in ICT compared to +5.7% in the total economy).

Table 6 Average hourly wage of employees (AHW), CZK

	AHW Total 2019	AHW Total 2020	AHW 2020/2019	AHW ICT 2019	AHW ICT 2020	AHW ICT 2020/2019
Q1	222	239	**107.8**	392	413	**105.4**
Q2	231	239	**103.6**	386	404	**104.5**
Q3	252	260	**102.9**	420	440	**105.0**
Q4	261	283	**108.2**	401	440	**109.8**

Total	**241**	**255**	**105.7**	**399**	**424**	**106.2**

However, the situation differs when we compare the development of average monthly wages (table 7). They do not take into account the average hours worked per employee. While the average monthly wage increased by 1.6% in the total economy, the ICT average monthly wage increase by 6.5%. We will analyse the contribution of ICT to the total average wage at the end of this chapter.

Table 8 presents data on the share of employees on total employment (self-employed comprised the rest). The share of employees in ICT is similar to the whole economy what falsifies the hypothesis of a too high share of self-employed persons in ICT due to the so-called Svarc System[6]). There is a significant impact of covid-19 pandemia on the share of hours worked by neither the self-employed nor the employees.

Table 7 Average monthly wages, CZK

	AMW Total 2019	AMW Total 2020	AMW 2020/2019	AMW ICT 2019	AMW ICT 2020	AMW ICT 2020/2019
Q1	33,469	34,957	**104.4**	61,154	65,398	**106.9**
Q2	35,036	33,467	**95.5**	60,124	62,297	**103.6**
Q3	34,628	35,613	**102.8**	58,764	63,081	**107.3**
Q4	37,042	38,354	**103.5**	59,561	64,269	**107.9**
Total	**35,046**	**35,599**	**101.6**	**59,892**	**63,772**	**106.5**

Table 8 Share of hours worked by employees on the total hours worked

	HWE/HW Total 2019	HWE/HW Total 2020	HWE/HW 20/19	HWE/HW ICT 2019	HWE/HW ICT 2020	HWE/HW ICT 20/19
Q1	0.8457	0.8489	**100.4**	0.8556	0.8463	**98.9**
Q2	0.8442	0.8534	**101.1**	0.8556	0.8445	**98.7**
Q3	0.8334	0.8331	**100.0**	0.8544	0.8374	**98.0**
Q4	0.8437	0.8501	**100.8**	0.8701	0.8518	**97.9**
Total	**0.8419**	**0.8463**	**100.5**	**0.8590**	**0.8450**	**98.4**

In table 9, one can see the increasing share of ICT on the economy in the time of covid-19 pandemia. The share of ICT on gross value added y-o-y increased by 0.43 p.p. while the share of employment increased by 0.30 p.p. measured by the hours worked (it means almost 10% increase).

Table 9 Share of ICT on total gross value added and on total hours worked

	GVA ICT on Total 2019	GVA ICT on Total 2020	Diff (p.p.)	HW ICT on Total 2019	HW ICT on Total 2020	Diff (p.p.)
Q1	6.010	6.231	**0.221**	3.051	3.358	**0.307**
Q2	5.526	6.360	**0.833**	3.019	3.432	**0.413**
Q3	5.395	5.699	**0.303**	3.014	3.239	**0.225**
Q4	6.447	6.792	**0.345**	3.178	3.445	**0.267**
Total	**5.843**	**6.271**	**0.427**	**3.065**	**3.367**	**0.303**

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[6] https://cs.wikipedia.org/wiki/%C5%A0varc_syst%C3%A9m; text in Czech only.

Although the development of hours worked differs between ICT and the total economy (–5.8% vs +3.4%), the contribution of ICT to the change of total employment was just at the level of 0.1 p.p. (table 10). The reason is that the share of ICT in the economy is small, at about 3% of the employment (table 9).

Table 10 Contribution of ICT to variation in GVA and employment (p.p.)

	Total change (%)	Contribution of ICT (p.p.)
Gross value added	–5.4	+0.090
Total employment (HW)	–5.8	+0.106

<p align="center">Source: Own computations.</p>

In table 11, we decompose the development of the average wage. The total average wage increased by 1.58%, increase in ICT average wages contributed by 0.34%, increase in non-ICT wages by 1.16% (both are the level effects), and the rest (0.07%) could be explained by the change in the structure of employment (substitution effect). One can see that changes in ICT wages (we remind that this industry makes only 3% of the total employment) contributes by 21.5% to the change of the average wage of the whole economy.

Table 11 Contribution of ICT to variation in monthly average wage (%)

Effect	Impact (%)
Monthly average wage development in ICT	+0.34
Monthly average wage development in non-ICT	+1.16
Change in the structure of employment (ICT vs non-ICT)	+0.07
Total change in monthly average wage	**+1.58**

<p align="center">Source: own computations.</p>

4. Discussion

We present the very first flash estimate of the ICT impact on key economic indicators. The interpretation strength is limited because no data from annual sources are available for this early analysis. The estimates are not fully comparable to our previous research in this area as we consider ICT Industry in this paper differs from the ICT Sector (Fischer and Vltavská, 2011). Indirect impacts of ICT on the economy cannot be early measured at all. There are some other interpretation obstacles due to the measurement constraints: for example, the short-term statistics and the quarterly national accounts are based on some crucial assumptions. One of the basic assumptions is that the economy's structure remains stable in a short period. As we see in our tables, the validity of this assumption is a question.

5. Conclusion

Covid-19 pandemia brings many challenges for the economic analysts and also for the data measurement. In this paper, we try to present a very early and preliminary analysis of the ICT impact on the economy when the government restrictions influence the economy.

Gross value added in ICT increased by 1.5% in 2020 (y-o-y based), while the total GVA felt 5.4%. Similarly, hours worked in ICT increased by 3.4%, the total employment fell by 5.8%. Development in a number of employees was smoother. The total amount of wages and salaries increased by 8.1% in ICT while remained stable in the total economy. There was a pretty surprising development in hourly labour productivity. Hourly wages of employees increased similarly in ICT

and the economy (6.2% and 5.7%, respectively). Monthly wages increased more in ICT (6.5% to 1.6%). Share of ICT on total GVA and total development sharply increased (0.43 p.p. and 0.30 p.p., respectively). ICT industry reduced the fall of total GVA and employment by about 0.1 p.p.). Total change in average wage (+1.58%) is explained by the wage development in ICT (+0.34%), wage development in non-ICT (+1.16%) and the structure of employment (ICT vs non-ICT; +0.07%).

We plan to improve and refine the analysis using additional data on the year 2020, available in the following months and years. There will be challenging to analyse indirect ICT impact in the time of structural changes.

6. Acknowledgement

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USE OF ROBOTIC PROCESS AUTOMATION TOOLS DURING AND AFTER COVID-19 PANDEMIC FROM THE INDUSTRY PERSPECTIVE: LITERATURE REVIEW

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robotic process automation, RPA, COVID-19, pandemic, coronavirus, business continuity, employment

Abstract

Main purpose of this article is to provide an overview of how Robotic Process Automation (RPA) tools were used during and after COVID-19 pandemic in different industries. This article is based of literature review which consist not only from journal articles but with regards to the dynamics of COVID-19 pandemic also from blogs and general internet articles. Although use of RPA tools is boosted by COVID-19 pandemics in majority of industries, some of them are badly affected by the pandemics and RPA implementation can be postponed.

1. Introduction

Every crisis or economic recession usually brings an increase of pressure to work efficiency, so companies are not being able to sell their products or services at the volume and price they used to be. In connection with the pandemic of the COVID-19 disease, unprecedented government restrictions have taken place, which have resulted in a partial freeze of the economy and citizens movement. Companies were forced to react in a very short time and implement a number of steps (Srivastava, 2020), (Kedziora, 2020). Work from home was introduced in a large scale. Not all industries were negatively affected by this situation, like online stores, which have experienced a sharp increase of demand. Here, too, it is possible to see the increase of pressure to work efficiency (Field and Murphy, 2020). This article is devoted to creating an overview of how companies in different industries have used RPA technology to overcome this crisis period and how they are preparing for the future.

2. Results of the RPA overview

2.1. RPA solution providers view

RPA solution providers have been actively involved in solving problems in both the public and private sectors. For example, the leading RPA provider UIPath has actively offered its know-how to the public sector institutions (Vellante, 2020). It seems that RPA providers are trying to act fast to broaden their customer base and build loyalty. According to UIPath, there are multiple ways how to

use RPA to solve the pandemic situation in healthcare, or how to streamline the administration associated with it and thus enable healthcare professionals to treat patients and not work in the administration (McDaniel, 2020):

1. Reduce patient administration time,

2. Automating the communication of test results,

3. Central processing of COVID-19 disease statistics for individual countries,

4. Ordering and administration of medical devices (masks, suits, shields etc.).

The Belgian government created a web application through which local entrepreneurs could apply for financial support to overcome the consequences of a pandemic and the economy lockdown. In an effort to process requests as quickly as possible, the entire system was overwhelmed. At one time, it was necessary to serve up to 800 users of the web application at once. Due to this, numerous queuing requests arose, which had to be processed one after another. As a result, the whole process was critically delayed. They subsequently created an UIPath RPA robot to help optimize the waiting time by verifying the eligibility of the applicant for financial support in several systems. (UiPath, 2020).

Chris Klayko from the US banking environment describes a similar situation. RPA robots helped banks to address the blast in processing SME applications for government-secured loans. Their processing is guaranteed by the Small Business Administration (SBA). The creation of the robot took less than 24 hours and thanks to him, the processing time of the application was reduced from 30 minutes to only 3 minutes. (Klayko, 2020).

2.2. Companies view related to the COVID-19 period

According to Bant, companies had to react very quickly as they have less stuff operating key processes but increasing cost pressure. That leads to escalating of putting robots to their processes and involving smarter technologies quicker than ever (Gartner, 2020).

From the point of view of companies that use RPA, the situation can be analyzed from these perspectives:

1. Replacement of an employee performing routine office activities who cannot arrive to work due to unplanned reasons (Srivastava, 2020). These reasons may be, for example, forced personal quarantine or restrictions on the whole population.

2. Reducing the number of human labor while maintaining the company's performance or increasing its flexibility in case of sudden changes in demand (Srivastava, 2020).

3. Quick adaption on new situations.

Leduc and Liu from the Federal Bank of San Francisco created a macroeconomic analysis of the impact of COVID-19 according to the DSGE model on job threats and automation. They concluded that the response to the COVID-19 pandemic had caused unprecedented interference in the economy in general, but also in the perspective of employees. Without an existing vaccine, employees remain potentially vulnerable to the virus, creating uncertainty and preventing them from performing work in the usual quality and volume. This invokes the acceleration of the deployment of robots, as they are not threatened by any disease and can perform health-hazardous tasks for humans. (Leduc and Zheng, 2020).

2.2.1. RPA examples from the department perspective

The Table 1 below lists possible groups of processes in which RPA may be a suitable tool for automation in the coronavirus period.

Table 1. Support of business processes using RPA according to the department   (Own work)

IT dept.	Configuring the environment for remote work (Shafiki, 2020), (Iafrate, 2020)	Registration of new hardware (Shafiki, 2020), (UiPath, 2020)	Remote helpdesk (Kanowitz, 2020)
HR dept.	Increasing the capacity of recruitment (Fuqua, 2020)	Vacation and attendance management (Shafiki, 2020), (UiPath, 2020)	Automation of talent pool creation (Fuqua, 2020)
Front-office	Increasing order processing capacity (Iafrate, 2020)	Increasing questions processing capacity (Iafrate, 2020)	
Back-office	Support of supply chain operations (Iafrate, 2020)	Processing of applications for support or subsidies (Klayko, 2020)	Government reporting (Iafrate, 2020), Audit (Martinelli et al., 2020)

2.2.2. RPA examples from the industry perspective

Several industries where automation has been used are shown in Table 2 by research firm Bain & Company. It shows examples of activities that companies had to strengthen in order to continue to provide their services in adequate quality (Saenz *et al.*, 2020).

Table 2. How companies support their functions with automation (Saenz et al., 2020)

Pharma	Support clinical testing for vaccine development, accelerating data entry and analysis	Distributor	Deploy process mining to analyze and react to supply chain issues in real time
Hospital system	Balance demand and supply to optimize 10x surge in personal protective equipment orders	Chemicals	Process 10x surge in orders for hand sanitizers
Banking	Process 50x surge in loan applications following the CARES Act	Hotels	Support overwhelmed contract-center staff managing cancellations
Insurance	Process 300 to 400 incremental Family and Medical Leave Act claims per day	Healthcare providers	Support claims and revenue management after back office furloughed 60% of staff

2.2.3. Overview of COVID-19 impact to RPA use from the industry perspective

Although both bank and a construction firm have to do their accounting or HR similarly, they are completely different in their business agenda, and so are their processes and opportunities for digitization and robotization.

Key industries are evaluated in terms of opportunities for RPA automation, impact of COVID-19 to those industries and estimated impact of COVID-19 to use of RPA tools, see Table 3.

Table 3. Overview of opportunities and impact of COVID-19 to use of RPA in specific industries (Own work)

Industry	Opportunities for RPA	Industry related impact of COVID-19	Estimated impact of COVID-19 to use of RPA
Banking and insurance	Fraud detection; Risk monitoring; Mortgage processing (Rutaganda, 2017)	Vast employees started to work from home, postponing payments	Positive - forcing automation
Constru-ction	Dealing with construction plan variants; Processing bigdata coming from sensors (Golizadeh, 2019)	Limited ability to hire cheap foreign workforce	Negative - government deficits and poorer firms will invest less
E-commerce	Handling peaks in shopping season; Processing customer complaints; Monitoring pricing; Providing accurate stock info; Payment processing (Oliinyk, 2020)	Unprecedented pressure on stock management, delivery frequency and volume	Positive - more money and natural demand for automation
Healthcare	Processing diagnose results; Faster patient data manipulation; Managing onboarding of emergency staff; Automating bulk orders (Williams, 2020)	Pressure on current workforce; Need to handle protective equipment distribution; Postponing unurgent healthcare	Positive - pressure on efficiency and flexibility
Manufacture	Processing of IoT bigdata; Helping fulfill regulatory compliance (Bazan, 2020)	Need for fulfilling hygienic rules; Less workforce attendance reliability	Neutral
Retail stores	Handling peaks in shopping season; Returns processing; Auditing; Goods analytics (Sarma, 2020)	Limited physical customer access and opening hours; Shift to online channel;	Negative - retails without online channel are bankrupting
Telco	Measuring network utilization; Customer data processing (Rutaganda, 2017)	Unprecedented utilization of home internet networks will cause tariff upgrades	Positive - more money for automation
Travel and tourism	Passenger record processing; Self-management; Chatbot integration (Charlton, 2020)	Constraining of travel; Need to process cancelation requests and vouchers	Positive - pressure on efficiency and labor cost savings

3. Conclusion

Remote work incorporation brings unprecedented opening of company IT infrastructure out to allow employees that are working from home to connect to the internal systems. It leverages IT security risks that has to be at least mitigated or completely prevented. Joel Lanz and Bruce Sussman published an article focused on Information Security Program Management in a COVID-19 World. The article shows that 88% of small business owners feel vulnerable to a cyber-attack but can't afford professional IT solutions (Joel and Sussman, 2020).

From all the processed content we can see companies consider RPA as relevant technology to overcome the COVID-19 pandemic. The main benefit of deploying RPA stands in the ability of a cheap and quick response when it is necessary to work with new independent apps or when it is impossible to change processes or create an integrated ICT environment. RPA is used in both private and public sector. RPA can bring attractive tools which can lead to partial automation without the need for large investments in business process reengineering or the creation of integrated information systems or software connectors like APIs. A parallel benefit, in case of new waves of the COVID-19 pandemic or the spread of other possible unknown diseases, will be better employee substitutability, ability to keep the business running and better ability to manage demand/supply shocks.

4. Acknowledgement

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THE 5TH GENERATION NETWORKS AND RISKS RELATED TO THEIR USAGE

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Keywords

5G; security; risks; network; Risk Assessment Matrix

Abstract

A fifth-generation network is rolling worldwide since 2019, so information security professionals must become familiar with the 5G security architecture and the risks that come with implementing this new technology. The introduction of 5G will also close the security gaps present in previous technologies. Professionals can appraise real benefits through implementing 5G technology like faster network, higher capacity and flexibility. This paper is devoted to the risks related to the usage of the 5G network. It aims to put 5G in the context of the other generations of networks, highlight the differences compared to the previous generation, and identify security threats based on the risk assessment matrix.

1. Introduction

Fifth-generation network, or abbreviated 5G, is a new standard in broadband mobile phone networks. The 5G technology was introduced to the public in 2019 (Tibken, 2019). This technology was built on previous generations of fourth-generation networks (4G) and third-generation networks (3G). Except for the latest information about the 5G network, people can hear pieces of information about the 6G technology, which could emerge around the year 2030 (English, 2021). The 6G will be related mainly to Artificial Intelligence. Nevertheless, this paper is devoted mainly to generation 4 (4G) and 5 (5G).

Each of the generations can be characterized by specific services extended by the generation (ITU 2021, Naseeb 2020):

- 3G brought the Internet to mobile phones and led to the expansion of smartphones,

- 4G offered faster data transfer and made it possible to watch streaming videos,

- 5G is designed to bring higher data rates, reduced latency and greater system capacity.

The 5G is another improved development phase of the IMT-2020 family of technologies (including 3G and 4G). It is important to highlight that the first implementation of 5G uses the existing 4G LTE infrastructure in a non-standalone mode. It means 5G does rely on LTE for now (ITU, 2021). Key differences among each generation of the networks and year of publication are shown in Figure 1.

The standards for 5G were defined by the 3rd Generation Partnership Project (3GPP). 3GPP defines any system using 5G New Radio software as 5G, and the definition came into general use by late 2018 (Minoli and Occhiogrosso, 2019). Minimum standards are set by the International Telecommunications Union (ITU).

The move upward of 5G itself started in 2019 in some countries (ENISA, 2020a). In 2020 the rollout began in the Czech Republic (Raymond, 2020). At the European Union level, ENISA developed a 5G toolbox. This toolbox provides a set of robust and comprehensive measures for a European Union coordinated approach to secure the 5G network (NIS, 2020).
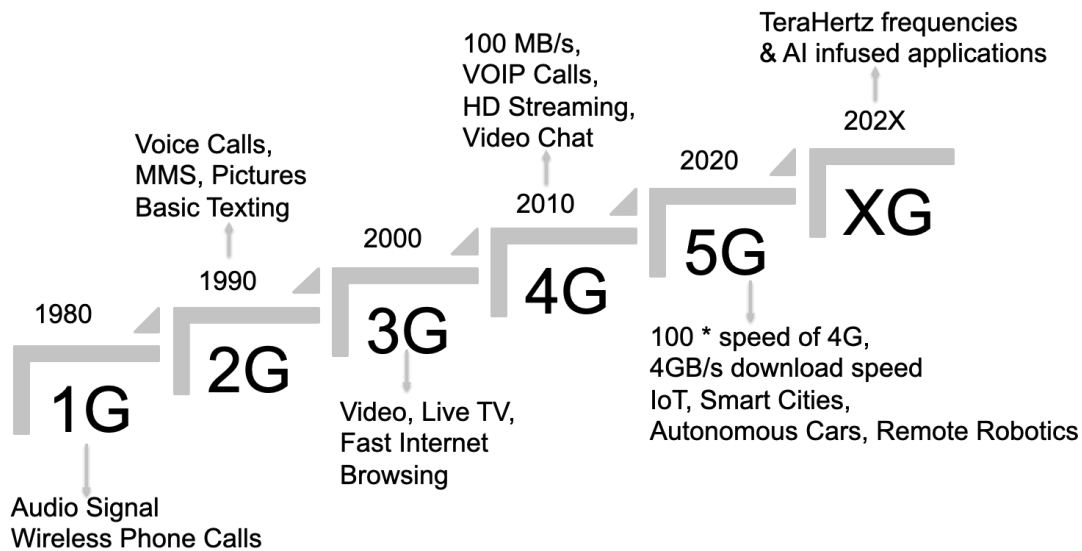
Figure 1. Network generations and their specifics (Naseeb, 2020).

5G is a general term, which is official split into three different types of 5G networks (Charig, 2021):

- Low band 5G: using frequencies similar to 4G (600-850 MHz) with download speed 30-250 Mbit/s.

- Mid band 5G: using frequencies between 2.5-3.7 GHz with speed 100-900 Mbit/s.

- High band 5G: using frequencies between 25-39 GHz with speed up to 20 Gbit/s.

The ITU standard determined a minimum specification of 100 Mbps downloads speed for 4G LTE, which, at the time, was highly hypothetical. Carrier networks today are only just now realizing these aims, many years later.

4G networks as of 2021 are the dominant network, with most voice, text, and calls being handled over 4G. That probably shouldn't change anytime soon, with 5G networks mostly looking to manage data. Thus, high-speed 5G phones will continue to use 4G networks foreseeable future (2030 to 2035 is estimated, but 4G could last even longer).

Manufacturers are just now coming out with 5G compatible devices, but carrier networks are nowhere near the minimum 1 Gbps with one millisecond of latency required for the standard (Baker, 2021). As we said, they are just now using 4G LTE infrastructure and thus approaching 4G LTE specifications.

The main benefit of 5G networks is further improving the quality of Internet connection services offered today. 5G also can connect thousands of 5G devices at the same time. For example, better connectivity will give more people access to digital education and digital skills. A faster and more stable connection can connect teams in multiple locations at once, which, for example, supports

remote work. Factories can be upgraded with automated processes and connected machines to increase workplace safety and productivity (Staff, 2019).

In one sentence, it can be summarized as follows: "The purpose is to be faster, more reliable and manage the scale of devices predicted for the Mobile Internet of Things (MIoT) which enabling the digital transformation of our society, business processes and manufacturing" (GSMA, 2020).

In a 5G business environment, security is a necessary enabler for the continuity of the business. Users already realize that security and privacy are essential, and they could be aware of the security/privacy service provided to them. It is believed that the extent and strength of the security mechanisms provided correlate with the perceived security level, at least in the long run (Huawei, 2016). The number of new types of devices can increase space for various types of attacks like impersonation, denial-of-service (DoS), eavesdropping, man-in-the-middle and repudiation attacks.

The second and critical benefit of the 5G networks is the speed of the connection, which means transferring a considerable volume of data in secure and high-speed manners is critical while preventing malicious files from penetrating (Cisco, 2018).

The number of connected devices, coworking and sharing of services impact the security of the connection. Security is a topic whose importance increases for a long time, and the number of devices and especially devices with critical impact on various activities highlights this importance.

This paper aims to analyze the current situation in security and compare it with the situation in 4G networks.

2. Methodology

For this work, the primary data collection methods using secondary sources analysis and document analysis are used.

The Risk Assessment Matrix (RAM) has been selected to process risks related to 5G technology. RAM (Duijm, 2015) is based on the likelihood of occurrence risk and severity of the consequence. For this paper we are taking these fundamental's steps from the Risk assessment matrix.

- The first step is risk identification based on ENISA (2020b) document.

- The second step is risk analysis based on the detailed literature review of the relevant document.

- The third step is representing risk severity and probability levels in a table. It involves weighing probabilities with improbable, probable and frequent levels against severity with negligible, restrictive, significant and critical levels. Overview in the form of a table help identifies the threat levels of risk. Risk level can be low (no particular precaution needed), moderate (some measures recommended), high (necessary steps need to be implemented), extreme (immediate implementation of the required measures).

3. Results

Each known network generation had its security requirements – except the first generation that had no security because of its analog form (Mavoungou at al., 2016). The most critical security and privacy areas in each network generation are shown in the following Figure 2.

Security of 5G networks and devices is mainly built on the principle of security rules and processes defined for 4G networks, and in parallel, 5G is designed to address plenty of threats identified not only in 4G and 3G and 2G networks (Wang et al., 2020).

In the beginning, we want to highlight that the 5G networks are not anything new, but it is an evolution of 4G networks that added higher speed and other improvements and enhancements to the previous generation of the networks.

4G related security threads come mainly in the following areas: wireless security, network entity authentication and deletion of data.

The 4G network is more assailable threads related to security and privacy than the networks' previous generation. This situation is because users are using many mobile devices running on 4G networks principles. The high number of users is interesting for those who want to misuse the weakness of 4G networks and who are creating malicious programs, viruses, who are using operating system vulnerabilities et cetera. A significant weakness is assailability to DoS attach, illegal use of mobile devices, and medium access control issues, described in Ghannam et al. (2018).
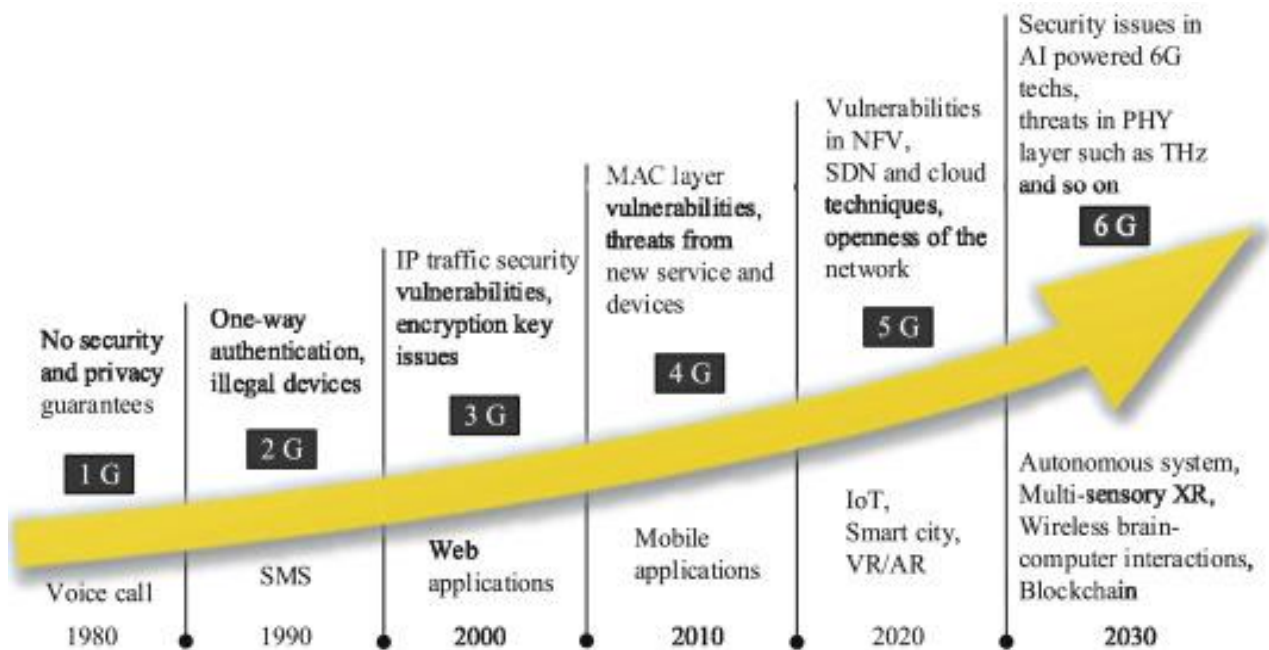
Figure 2. Evolution of security and privacy issues in wireless systems (Wang et al., 2020).

The 5G networks, which are the most important area for this article, can be characterized by the fast speed of the connection, secure architecture, and a new way of facilitating connection among devices. One of the 5G networks' essential expected impacts is exponential growth in Internet of Things (IoT) devices and smart cities (Doucek et. al 2018, Potančok and Černý 2020). IoT devices usually operate with constrained resources, and the precondition for their usage is the high-performance network to be able to communicate with backend systems often based on cloud-based servers. The number of new devices with the arrival of 5G is relatively small compared to previous generations, but the contrary number of devices is increasing exponentially for the reasons mentioned above. Except for exponential growth of the number of devices is an important type of devices, which are newly used and purpose of their usage. New devices are used in automotive, cloud services, manufacturing, healthcare, et cetera. In these areas is the importance of security and privacy is highlighted (Cisco, 2018).

The security of the network generations can be analyzed from two points of view:

- What is not changed = what is the same in both 4G and 5G:
    - network access security,
    - domain security.
- What is different:
    - access network & authentication mechanisms,
    - backhaul networks,
    - core network security,
    - secret adaptive frequency,
    - policy-based communications.

Improvements of the security in 5G networks are based on the new techniques used to improve the performance of the 5G networks (Ahmad et al., 2019). An excellent example of the new technique is Multiple Input Multiple Output (MIMO), which helps to defend primarily from passive and, to a lesser extent, from active eavesdropping (Pattaranantakul et al., 2018).

An essential part of security is privacy, which has to be managed and analyzed in 5G networks. New privacy issues in 5G networks are mainly related to the diversity of business types and application scenarios in this generation of the mobile network. The platform's openness means that sensitive information can be easily changed from a closed state to an open state. From these and other reasons, privacy issues become a problem that must be solved.

We can divide security and privacy issues in 5G networks into three architecture tiers: (1) the access networks with new security challenges thanks to the node's diversity, (2) the backhaul networks between the base stations and (3) the core network. The core network in 5G is dynamic and consists of Network Functions Virtualization, Software-Defined Networking and cloud techniques. The massive number of devices can cause signaling overload, increasing the possibility of a DoS or resource attack. Signaling overloads can be dealt with using lightweight authentication and key agreement protocols or protocols that allow the devices to be grouped. On the other hand, the new techniques used to improve the performance of the 5G network could also create security breaches (Wang et al., 2020).

The most important change between 4G and 5G networks as defined above can be shortly described as follows: In authentication mechanism two new nodes providing separation of networks are employed between user equipment (UE) and the network database: security anchor function and authentication server function (Wraycastle, 2019).

The ENISA (2020b) define set of various threats and their probability. You can see the list of threats in Table 1.

Table 1. List of 5G threats

ID	Threat	Threat details
01	Denial of Service attacks	It causes shutting down a machine or network, making it inaccessible to its intended users by jamming, tampering, flooding, or denial of sleep (Shikha and Raman 2014; Gavrič and Simič 2018).
02	Traffic sniffing	It allows an attacker to identify resources that can be compromised (Wang at al., 2014).
03	Man in the middle/ Session hijacking	The attacker inserts himself between two devices in a private mode, so all packets between those devices route through him. The attacker can potentially falsify data (Ahmad at al., 2018; Sowah et al., 2019).
04	Interception of information	With a strong receiver and antenna, an attacker can locate the nodes, and destroy them by interception of the messages (Alam and De, 2014).

ID	Threat	Threat details
05	The Sybil attack	A malicious device is illegitimately taking on multiple identities, and it targets fault-tolerant schemes (Newsome et al., 2004).
06	Traffic analysis attack	An attacker concludes the data traffic pattern by eavesdropping on the identities of the nodes. The attacker can harm the sensor network (Alam and De, 2014).
07	Abuse of virtualization mechanisms	It allows access to the host machine from the guest machine (ENISA, 2017).
08	Injection attacks	It may enable the owner's impersonation and creating the illusion that legitimate user is controlling the device (Gonzales-Manzano, 2020).

(ENISA, 2020b; authors)

In the following Table 2 is shown probability and severity of the threats mentioned above. Probability has improbable (1), probable (2) and frequent (3) levels. Severity has negligible (1), restrictive (2), significant (3) and critical (4) levels. Based on those factors, a risk level is assigned.

Table 2. Levels of probability and severity for individual 5G threats

Threat ID	Probability (1-3)	Severity (1-4)	Overall risk (1-12)	Risk level
01	Improbable (1)	Critical (4)	4	moderate
02	Frequent (3)	Critical (4)	12	extreme
03	Probable (2)	Critical (4)	8	high
04	Improbable (1)	Significant (3)	3	low
05	Probable (2)	Significant (3)	6	moderate
06	Probable (2)	Critical (4)	8	high
07	Frequent (3)	Significant (3)	9	high
08	Frequent (3)	Critical (4)	12	extreme

(ENISA, 2020b; ENISA, 2020c; Liyanage at al., 2018; Palmer, 2019)

As we can see from Table 2, the threats with extreme risk level are (02) Traffic sniffing and (08) Injection attacks.

4. Conclusions

Security is not a one-time event in any evolving technology, but it's a continuing process, and 5G technology is not an exception. Regardless of a considerable amount of 5G security work at the level of standards, significant unknowns remain. Professionals have to regularly study and implement GSMA and 3GPP recommendations to protect their 5G networks.

5G technology is vital for consumers, businesses and the digital economy as we move into Industry 4.0 and explore all that 5G has to offer, including things we haven't thought of yet. 5G is of great importance because it can support millions of devices at ultrafast speeds and transform people's lives worldwide. 5G brings ground-breaking services to consumers and businesses. It could be one of the most critical drivers of innovation and economic growth over the following decade, generating many new, high-paying jobs.

5. Acknowledgement

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SECURITY GOVERNANCE IN CLOUD ENVIRONMENT

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Keywords

Cloud computing, cloud governance, cloud controls, shared responsibility, cloud security

Abstract

Cloud governance plays an important role in the effectiveness and security of cloud services and the entire IT environment of any organization. The target of this paper is to introduce five areas of cloud security governance that are considered as the most important one by the paper's author. The areas were identified through a review of existing publications and by the author's personal experience with cloud environments. The author also provided a comprehensive literature review of cloud computing bases that affect cloud security governance in organizations (e.g. cloud adoption). As the most important areas, the author identified contracts with cloud vendors, shared responsibility model, cloud controls catalogs, possibilities of cloud platforms and compliance (regulations). The discrepancies within these areas may lead to severe security and operating issues related to the deployed cloud services.

1. Introduction

Technology transformation and innovation are visible in organizations from all sectors around the world. One trend in the technology transformation, also referenced as "digital transformation" is the adoption of cloud solutions that bring organizations benefits from many perspectives. The speed of the adoption was in the previous year greatly affected and increased due to the COVID-19. Multiple business reports and analyses also described this increased trend: *"In a sense, the global health crisis has served as a de facto catalyst for establishing the value and flexibility of cloud computing (once again) and led to accelerated adoption. This global health crisis has proved to be an opportunity for the cloud market, with a definite surge in cloud adoption globally across diverse industries. According to Gartner, in the aftermath of the Covid-19 crisis, the worldwide end-user spending on public cloud services is forecast to grow 18.4% in 2021 to total $304.9 billion."* (Aggarwal, 2021) Another analysis describes the situation as: *"A confluence of existing factors driving cloud transition has been further accelerated by the COVID-19 crisis: Cloud spending rose 37% to $29 billion during the first quarter of 2020. This trend is likely to persist, as the exodus to virtual work underscores the urgency for scalable, secure, reliable, cost-effective off-premises technology services. In fact, despite the inevitable economic downturn in the wake of the pandemic, cloud spending is estimated to rise 19% for the full year, even as IT spending as a whole is forecast to fall 8%, according to industry analyst Gartner. (...) In a recent PwC survey, almost 75% of finance leaders said they were planning for a more agile business environment going forward; the cloud's flexible cost and scalable service can be an important component of this agility."* (PwC, 2020).

Cloud adoption had, nevertheless, an increasing trend even before the COVID-19 crisis. The analysis of the increased cloud adoption and usage are described in reports such as Cloud Security Report 2020 (Check Point, 2020), State of the Cloud Report 2020 (Flexera, 2020), Cloud Adoption and Risk Report 2019 (McAfee, 2018), Cloud Security Report 2018 (Crowd Research Partners, 2018) and State of Cloud Security 2018 (Cloud Security Alliance, 2018).

From the above-stated findings, it is obvious that the importance for the complete and correct (or at least sufficient) governance level of cloud environment is highly required. Any lack or discrepancy in the cloud governance might result in severe security issues since e.g. the cloud resources would not be managed correctly, responsibilities would not be clearly assigned, or administrators would not operate and configure the resources according to defined processes.

In the beginning, the definition of cloud computing is important to be included. National Institute of Standards and Technology defines that as: *"a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (…) that can be rapidly provisioned and released with minimal management effort or service provider interaction."* (Mell, et al., 2011) The document further defines five essential characteristics of each cloud (on-demand self-service, resource pooling, measured services, broad network access, and rapid elasticity), and two cloud models (service and deployment). The service model defines what is provisioned – Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS). On the contrary, the deployment model defines how a cloud service is provisioned – Public cloud, Private cloud, Hybrid cloud, Community cloud.

The authors of (Jackson, et al., 2018) look at cloud computing from a different perspective: *"Cloud computing is a model. It is not a specific technology. You cannot go and buy a cloud computer. The term is used to describe an economic and operational model for the provisioning and consumption of IT infrastructure and associated services."* Besides the technical factors and aspects, the authors of this publication further emphasize and pay great attention to the financial and strategy (business) factors and aspects that play a significant role in the success of cloud adoption in any organization. The authors also touch on the cloud adoption process since cloud solutions in all organizations always start with their adoption. Cloud adoption is there defined as: *"Cloud adoption is a core component of digital transformation. Organizations must align modern technology and current economic models to business strategy. Transformation requires a new approach that balances cost and technology choices with company direction and client consumption models."* Many other topics that relate to the architecting and governing of cloud solutions are further described in this publication.

Regarding the mentioned cloud adoption, many researchers have already analyzed the factors that positively and negatively affect the decision-making whether to adopt cloud solution and success of the complete cloud adoption. The authors of the article (Oke, et al., 2011) reviewed 8 particular publications with research that aimed to identify the most significant factors of cloud adoption. As a result, the authors gathered fifteen factors: *Competitive pressure from within the industry, Size of the organization, Capacity of the organization, Structural template (necessary infrastructure needed), Specialized human resources, Nature of the industry, Technological advancement, Willingness of clients, Availability, Reliable data storage, Performance, Cost of accessibility, Perceived ease of use, Privacy, Client's readiness*

Capability Maturity Model (CMM) adjusted to cloud environment that enables to assess the maturity level of organization's processes is presented in (Moonasar, et al., 2020). The authors defined the particular levels based on the maturity within seven areas: IT Governance, Service model, Deployment model, TOE (Technology, Organization, Environment), DOI (Diffusion of Innovation), RDT (Resource dependency theory). Examples of the level definitions are present in Figure 1.

Level	Domain	DOI	TOE	RDT	IT Governance	Service Model
Level 1: Initial	Description	Innovation not driven through CC	Technology not cloud based, no top management involvement	Control of all resources by organization	No cloud compliance and security process or governance	All infrastructure, platforms and software onsite
	Effects	Bottom Up IT usage, There are some risks to the organization and benefits of CC cannot be unfolded to its potential				
	Recommendation	Formalize usage of CC, Address issues of management support				
Level 2: Assessing	Description	Innovation through technology is assessed, Reinvention through new features and functionality of cloud evaluated	Performance of applications in the cloud assessed (includes bandwidth and latencies). Organizational awareness of CC	Assess different cloud service provider models, contracts and SLAs. Consider data ingestion and egestion impacts	Awareness of CC governance issues. Assessment of organizational knowledge acquisition	Assess impact of the different cloud service models on organizations business model

Figure 1 Example of Cloud Capability Maturity Model definitions (Moonasar, et al., 2020)

The possibilities that organizations have in the area of cloud governance and management are greatly affected by the possibilities provided by the cloud vendors. For that purpose, a very detailed assessment of cloud vendors, including a very precise identification of organizations' requirements should be performed. The authors of (Svatá, et al., 2020) focused in their publication on the identification of significant areas within the cloud vendors assessment and split the controls into six categories – infrastructure and technology, information security, vendor quality, service quality, pricing and (additional category) ERP applications quality. In their subsequent article (Svatá, et al., 2020), the authors focused on a detailed analysis of infrastructure/technology and information security areas.

2. Methods

The author of this paper finds an answer to the research question *What are the main areas of cloud security governance in organizations?*

The target of this paper is to provide readers with research results dedicated to answering the two above-stated questions. For this purpose, the author researched a significant quantity of articles and frameworks that are relevant to the topic of cloud governance. The author also draws from his professional experience with cloud solutions in organizations.

The initial literature review within *Introduction* chapter presented important theory and findings that serve as a theoretical basis for the main research within the cloud governance area. Then, the analysis-synthesis method was applied for the research findings. The particular research results are divided into separate Sections 3.1 – 3.5.

3. Results

The authors of (Shaker, et al., 2014) define cloud governance as: *"A Cloud governance should contain processes to apply Cloud Computing inside the organizations and applied controls to facilitate it. Moreover, it must adopt the organizational roles and responsibilities to ensure better support of implementing Cloud Computing governance. Finally, it should use all available technology tools that will help to apply the governance framework."* Another definition of cloud governance is provided in (Bounagui, et al., 2014): *"governance of cloud is more than policy management and defining processes and procedures to ensure that those policies have been correctly implemented. Cloud governance is about to support business strategy and ensure delivering value, service quality, and security regardless of controls and physical location of data and services."*

The sections below are dedicated to particular areas that play a significant role in the governance of the cloud environment in organizations.

3.1. **Contracts**

Contracts with cloud vendors are one of the most important and powerful tools for assuring the organization receives the negotiated quality of the cloud service. *"The contract is your only guarantee of any level of service or commitment – assuming there is no breach of contract, which tosses everything into a legal scenario. Contracts are the primary tool to extend governance into business partners and providers."* (Brunette, et al.) The areas present in the contract should cover e.g. data location, secure data deletion (incl. after service provision termination), protection of data, terms of contract termination, privacy concerns, monitoring of resources and many other areas. (Bushey, et al., 2015)

The easiness of negotiation and importance of the well-negotiated contracts greatly differ with service and deployment cloud models. The service model affects the number of cloud resources and the level of their competencies in the organization. E.g. the contract for the Software-as-a-Service model, where organizations receive complete software without any maintenance of the underlying infrastructure, is more important than for organization that utilizes the Infrastructure-as-a-Service model where they receive only the underlying infrastructure and maintain everything builds on it. Similarly, at the deployment model, organizations will have it easier to negotiate a contract for the private cloud than for the public cloud where the service is shared with much more users/organizations. The easiness of the contract negotiation is naturally affected also by the size of the organization. (Brunette, et al.)

As the main contract for the cloud services is considered the Service Level Agreement that defines the quality of the provisioned cloud service. The SLA should also cover the entire life cycle of the service (Labidi, et al., 2018).

The contracts with cloud providers, however, might be hard to negotiate. This might especially come with the biggest cloud providers that have a large number of customers. Then, organizations need to consider whether they accept the contract offered by the providers or address a different cloud provider.

3.2. **Shared responsibility**

The shared responsibility principle indicates that some portion of the responsibilities at the cloud service provider's (CSP) side and some of them on the cloud service customer's (CSC) side. The responsibilities should be clearly defined to avoid any blank spot where one side would assume that it is the responsibility of the second side (Synopsys, 2018). The exemplary division of responsibilities of IaaS, PaaS and SaaS solutions are visible in Figure 2.
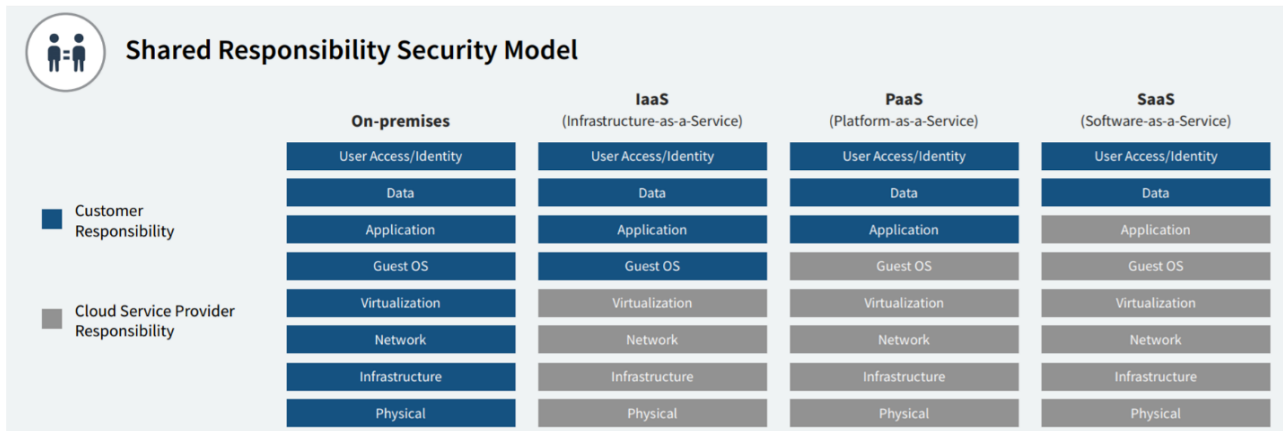
Figure 2 Shared responsibility model between Cloud Service Customer and Provider (Oracle & KPMG, 2020)

Insufficiently and unclearly defined responsibilities may have a severe security impact on any organization. Besides, (in)correct understanding of the shared responsibility model principle affects also compliance with standards and regulations. The consequence is that when a CSP declares that its platform is compliant with a certain regulation, it does not mean that the implemented cloud platform/solutions within a certain CSC is also compliant. The CSC needs to ensure that also the part that is under its responsibility is compliant with the regulation.

3.3. **Cloud controls catalog**

Organizations should onboard controls or perform an assessment with the usage of those controls to ensure that the cloud environment has been deployed, managed and governed well. As an example, three widely known control catalogs will be present.

The standard *ISO/IEC 27017 Code of practice for information security controls based on ISO/IEC 27002 for cloud services* is an extension of highly used standard *ISO/IEC 27001 Information security management systems — Requirements*, or more precisely *ISO/IEC 27002 Code of practice for information security controls*. It leverages all controls from the original catalog and where possible, it enlarges them with cloud-specific requirements for CSP and CSC. Besides, several new cloud-specific controls are added. In total, the catalog consists of 121 controls and 14 domains.

The second catalog was developed by *Cloud Security Alliance* and is named *Cloud Controls Matrix (CCM)*. This catalog contains 197 controls divided into 17 domains. The examples of domains are Change Control & Configuration Management, Data Security & Information Lifecycle Management and Infrastructure & Virtualization Security. The catalog is applicable to be used on both CSP and CSC sides, however, the primary usage is meant for CSP.

The last cloud catalog is developed by *Federal Office for Information Security (Germany)* and is called *Cloud Computing Compliance Criteria Catalogue (C5)*. This catalog is partly built on the previous CCM and the primary usage is also meant for CSP. This catalog includes 196 controls divided into also 17 domains.

3.4. **Cloud platform capabilities**

Many cloud providers offer their customers security services that enable easy implementation of security controls within the cloud environment. CSCs have usually also the opportunity to select a group of controls that is applicable for some standard or regulation (e.g. ISO/IEC 27001, Payment Card Industry Data Security Standard).

An example of such a service is Azure Policy in the Microsoft Azure platform. This service enables organizations also to apply their internal policies and restrictions on the cloud environment. The example applied controls in Azure Policy are visible in Figure 3.
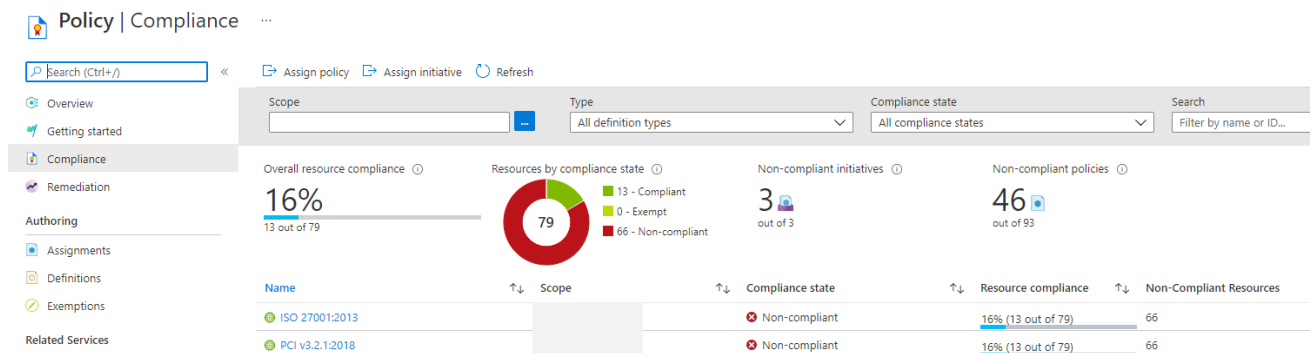
Figure 3 Shared responsibility model between Cloud Service Customer and Provider (Oracle & KPMG, 2020)

Similarly, Amazon within its Amazon Web Services platform offers the Security Hub service and Google within its Google Cloud Platform offers the Security and Command Center service.

3.5. **Compliance**

The above-mentioned cloud platform capabilities provide organizations with a tool that may support them with achieving compliance with certain standards or regulations. These capabilities might not be 100 % accurate since they might not necessarily cover all possible configurations, however, they offer a quick indication of the compliance state.

The cloud environment adheres to the compliance requirements similarly to the on-premise environment. Among the often regulations that are often linked with the cloud environment belong e.g. General Data Protection Regulation (GDPR), Payment Card Industry Data Security Standard (PCI-DSS) or Health Insurance Portability and Accountability Act (HIPAA) (Cloud Standards Customer Council, 2016).

4. **Discussion**

This paper offered an overview of five areas that the author of this paper considers among the most important ones for the correct cloud security governance in organizations. The selection of those areas was performed based on the research of existing publications and author's own experience in the cloud security area. Nevertheless, the organizations should bear in their minds that cloud security governance starts with the entire beginning of cloud service adoption. They should invest a significant amount of time and energy to identify all requirements and plan the governance of the environment. If this phase is underestimated, it may bring a significant impact in some of the later phases. The analogy is with software development where late major changes bring a great delay and inconsistency. Organizations should assure that their approach to cloud security governance is sufficient. One of the most effective ways how to find that is to have an external independent assessment in this area performed. The specialized companies are able to effectively identify discrepancies in any area of cloud governance. Besides, the organizations should receive also a list of recommendations to the identified findings.

5. Acknowledgement

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STREAMING SERVICES AND DATA ANALYTICS

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Keywords

Abstract

Nowadays, streaming services are very popular. We can meet them in the form of providing content (stored or live) or in companies in the form of analytics. In every possible form of streaming service, there is one thing in common, namely the customer of the streaming service. The information that the customer leaves us during its use is an important commodity of the company. With the help of the article, we try to capture both possible forms of streaming and present them in more detail. Content streaming and streaming analytics are interconnected, for example, companies that provide content streaming (such as Netflix) use cloud analytics to analyze their data. The article describes the general possibilities of streaming and their possible platforms based on the subject of streaming. In the next part of the article, we present streaming in the form of analytics, which is appearing more and more in companies.

1. Introduction

Streaming and streaming services are a major phenomenon today. Popularity of the streaming services has significant development which can be named almost as a boom. According to (Bacon, 2020) during the pandemic in 2020, the use of streaming services increased by 37%. Streaming service is a content, which is delivered to consumer via an Internet connection to the subscriber's computer, TV or any mobile device which is connected to the internet (PCMAG, 2021). Streaming is a method of transmitting or receiving electronic data (especially video and audio) over a computer network as continuous flow of a date. Important part of the streaming is a situation, that user can watch/listen the video although the rest of the data of the flow is still being received (Corriveau, 2019). Streaming is based on the electronic communication which gave us a lot of various ways how to analyze our subscribers. The incredible growth of the number of subscribers the providers want to know their users (customers). The revenue generated by the whole streaming services market is projected to reach 71 billion USD in 2021 and until 2025 is projected to reach 149 billion USD until 2026 (Reports, 2021). The most important factors driving the size of the market with streaming services are the increasing number of mobile devices, increasing amount of internet users, increasing speed of the internet connection, the effects of the COVID-19 pandemic, and the growing need for delivering digital content to maximum number of the end users (Reports, 2021).

Factors, which will drive streaming services market to the revenue projected for 2026 are various technological innovations. The highest impact into the streaming services market have Artificial Intelligence (AI), block-chain technology, deep learning, and natural language processing which increase ability of the providers of the digital content to analyze the customers/users of provided digital content.
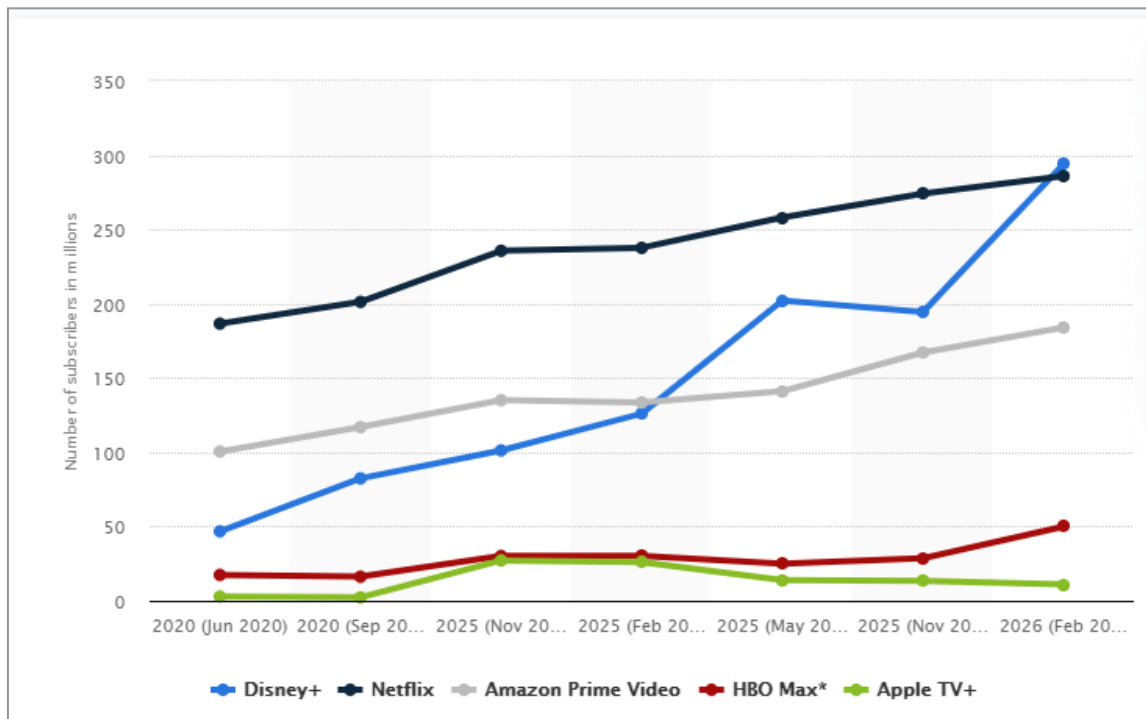
Figure 1. Projected mount of subscribers of video streaming providers between years 2020-2025.

Source (Stoll, 2021)

One of the first providers to achieve the highest market share today is Netflix, a global company (operating in 190 countries). In December 2020, it had almost 200 million subscribers as displayed in the picture bellow. The biggest competitors are Amazon Prime with 130 million users and Disney + with 90 million users.

From revenue point of view, the Netflix has revenue 25 billion USD (Netflix, 2021) in 2020 as well as Amazon Prime Video with revenue 25.21 billion USD (Brian, 2021) and Disney+ has revenue 18 billion USD (Mansoor, 2020) both with significantly lower number of subscribers in comparison with Netflix.

The goal of this paper is analysis of the key aspects important for analysis of the customer (subscriber) of the video streaming services as a precondition for definition of the "Architectural design of a data-oriented solution for streaming services" and using data mining technic for better understanding clients life cycle based on information in data (Potancok, Stepanek, Marik, Sperkova, Vitova-Duskova, 2020).

2. Methodology

The most important part of the definition, in respect of the methodology, is selection of the area of "streaming services and data analytics". This paper is devoted to the lifecycle of the customer using the streaming services.

This paper is based mainly on analysis and synthesis of existing state of the art which allows us define new approaches important for the definition of the "Architectural design of a data-oriented solution for streaming services" and finding new patterns in data within methods of data mining.

2.1. General streaming options

Streaming comes from the English word "stream", which means stream of water. Streaming is the flow of traffic from a streaming service provider to end users. We may include in the streaming service the transmission of only audio (audio) content or the transmission of audiovisual content.

Streaming can be divided into individual categories within different dimensions: by content, by time and by bitstream variability (Popelka, 2013). Streaming can be divided according to the form of streaming, i.e. live streaming or streaming of stored content.

- Categories according to individual dimensions

    o *According to the content*: According to (Popelka, 2013), within content, we can divide streaming into two categories. The first category is the subject of transmission of audio only and the second category is the subject of video and audio transmission, ie. Audiovisual content.

    o *According to time*: Within time, streaming can also be divided into two categories (Popelka, 2013). The first category includes streaming by broadcast time, and within the second category, streaming is independent of broadcast time. We can include television or online broadcasting in the first category. In the second category we can include VoD (Video on Demand) or offline streaming.

    o *According to bit rate variability*: Within a variable bitstream, we can distinguish between non-adaptive and adaptive streaming (Popelka, 2013). Non-adaptive streaming is one where the client chooses the quality of the content. The quality of content can include higher resolution, bit rate, etc. In contrast, adaptive streaming is more autonomous. If the quality of the data line (network connection) decreases, the quality of the streamed content will automatically decrease.

- Categories by form of streaming

    o *Live streaming*: In live streaming, a content provider provides the user with content that is currently in progress. Within content, this can be online reports, news or other shared online content. The specificity of live streaming is that, on the one hand, there is a real-time video transmission device that transmits in real time through the provider to the user or users. (Spurny, 2017)

    o *Streaming stored content:* Streaming stored content is streaming where the content has long been uploaded and is stored in a cloud solution.

2.2. General Platform for streaming services

There are many platforms on the market for streaming stored or live content. The best ones are evaluated either by the number of users or by the size of the profit. Platforms can be divided into paid and unpaid platforms. In most cases, paid platforms are used by businesses or personal users with sensitive live or stored streaming content. On the other hand, unpaid platforms are also supporting the market. Unpaid platforms usually contain not very sensitive information such as live advertising, news, experience sharing and others. Unpaid platforms are often used by personal users such as YouTube. Each platform has a slightly different content, but in most cases, it is videos containing movies, series, documentaries, tutorials, instructional videos, etc.

- *Overview of platforms within streaming stored content*: When choosing a platform, the user chooses content based on price, content, and area of use. According to (Bacon, 2020)), Netflix, Amazon Prime Video, Disney +, HULU and HBO NOW / HBO Go are among the top ten among paid streaming platforms for TV shows. For the Brightcove Engage, UStream (IBM Cloud Video), Kaltura, Wowza and Vimeo business areas.

- *Overview of platforms within live streaming*: There are also many platforms for live streaming. According to (Shahzeidi, 2020.) the best is YouTube live, Facebook Live, Instagram Live, LinkedIn Live, Twitter Live, TikTok Live, Snapchat Live, Twitch. For live streaming within computer games is Facebook Gaming, YouTube Gaming, Uscreen, Wowza and others.

3. Results & Discussion

Two main factors influencing the definition of the life cycle of the customer (subscriber) are:

- the subject of business, which is providing streaming services to the subscriber and

- the company's goals, which is usually increasing revenue and profit.

Each customer carries data information that may be key one for the company providing streaming services. Each data/information about the customer can affect not only the direction of the business, but also the size of the business. Properly grasped data (technically and analytically) can help with customer retention, increase profits, and improve user-to-operator communication.

For the purpose of this paper we will be analyzing and discussing mainly the first factor – provided streaming service and all aspects which can be analyzed in respect of the customer lifecycle.

3.1. Attributes important for streaming data analytics

The most important attributes, which are important for analysis of customer lifecycle are:

- data gained during registration - name and surname, username, password, location, information about payment methods, new users etc.

- data gained during consumption of the service

  o after login - data and time, path of selection

  o during usage - direction of used content (genre), the most used genre, the least used genre, number of intermittent monitoring, number of continuous watches, number of repeated watches, number of concurrent playback session (if allowed by the provider), data consumption, new viewers, frequency of usage, average time watching

  o from the connection - IP address, browser, connection speed, equipment, device screen resolution, from which country is video played

Analysis can be done with accent on the following factors important for the provider of the service. All the above-mentioned analysis can be done per each video, live channel, location information, device type, information about consumer of the service, type of the provided service (recorded video, live broadcast I real time), quality of the video preferred by the user etc.

3.2. **Data Analytics**

Attributes and other factors available for the data analytics are one side only. The second very important part is the data analysis itself.

We have two basic approaches to data analysis:

- Historical analytics using a historical data for batch analysis and predictive analysis
- Real-time analytics visualize and analyze data immediately as it appears in the computer system
- Streaming analytics

Historical analytics

Historical analytics is mainly related to DWH (Data warehouse) technologies and approaches known as Business Intelligence. In the new age the part of the historical analysis can be big data analysis. Data in case of historical analysis are refreshed mainly on daily frequency. Data analysis is mainly about Looking backwards because this data and data analysis informs us about history. Based on the various statistical and data mining approaches we can look ahead and forecast. For the forecasting the historical data are much better in comparison with data used in real-time analytics.

Using the historical data and external information (e.g. twitter, TV rating, etc.) and correctly placed hypotheses, we can better analyze the client's life cycle (Nixon, Ciesielski, Philipp, 2019). In the case of a TV content, we can predict future audiences and reduce the cost of planned advertising and increase the company's profit (Zhu, Cheng, Wang, 2017). In the case of streaming stored content, we can predict the probability of popularity of an individual program (i.e. a movie, series, etc.) to a specific user and recommend suitable content. Through this process, we can increase the satisfaction of users of the platform.

Within historical analytics we can use data mining methods such as unsupervised learning and supervised learning. Using these methods, a company can get to know its users or viewers in depth.

Real-time Analytics

Real-time analytics helps and allows organizations analyze data immediately as it appears in the computer system / as the data is available. Real-time analytics are crucial to a modern support strategy (Martin, 2019). In real-time we can visualize amount of calls in a real-time, changing queues, and which channels need support to improve the efficiency. Important use case of the real-time analytics is support of analyzing risks which helps companies avoid possible negative factors. From positive side the real-time analytics helps companies with improving their results vis an increase in profits, improved customer service and new customer ventures. Important factor of the real-time analytics it technical (hardware side). Real-time analytics (sometime called streaming analytics) platforms can process millions of events per second. *"Because data in a Streaming Analytics environment is processed before it lands in a database, the technology supports much faster decision making than possible with traditional data analytics technologies,"* Philip Howard of Bloor Research said in a recent Datamation interview (Freeman, 2016).

Real-time analytics can be split into:

- On-demand real-time analytics is a reactive approach, in which user processes a request through query and then delivers the result as analytics
- Continuous real-time analytics, which is more proactive type of analysis in which users are continuously informed about ne situations via alerting in real time.

Advantages of the real-time analytics

- errors within the organization are known instantly (for example, real-time insight into errors helps organization react quickly to mitigate the effects of an operational problem)

- it allows the companies to be more competitive in real time

- cost savings (for example, the company need not wait for decision company's leaders for some decision, but they can quickly react of the new thing in the market and save a lot of money) and many more …

Disadvantages of the real-time analytics

- high purchase price, not many expert available,

- high maintenance cost, etc.

Streaming Analytics

Streaming analytics is a data processing discipline sometimes called as an event stream processing which provide some action on real-time data though the use of continuous queries (Freeman, 2016). Streaming analytics connects to external data sources, which allows applications to integrate certain data into the application flow or update the external database with processed information. According to analyst Philip Howard who says the stream is actually a development of Complex Event Processing (CEP). CEP and streaming analytics services enable actions that are based on analyzing a series of events that have just occurred (Freeman, 2016).

The streaming analysis analyze motion data using continuous queries. The most important part of this definition is that analyzed streams are triggered by a specific event. This event usually happens because of an action or set of actions. Streaming analytics provide quick and appropriate time-sensitive processing. Examples of actions can be financial transaction, a website click, starting of video streaming or logging to the system of the streaming data provider. The goal of the usage of the streaming analytics platforms is extraction of business value from data.

Streaming analytical approaches becomes one of the most important terms in Big data analytics / Fast Data analytics for companies. These types of analysis enable companies to use all available data immediately. Companies can via streaming analytics generate analytics reports as and when the data appears. It ideally takes a minute. Furthermore, using streaming analytics, enterprises can receive fresh and contextual analytics reports.

Advantages of the streaming analytics:

- providing a deeper view of the data through visualization (for example, KPI data can be viewed in real time)

- real time understanding of customer behavior (for example, enables the company to obtain quick information about the customer's life cycle and his habits and thanks to that he can quickly respond to his needs)

- it allows companies to stay competitive (for example, allows the company to identify scale trends, compile information and generate company forecasts etc.)

- reduced Costs of companies (for example, streaming analytics reduce expenses on end user questionaring) and many more…

Disadvantages of the streaming analytics

- not many expert available,

- high purchase price etc.

4. Conclusions

Streaming and streaming services are a major phenomenon today with significant increase of the number of users and revenue generated by the market. The demand side of the streaming services expect increasing amount of content provided by the provider and on contrary management of the supply side (provider) need relevant in formation to be able to make relevant decisions not only about the content but especially about pricing for the services, investments into marketing supporting growth etc. The management of the supply side needs information as soon as possible to be able to make fast decisions. These decisions are based on proper categorization of streaming services.

Categorization of streaming services can be based on various attributes. One of the most important breakdowns is form of streaming, which is life streaming and streaming of stored content. For the customer lifecycle we must work with specific set of attributes, which are valid for both types of mentioned streaming services. We identified three groups of attributes important for both types of streaming services.

All groups of attributes can be based on three different approaches to analysis and each of them requires different technologies, costs, and preconditions.

Having information in real time is a new trend that brings companies greater competitiveness. Who has correct data first wins. The price for real-time data are higher costs in comparison with historical analysis. For these reasons all companies must always consider which analysis method best suits to them based on the available data and expected delivery speed of the data. Each method has own advantages, which can be used with right combination of data and technology and these reasons can lead to usage of the combination of all approaches in a company. The streaming analysis for the most important data with fast delivery of information and immediate action and real-time/historical analysis for other analysis.

5. Acknowledgement

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INVESTIGATING THE EFFECTIVNESS OF CHATBOTS

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Chatbot, Efficiency, Measurement

Abstract

Chatbot is currently known as one of trends in the Fourth Industrial Revolution. However, there are no proven approaches to measure its effectiveness. The main objective of this paper is to investigate this issue, describe its current state, and to analyse possible known alternatives for measuring the chatbot effectiveness further and to possibly identify a suitable approach according to selected criteria. A literature search was performed within the paper's concept. A document study, questionnaire survey (in the form of pairwise comparison, where output is an expert opinion) and a semi-structured interview were used as specific data collection techniques. The 2018 approach by D. Peras was selected to carry out an analysis of approaches to measuring chatbot effectiveness.

1. Introduction

The start and adoption of the "Industry 4.0" initiative has progressively changed and continues to change the thinking philosophy of today's companies. Under this concept, one can imagine the transformation of production into a fully integrated automated and continuously optimised environment, which regards the digitisation of industrial production, as well as a comprehensive system of changes associated with phenomena such as the Internet of Things, Services and People, autonomous robots and artificial intelligence development, Big Data analysis, digital twin, virtualisation, cloud computing, and augmented reality. The third industrial revolution gave companies the form of information, i.e., information knowledge, which contains the ability to manage information efficiently. The fourth industrial revolution subsequently follows and enables the use of newly introduced technologies to streamline the use of resources significantly (Mohelska & Sokolová, 2021). The focus of this paper is about a technology called chat robot, more frequently referred to as chatbot, which can be included among the trends mentioned above. While its origin dates to the 1960s, it generally began to find its use in various forms in the recent years (Kotoučková, 2020), (Bureš et al., 2012). Because of its abundant deployment, it is often discussed

whether it really fulfils its purpose, or it is merely an idea of the robot's ability to effectively replace human activity. A company needs to have a well-established process for measuring this technology's effectiveness to be able to answer this question. However, a unified approach has not been developed yet to be used frequently, and this is the focus of this paper.

2. Research Objective and Methodology

The main goal of this paper is to select an appropriate tool for measuring the chatbot effectiveness. In this regards the following research question was formulated: RQ: "How is it possible to measure the effectiveness of a chatbot?"

To fulfil the main goal of this paper the following sub-goals must be carried out:

1. Definition of the term chatbot - Literature Review
2. Determining the evaluation criteria of tools for measuring chatbot effectiveness
3. Identification of tools that can measure chatbot effectiveness
4. Selection of a suitable tool for measuring the effectiveness of the chatbot

A search of literature was made initially focusing on chat robots, and subsequently on measuring the effectiveness of IS/ICT and approaches to measuring the chatbot effectiveness. Both printed and electronic sources were used, mostly foreign studies obtained from scientific databases, such as Science Direct, Springer, Web of Science. Keywords such as "chatbot", "effectiveness", "measurement", "assessment", "evaluation", "metrics", in various combinations were used while searching these databases. Both quantitative and qualitative research methods were progressively used to select a suitable tool for measuring the effectiveness of the chatbot. A document study, questionnaire survey (in the form of pairwise comparison, where output is an expert opinion) and a semi-structured interview were used as specific data collection techniques. Moreover, a multi-criteria analysis was performed in the Expert Choice 2000 decision support tool, by which a proper approach was selected to help measure chatbot effectiveness. Relevant criteria and their individual weightings were first identified. This was done using an expert opinion produced using the paired comparison method, in which a total of six KC ČSOB experts involved in the issue evaluated the selected criteria and determined their perceived importance. Comparative results, along with the calculated weights of the defined criteria, were recorded in the partial and one aggregate Saaty matrix. Data retrieved and summarized has been transferred into the Expert Choice 2000 analytics software, using which then, depending on the criteria and their weights, one of the alternatives was compared and selected, a suitable approach to measuring the effectiveness of the chatbot.

3. Literature Review

3.1. Chatbot

Chatbot (also referred to as "chatterbot" or "chat robot") is a technology for automating or simulating human conversation. Adamopoulou & Moussiades (2020) consider chatbot as an artificial intelligence program and a Human–computer Interaction (HCI) model (Mehra, 2021). HCI interactions are especially interesting for the evolving industry of enterprise chatbots Shawar and Atwell (2007) define this technology as a computer programme that mediates interaction between it and a living person using natural language. This means that it should not be recognised that a person is communicating with a robot during the process, and thus there should be an entirely abrupt transfer of information between the two parties. Brandtzaeg and Følstad (2017) believe the

interaction occurs over chat interfaces, which companies frequently put on their websites or by existing platforms such as Facebook Messenger, WhatsApp, Skype, Slack, and others. Some include voice-powered virtual assistants such as Siri, SVoice, Google Assistant, Cortana, and Alexa (Rieke, 2018). Lokman and Zain (2010) believe that its roots date back to 1966, when Professor Joseph Weizenbaum introduced the first chat robot, called ELIZA, whose behaviour was based on the simple principle of searching and creating outputs according to the keywords given as inputs, subjected to the decomposition (transformation) rules, and later it became an inspiration for further chatbots. In 1995, Dr. Richard S. Wallace came up with A.L.I.C.E. (Artificial Linguistic Internet Computer Entity). This led to a new Artificial Intelligence Markup Language (AIML), based on XML (eXtensible Markup Language) dialect, creating naturally speaking software agents. A mathematician named Alan Turing came up with a test to find if the evaluator (real person) recognises whether they are conversing with a chatbot or a human individual. In this test everything takes place in two separate rooms, the evaluator is in one room and human and artificial in the other. Then the evaluator asks questions to which they receive answers, when a chatbot conversation was not detected, the machine passed the Turing test. The Loebner Prize has been an annual competition since 1991 based on passing the Turing test. Russel and Norvig (2010) however, question the practicality of this test in the Loebner Prize competition. One other successful chatbot is Mitsuku chatbot created by Steve Worswick, which is the current five-time Loebner prize winner (Wakefield, 2019).

The application of Chatbot has increased in recent years, its widespread deployment came in 2016 when Facebook and Microsoft started to officially support the use of robots within their platforms (Khorozov, 2017). Business Insider Intelligence (2016) presents the results of a survey conducted by Oracle in 2016, where approximately 80% of surveyed American companies owned or planned to launch a chatbot by 2020 at the latest. According to Nicastro (2018) Inbenta, rated a 50% preference for chatbot communication when shopping online over customer support calls, with 72% of shoppers considering its services to be very helpful and error-free. In the Czech Republic, the Feedyou agency has several cases of successful chatbot implementations in the corporate environment. Companies such as ČEZ, a. s., STRV, s. r. o., Fincentrum, a. s., Knorr-Bremse, s. r. o. and others have benefited from this technology in areas such as HR, customer support, sales or even GDPR (Feedyou, 2019). To be able to accurately consider the introduction of technology as successful or effectively fulfilling its purpose it is necessary to consistently measure its effectiveness. In this regard, no unified approach has been developed that companies could use to assess their chatbot. Other approaches generally deal with the effectiveness of IS/ICT and further present approaches to measuring the effectiveness of chatbot, which are based on foreign studies dealing with this issue.

3.2. Connection with artificial intelligence

Artificial Intelligence (AI) is an interdisciplinary science about the formation of machines or systems that will use a procedure in solving a certain task, which would be considered a manifestation of their intelligence (Minsky, 1967). This definition is based on the Turing test and can be liberally interpreted so that the complexity of solved tasks requires the use of human intelligence. Algorithms and techniques of AI increases the precision of the execution of automated processes (Ribeiro et al., 2021). Čermák (2018) believes that complexity is characterised by the number of all possible solutions and the second attribute is limited by knowledge. He adds that AI deals with the search for boundaries, including the representation of acquired knowledge and processes, the acquisition and use of it in solving problems, and uses various approaches and algorithms to find the basis of very complex tasks. According to Stuart and Norvig (2010) AI not only attempts to understand intelligent entities but also attempts to build them. In 1958, John McCarthy created a language for artificial intelligence called LISP. In the early 1970s, the

PROLOG language was created by A. Colmerauer. Moreover, several universal systems were designed through this period that were unable to solve highly specialised tasks. The expert systems task is to simulate the decision-making process of specialists in solving complex tasks using a knowledge base. MYCIN and PROSPECTOR are considered as successful pioneers of expert systems. Relationships of a social and affective nature that contain artificial entities, like social chatbots, may now be designed due to advances in AI (Skjuve, et al., 2021). Chatbots can function using predefined rules based on language structures (rule-based) or using a statistical model of natural language processing, which deals with the machine learning.

3.3. ICT/IS effectiveness

Molnár (2000) believes it is important to examine systems with a purpose in terms of information system (IS) and information technology (IT), i.e., information and communication technologies (ICT). IS represents the need for information, while IT represents the satisfaction of this need. These systems are called target behaviours. The evaluation of efficiency addresses the issue of needs and their fulfilment as well as the expectations of the involved parties. From a company-wide point of view, these can be:

- owners who see IS/ICT as a permanent appreciation of the assets invested in the company,

- managers who can effectively manage the company based on IS/ICT,

- employees to whom IS/ICT offers benefits in the form of a superior, more efficient, and fully integrated work environment,

- customers to whom IS/ICT brings greater added value of the needed product or service.

The selection of indicators depends on the case, and the most relevant relationship for evaluating effectiveness is measurable by the degree to which objectives are achieved, i.e., as follows:

Effectiveness = achieved goal value / planned goal value.

4. Results and discussion

To accomplish the objective of the paper, it is necessary to select a suitable approach for measuring chatbot effectiveness. Hence, an analytical decision support tool called Expert Choice 2000 was selected. According to Expert Choice (2020), the first step in multi-criteria decision-making is to define the goal that should be achieved.

The next step is to establish selection criteria. This was chosen based on a careful study of scientific studies dealing with the evaluation of chatbot and the advice of ČSOB experts. Five areas are selected as the most important criteria, which, should not be missing in the right approach to measuring chatbot effectiveness. These include:

- user friendliness - evaluating the impression of the chatbot on the user and whether they are satisfied with their services during the interaction,

- information ability and equipment - finding out and supplementing the state of the chatbot knowledge base so that the produced outputs can satisfy the user's needs,

- language level and equipment - evaluation of the chatbot's ability to create correct and verbally diverse outputs in terms of spelling and grammar,

- humanity - assessing whether the chatbot behaves like a human,

- business aspect - finding out what added value chatbot brings for a company and the metrics associated with it.

The established criteria can be considered important, but not to the same extent. Thus, it is essential to determine suitable weights for each of them. Questionnaire survey results were used in the form of a pairwise comparison for this purpose. The research involved six selected managers and analyst interested in this issue, which were capable of relevant assessment (they cover the administration, operation, support, and all processes related to a chatbot). The survey's goal was to find out the importance that managers associate with the defined criteria, based on which their final weights were determined, i.e., the expert opinion. The questionnaire was created according to the Saaty method of pairwise comparison and the form of its processing was inspired by the Expert Choice 2000 programme. The data obtained from the performed research were processed into partial Saaty matrices. Initially a matrix was created for every expert individually, whereby the output was the calculation of the partial and total geometric diameter and subsequent weights for the first to fifth criteria. These calculated weights were transferred to a common matrix showing their relationship from the first up to the sixth respondent. Then, an arithmetic mean was calculated from the individual weights for each criterion, giving the values of the resulting (uniform) weights (Table 1).

Table 1. Determined weights of criteria and their final order

Criterion	Weight	Sequence
User friendliness	0.214	3.
Information ability and equipment	0.345	1.
Language level and equipment	0.099	4.
Humanity	0.045	5.
Business point of view	0.297	2.

Respondents consider information ability and equipment (to satisfy the needs of existing or potential clients) as the most important criterion. Hence, ensuring information capability and equipment represents added value for the customer and it is followed by the business aspect, which is formed by metrics evaluating the added value for the company. The weights of both criteria independently are around one third of the five criteria and so together they represent a nearly two-thirds preference overall. Then, metrics focused on these two aspects should not be missing in a suitable approach to measuring chatbot effectiveness.

User friendliness is the third most important criterion, this needs an evaluation on how the chatbot acts towards the user and how satisfied users are with its services. Therefore, it is necessary to ensure the possibility of gaining the most pleasant and effective experience that the user receives during interaction with the chatbot. Language and equipment are less important. This means assessing the chatbot's ability to produce correct and verbally diverse outputs where the user can apprehend a precise interpretation of the transmitted information. Humanity is the least important criterion. In the case of artificial intelligence, humanity testing plays a vital role, the chatbot is designed to fulfil a specific task. The user however knows that they are conversing with a chatbot and not a live operator, so the company pays more attention to other more important criteria.

Searching the following Keywords "chatbot", "effectiveness", "measurement", "assessment", "evaluation", "metrics" and their combinations in scientific databases such as Springer, Science Direct, Web of Science discovered only a few publications that would be of use for the purposes of the paper. Seven studies were selected by the method of analysis and subsequent synthesis, which dealt with at least two areas of measurement, i.e., selection criteria and included useful metrics. Four from these seven studies were selected by discussing the most relevant findings, which offered the most comprehensive approach to measuring the chatbot effectiveness (dealt with at least four of the five required measurement areas). The following alternatives were chosen to select a suitable

approach to measuring chatbot effectiveness: Kuligowska (2015), Maroengsit et al. (2019), Peras (2018), Radziwill and Benton (2017).

5. Conclusions

The following two graphs (Figures 1 and 2) were created using the multi-criteria decision-making process implemented in the vAHP software product Expert Choice 2000, exhibiting the suitability of selected approaches to measuring the effectiveness of the chatbot.
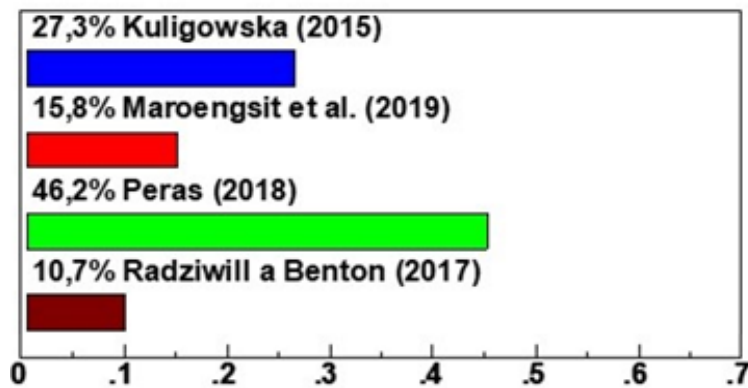
Figure 1. The result of selecting a suitable approach to measuring chatbot effectiveness in percentage terms

Figure 1 illustrates the changes in the suitability of separate approaches. Based on the multi-criteria analysis results, the best rated approach is from Peras (2018), which achieves almost 50% fulfilment of the evaluated criteria compared to other alternatives. Only 10% of the criteria were met by Radziwill and Benton (2017), which was insufficient and unsatisfactory in terms of the three out of five criteria.
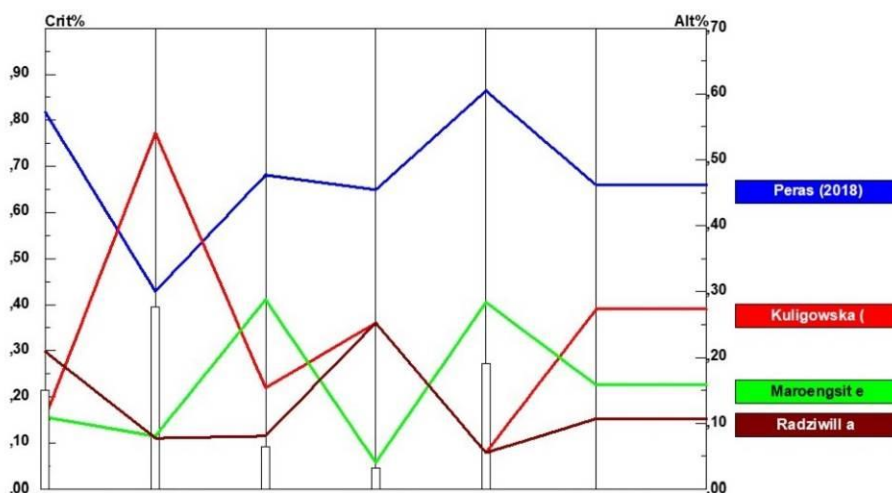
Figure 2. Graphical representation of the selection of a suitable approach to measuring chatbot effectiveness

(according to individual criteria - User friendliness, Information ability and equipment, Language level and

equipment, Humanity, Business aspect).

To answer the research question, the most fitting approach out of the four analysed was the method of measurement created by Peras (2018), who divided the process of evaluating the effectiveness of chatbot into five standpoints. The defined aspects fully capture the chosen criteria, and it has a better score compared to other alternatives, with only one exception. This exception is the visible

fluctuation recorded in the criterion "Information ability and equipment", which was given the highest importance by the participants forming the expert opinion of the individual scales (Figure 2, second value). Here it was exceeded by Kuligowska (2015), who directly deals with evaluating the knowledge base equipment, and in terms of overall results, it finished in second place. In other matters, the measurement method was comparable to the two remaining approaches, and the largest decline was recorded in the commercial aspect because of lack of its consideration. Maroengsit et al. (2019) was in the third place and took one third of what the preferred approach from Peras (2018) and was described as unsatisfactory for two criteria. The approach from Radziwill and Benton (2017) is the least useful comparison of competitions, which is insufficient from the perspective of three criteria and its main problem is due to the lack of the implementation method for its proposed attributes and more detailed elaboration into partial metrics.

6. Acknowledgments

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THE TECHNIQUE TO SOLVE SYSTEM CAPABILITY PROBLEMS PREDICTIVELY AND PRESCRIPTIVELY

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Keywords

Dynamic capability, system potential, efficiency, model, technique

Abstract

Problems of predictive and prescriptive research of the value of system's dynamic capabilities and closely related issues such as the value of information technology continue to be of interest for researchers at the intersection of economic, information systems, management science, and operations research. Information Systems literature conceptualizes that information technology is a platform for agility that derives value to the firm. Economic literature conceptualizes that dynamic capability is the ability to sense and then seize opportunities quickly and proficiently. Information systems shall perform information operations for such agility and capabilities, such as sensing operations considered in the paper. This paper examines the techniques to solve dynamic capability and information technology value problems. Problems solved analytically, predictively, and prescriptively. This goal paper suggests a technique to solve IT problems' dynamic capabilities and value with a new mathematical formalism. The author describes models, application example and discuss results. The formalism, families of alternative stochastic networks, is described on application example. Such families of networks allowed us to model alternative functioning cases due to changing system environment conditions and the environment's impacts, determined by sensing information operations. Researchers can now create analytical models to research dynamic capability organizational capability, sustainable development, information technology value. Numerical results obtained with the developed application are analyzed with R statistical language and illustrated with R 3D graphics plots.

1. General

There is a gap between the need to decide a variety of problems, such as infonomics (Laney, 2017), IT value (van de Wetering), information technology (IT), and information systems (IS) governance (IT Governance Based on CobiT 4.1: A Management Guide, 2010; Mitchell & Switzer, 2012), process mining (van der Aalst, 2011), strategic planning problems (Warner & Wäger, 2019), on the one hand, and theoretical models and methods available for such problems decision as related mathematical problems - on the other hand. The research hypothesis is that gap mentioned can be filled with suggested analytical, predictive, and prescriptive models. Families of alternative stochastic action networks suggested as such models.

System capability is a system's ability to achieve changing goals to react to the evolving environments (Di Stefano et al., 2010). We consider complex technical systems (CTS), which are such systems that include interrelated elements of a different nature, i.e., mechanical, organizational, human, and technological components. For such CTS system, the capability

required to react correctly to CTS environment changes and impacts, mainly - to respond to environment attacks, respond to goals changes so - to interact properly with the environment and parts of the system under environmental impacts. Information operations of sensing kind (performed by humans or sensors) are needed (Raschke, 2010) to create such capability and provide interaction under changed conditions. The system capability is used to estimate information technologies performance indicators, dynamic capabilities indicators, organizational capabilities indicators, system dependability indicators, agility indicators, IT value indicators (particularly – sensing operations value for the system under study). Further, indicators of this property are used to solve various practical problems as appropriate mathematical problems of indicators estimation and the CTS elements, capabilities, information operations synthesis based on indicators, estimated as a function of possible CTS characteristics (Geyda & Lysenko, 2014; Geyda & Lysenko, 2020). For estimation of such property complex of models is necessary. It shall reflect the interacting system, its environments of a different kind, and information operations. Information operations must check the system and its environment functioning states (sensing operations) to measure their correspondence (measuring operations). Then information operations are used to choose further actions (choice operations) and then alternate the CTS functioning to achieve a possibly changed goal (alternate operations). Models of information operations use as a reaction to modeled environment changes, and families of alternative stochastic networks were considered in our previous publications. This publication concentrates on families of alternative action networks application implemented, example computations details, and obtained numerical data analysis and visualization.

2. The Environment Model Example

For the environment model in Figure 1 let us suppose that each state of the environment $c_i^e(T)$ at the given moment T determined by environment action a_i^e, performed at this moment. $i -$ action identifier. State $c_i^e(T)$ actualized at the beginning of the environment's action and changed to the next state to start a new action immediately after ending the previous one. The example environment model is based on the assumption that the environment performs one and only one action at any given moment. The characteristics of the environment states are illustrated in Table 1.
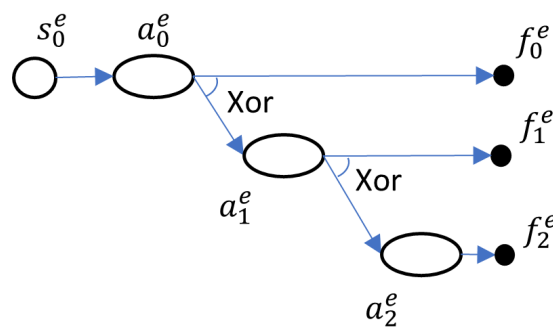
Figure 1: Simple environment model

Actions states at any time interval are calculated under the condition that a sequence of preceded actions (and states) of the environment are implemented before each consecutive environment action (and so, state) starts. Actions and correspondent states of the environment sequences C_n^e form the vector (multidimensional array) $C^e, |C| = N$ of possible sequences of actions of the environment. Table 2 describes the CTS's possible actions (in response to environmental demands) and modes of these actions. The objective of the model M^e of the environment, functioning is to construct the array C^e and to calculate its characteristics, required for model M^s of system

functioning in changing conditions. The example of C structure is shown in Table 3. Let us designate $s_1^d(T_m), \dots, s_k^d(T_m)$ −caused by the actualized goals of the environment demanded states of the system at future moments $T_m \geq T_j$ (as a rule, $T_m \neq T_{i+k} \in T$). These states shall be properly determined at sensing moments T_m with appropriate sensing operations. In the example, moments T_m are non-probabilistic and the moments are given.

Table 1: The Characteristics of the Environment State

$P_{i,i'}(T_i)$	P_{nj}^a	T_i	T_{i+1}	$s_1^d(T_m)$	...	$s_k^d(T_m)$	...

3. Role of Information Operations in System Functioning Alternation

Demands to the system functioning are formed based on actualized goals and technology description by information operations Ti^{sbe} of different kinds. For example, demand s_k^d is the subnetwork g_k of system functioning whose actions should be successfully implemented up to the given moment T_m, and total cost C^d to perform technological operations shall not be larger than allowed. The estimated probabilities of the sequences characterize each line in Table 3 C_n^e and cells c_{nk}^e being implemented. Each cell c_{nk}^e corresponds to the estimated probability of the state actualization at the cell time frame, provided that the given state sequence C_n^e realized. Each sequence contains states - $< c_0^e, \dots c_i^e, \dots, c_{i+1}^e \dots c_p^e, \dots c_m^e >$ of alteration (transitions). These alternations are implemented according to the information operation. The need to perform informational and then transitional operations is caused by a changing environment. It is typical for the complex technical and socio-technical system, considered an example, and for other systems, which regularly interact and are altered by environmental actions. Such need is genuine for digitalization in various industries, described by such popular terms as digital production, digital medicine, digital economy, and digital state (Parida et al., 2019). As evidenced by the analysis of digitalization (Rosenberg, 2021; Zhu, 2021), its research based on the dynamic capabilities, organizational capabilities of the system use, and the ability of the system and its operating personnel to change functions so that it better meets changing conditions, improves and achieves changing operation goals.

Table 2: The actions and action modes data

a_i	a_{mi}	t_a	t_b	...	Operation name
1	1	3	5	...	Conn. of the P921A to IA
2	1	8	30	...	Conn. of the P27AB to IA
...	...	...	...	...	...
n	1	12	55	...	Fueling of the P921A
...	...	...	...	...	...

Table 3: Alternative Sequences of Environment States in Time

№	$< c_i^e >/T_z$	T_0	T_1	T_2	...	T_j	...
	$< c_0^e >$	c_0^e	c_0^e	c_0^e		c_0^e	
	$< c_0^e, c_1^e >$	c_0^e	c_0^e	c_0^e		c_1^e	
...	...	c_0^e	c_0^e	c_1^e	...	c_1^e	...
n	$< c_0^e, c_1^e, c_2^e >$	c_0^e	c_1^e	c_1^e		c_2^e	
...	...	c_0^e	c_1^e	c_2^e	...	c_2^e	...

The new property of the system capability proposed is an operational property that characterizes the system's ability to achieve the changing (i.e., current and possible) goals during operation (in a

changing environment). Such property depends on the characteristics of the "target" and "transition" functions of the CTS, including the informational actions performed to check the state of the CTS and the environment, develop prescriptions for performing technological operations, and bring the orders the executors.

This property's indicator is evaluated depending on the composition and characteristics of different types of possible actions. They form a set of choices in the problems solved. The system's capability is represented by a corresponding random variable's characteristics describing the system states' compliance measures with requirements or attributes that describe such measures of compliance (e.g., random vectors, graphs). To estimate IT performance indicators or digitalization effects indicators under conditions of change and interaction, we proposed using the difference between system capability indicators values for new (for example, digital) IT technology use and primary (for example, traditional) IT technology use. Thus, IT I_a indicator $\Phi(I_a, I_0)$ compared to primary IT I_0 can be estimated as difference:

$$\Phi_1(I_a, I_0) := \psi_1(I_a) - \psi_1(I_0), \Phi_2(I_a, I_0) := \psi_2(I_a) - \psi_2(I_0). \quad (1)$$

where $\psi_i(I_i) -$ scalar indicator of kind $i = 1, 2$ (from the set of mode, median, moment, quantiles) of system' capability under condition IT of kind a used. As a result, if two sensor technologies used, the $\Phi_i(I_a, I_0)$ can be used to determine the best technology. Further, it can be used to solve sensor technology $I_a, a \in \overline{1, A}$ an optimization problem to achieve the best $\Phi_i(I_a, I_0)$.

4. Example of System Alternative Functioning Modelling in Application Developed

Alternative functioning is modeled with $FASAN -$ the families of alternative stochastic action networks, which allow alternate system functioning modeling. $FASAN$ is a system of graphs. $FASAN$ defined based on sets of graphs (the base of $FASAN$), relations between them and states, and mappings between graphs and states. With the use of the $FASAN$ it is possible to describe alternations of the functioning, including alternations defined by networks of operations. As shown in previous works, network chains form possible trajectories of system functioning alternations according to each given row of environment functioning alternatives.

Results obtained are $M_z = m_u(S_z)$ the measures of sequences of environment realizations, cuts actualizations, corresponding networks actualizations for each possible sequence of operations, and measures $W_z = w_u(S_z)$ of the results of such operations compliance to the demands $s_k^d(T_m)$ to results. $s_k^d(T_m)$ provided by the information operations. The measures mentioned are conditional. Depending on the time and system characteristics they form the system capability multidimensional measure $\Omega(D, T)$:

$$\Omega(D, T) = \omega(S_z, D, T, z \in Z) = < M_z(D, T), W_z(D, T), z \in Z >,$$

Where $D -$ decision concerning system characteristics. $\Omega(D, T)$ can be referred to as multidimensional discrete probabilistic distribution of system functioning results of various kinds at possible conditions. $\Omega(D, T)$ allows solving contemporary research problems as mathematical problems of choice or optimization by system capability indicators.

5. Methodology

As a result of computations, the multidimensional matrix structure of probabilities sequences depending sequences of environment conditions formed. An example of such structure is:

[35,"01",0.001043672574109,...,0.0001575290810923],

where the first two numbers are the ID of system functioning, and ID of environment functioning, and further real numbers are probabilities. These structural elements are used to build reports with the use of R statistical language. It allows analysis of computed probabilistic data with the use of established probabilistic routines. Figure 2a) produced by R program from two comma-separated values files with output data for sequences of the system functioning, which corresponds to environment changes of the length one in the environment. Axes are sequences of functioning actualizations, compliance, and total probabilities. Figure 2 b) produced for the system functioning sequences, which corresponds to environment changes sequences of the length of two events in the environment. The R code use generic R function persp() to produce plots from zz1 and zz2 dataframes with $\Omega(D, T)$ data: persp(iXY01$x, iXY01$y, zz1, ylim = range(iXY01$y)*0.12,xlim = range(iXY01$x)*0.5, xlab = "Actualization probability", ylab = "W", zlab = "Total possibility").

a)   **b)**
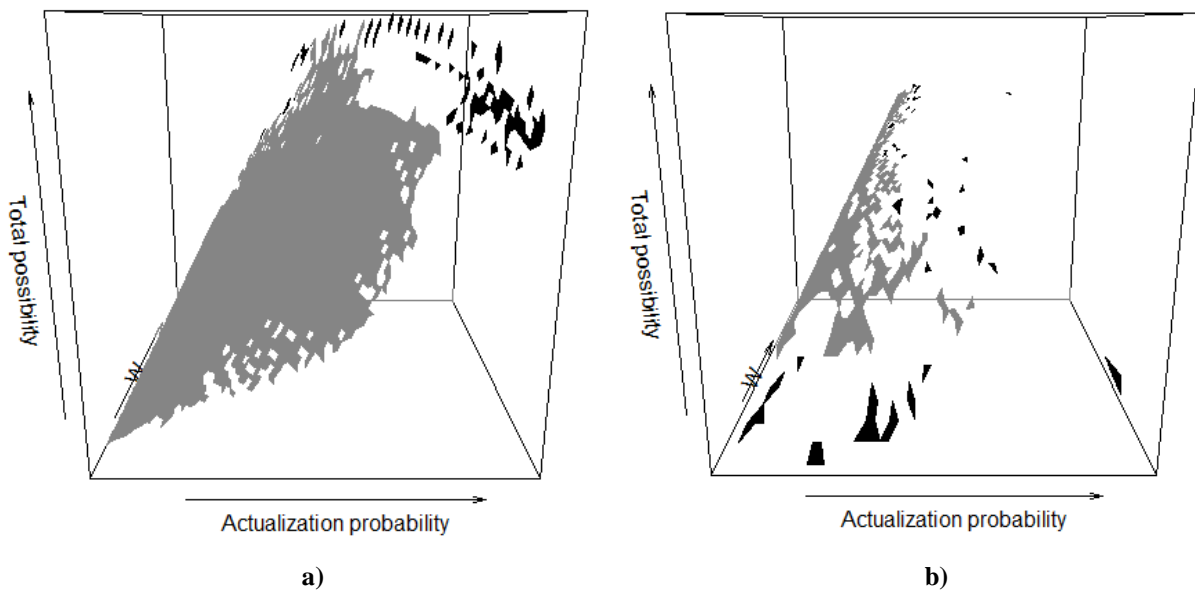
Figure 2: The possibilities of transitions and correspondences in the sequences of the length one (a) and two (b)

The surfaces a) and b) obtained are quite dense, excluding series of points in the upper part of the Figure, i.e., realizations of functioning with highest actualization possibility and highest compliance are rare (shown as black areas) events. In contrast, regular compliance - actualization's pairs form a regular structure (shown as a grey area). The feature mentioned gives the possibility to represent such surfaces with the use of a frequent structures approach.

6. Conclusion

As a result of the suggested models and application, the quantitative estimation of indicators of system capability, dynamic capability, IT value becomes possible, the number of information technology (IT) and information systems (IS) governance, process mining, strategic planning problems, can be solved now as related mathematical problems, predictively and prescriptively.

Therefore, the research hypothesis is confirmed. Precisely, models of the environment and system interplay, presented in the article, estimate the sensor kind information operations' quality. Results obtained can be further used for system capability indicators prediction based on some structural features of probabilities dependencies discovered in the article.

7. Acknowledgement

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INNOVATIONS AND STRATEGIES IN A PANDEMIC ERA

INNOVATING EDUCATION FOR A FUTURE SECURE SOCIETY

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Abstract

Ensuring a secure and resilient society represents a challenge for all governments in today's globalized world. Recent Covid-19 outspread has shown vulnerabilities of a modern interconnect society which faced health-, economic- and cybersecurity threats in the same period. It also put enormous pressure on the smooth functioning of both private and public services and accelerated its development which is not imaginable without fast digitization. A new type of education is needed to raise future experts to think strategically and plan, design, purchase, or implement modern digital services for citizens and ensure their secure and reliable operation. They should understand the principles of contemporary society, its most challenging problems, significant threats, and the importance of multi-faceted views and have the necessary skills to communicate the issues and formulate visions in a multidisciplinary environment. The paper will compare selected world-class universities and government initiatives towards this new type of education, such as the U.S. Digital Service Academy. It will show other instruments such as Digital Innovation Hubs of the EU and cybersecurity qualification frameworks. Finally, it offers the new program on cybersecurity provided by Masaryk University as a working example of a study program with ambitions to help securely digitize modern society.

1. Introduction

Cybersecurity is a prerequisite for Europe to achieve digital sovereignty, while it also is a promising economic discipline growing 15-20% annually (Doucek & Hološka, 2019; European Commission, 2021). The specific goals of the Digital Europe Programme in cybersecurity are:

- advanced cybersecurity equipment, tools, and data infrastructures, together with the Member States

- knowledge, capacity, and skills related to cybersecurity; best practices

- wide deployment of effective state-of-the-art cybersecurity solutions, paying particular attention to public authorities and SMEs

- capabilities within the Member States and the private sector in support of the NIS Directive

- resilience, risk-awareness, at least basics levels of cybersecurity

- enhancing synergies and coordination between the cybersecurity civilian and defense spheres by facilitating knowledge and best practices, and more.

On the European scale, there is evidence of interest in hundreds of thousands of cybersecurity professionals – generally up to 800,000 vacancies in IT in general, of which up to 2022 according to the *EC Communication: Resistance, Deterrence, and Defense… 450/2017* there is up to 350,000 vacancies in cybersecurity. Multidisciplinary professional education is explicitly needed by Czech authorities (NÚKIB) and economic associations. Specifically, small and medium enterprises are endangered due to the high-tech nature of the skills required and lack of specialists in the field, see Kasl (2018).

Therefore, the goal of the paper is to show ways, models, and priorities taken by relevant authorities towards educating cybersecurity experts.

1. Outline and methodology

First, we focus on cybersecurity as a crucial precondition of all government e-services and infrastructures. We identify skills gaps, namely among cybersecurity professionals having at least a bachelor's degree. To overcome the gap, many study programs on cybersecurity recently emerged. However, they might vary in quality and specific focus. Therefore, the goal is to find a common denominator of university (preferably undergraduate) degrees in cybersecurity implemented on a top university. By a common denominator, we mean the actual study contents that are present almost everywhere. Secondly, we want to identify the specific parts that the top-level school provide as their unique specializations are still related to cybersecurity or information security. Thirdly, we focus on resilience, critical infrastructure protection, government digital services (e-government), and cybersecurity of other (at least partially) public services such as healthcare. The research has been organized as follows.

The best ranking universities in Computer Science by *THE World University Rankings 2021* currently enlists 827 institutions worldwide and is considered a transparent, reliable source of ranking data based on well-defined criteria. Thus, ten best-ranking universities in Computer Science, according to their overall score, have been selected. For each chosen university, we found the study program or programs that fit the following criteria (order from highest priority):

- *Undergraduate* program on cybersecurity and/or critical information infrastructure protection.

- *Graduate* (Master) program on cybersecurity and/or critical information infrastructure protection.

- *Professional* (postgraduate, lifelong, continuing) program on cybersecurity and/or critical information infrastructure protection.

- *Program with sub-specialization* on cybersecurity and/or critical information infrastructure protection.

After the selection, we compared the university program profiles with the US Digital Service Academy (USDSA as a pragmatic, purpose-oriented, federal government-initiated alternative to top

research universities in the US and abroad recently established to overcome the gap in high-profile experts serving the government.

In the EU, we see a similar initiative in the Digital Europe Programme. It also defines European Digital Innovation Hubs (EDIHs) that will function as one-stop shops that help companies dynamically respond to the digital challenges and become more competitive, so we included the Czech Cybersecurity Innovation Hub as an example of a fully operational hub serving not only the SMEs but also public administration to increase the quality and enforce cybersecurity in public services.

Finally, we show an example of the currently launched carrier-oriented Bachelor's study program on cybersecurity to educate cybersecurity experts for industry and public services. We compare its graduate profile and content with those from top-level universities and USDSA.

2. Top university programs

2.1. University of Oxford

The *Software and Systems Security Master* program at the University of Oxford (Oxford, 2021) teaches the principles of systems security, emphasizing the security properties and implications of software and information technologies. Apart from the commonly taught courses on security principles, secure design, security management, it has specialized courses on *building information governance, mobile systems security, and wireless networks*. It can be characterized as technologically oriented, focusing on infrastructures (networking, wireless, buildings, clouds). It also features risk management and the role of people. Specifically, Oxford educates experts for *certificates of the GCHQ*, an intelligence, cyber, and security agency of the UK.

2.2. Stanford University

Stanford University educates undergraduate computer science and security experts (see Stanford, 2021) based on a solid STEM and, namely, electrical engineering background in courses such as *calculus, mathematical foundations of computing, introduction to probability for computer scientists, mechanics, electricity, and magnetism, programming abstractions, introductory electronics, engineering fundamentals elective, technology in society, programming abstractions, computer organization and systems, principles of computer systems, mathematical foundations of computing, introduction to probability for computer scientists, data structures and algorithms,* and *senior project.*

2.3. Massachusetts Institute of Technology (MIT)

A powerful point of MIT's offer is the professional (postgraduate) program on information security and cybersecurity (MIT, 2021). In a compressed form, it teaches the following courses – *Introduction to information security fundamentals and best practices, Ethics in cybersecurity & cyberlaw, Forensics, Network Assurance, Secure software & Browser security, Business information continuity, Information risk management, and Cyber incident analysis and response.*

2.4. ETH Zürich

This *Cyber Security Master* program at ETH Zürich offered in collaboration with E.P.F. Lausanne (see ETH, 2021), provides a broad set of courses ranging from cryptography and formal methods to systems, networks, and wireless security. So, it is well-founded in theory and the latest technology

trends covering *security engineering, system security, network security, applied cryptography, applied security laboratory, and advanced topics in communication networks*. One of the unique features of ETH offer is the presence of *professional degrees in cybersecurity*, namely C.A.S. (short) and DAS (longer).

2.5. Carnegie Mellon University

Master of Science in Information Security program at Carnegie Mellon University (Carnegie Mellon University, 2021) aims to prevent electronic intrusion of the most critical IT networks. It is also focused on defense against online *media assets thefts and identity protection* as a somewhat unique feature. The university also offers the *Information Security Policy and Management* program, where attention is paid to *risk management, information security, and digital privacy*.

2.6. Cambridge University

The undergraduate *Computer Science* program of the University of Cambridge, see (University of Cambridge, 2021), is constructed substantially from a well-founded theoretical background where three compulsory computer science exams on foundations of computer science, object-oriented programming, operating systems, and digital electronics, graphics, interaction design, and mathematics. Secondly, the students make four topics *Theory* (logic and reasoning, computational theory), *Systems* (computer design, computer networks), *Programming* (compiler construction, advanced algorithms), and *Applications and professionalism* (artificial intelligence, graphics, security). There is also a group project that reflects current industrial practice. Students write a non-trivial dissertation on a project that is often linked to recent research.

2.7. Harvard Extension School

The *Cybersecurity Graduate Certificate* at Harvard see (Harvard Extension School, 2021) helps to gain a critical understanding of the technological needs, threats, and cybersecurity weaknesses. The applicant gets knowledge tools and protocols to navigate, use, and manage security technologies and insight into cyberspace's legal, social, and political dynamics. It covers in the general *data network* and *communications technology, architecture, management*, technical and organizational information security risks, and *communication tactics to mitigate these risks* for both traditional and cloud-based environments, effective enterprise information *security policies* that address internal and external *national and international threats,* strategies and protocols needed to *secure and monitor computer networks* in global organizations, including *forensics, governance, regulation*, and *compliance, software application lifecycle, cyberspace, and international security*.

2.8. National University of Singapore

Bachelor of Computing in Information Security provided by the National University of Singapore (National University of Singapore, 2021) expects an internship in *industry*, *voluntary welfare* organizations, or *start-up internship*. Otherwise, the program is robust in all fundamental computer science and technology pillars, ranging from programming, data structures, SW engineering, operating systems, and computer security. Computer security-related courses include *information security management, cryptography theory and practice; cryptography, computer security practice, software security, algorithmic foundations of privacy, IoT security, systems security, network security, database security, web security, biometric authentication, legal aspects of information security, digital forensics, penetration testing practice, its governance, legal aspects of information technology, compliance and regulation technology, blockchain and distributed ledger technologies, ethics in computing and effective communication for computing professionals.*

2.9. University of California, Berkeley

UC Berkeley School of Information provides *a Master of Information and Cybersecurity*, see (University of California in Berkeley, 2021) that prepares students for a professional career in cybersecurity. Based on a holistic approach to cybersecurity, students develop technical expertise while understanding behavioral, economic, legal, and ethical concerns. The areas of interest involve *secure coding, network security, government, and national security, cryptography, usable privacy and security, operating system security, cyber risk, privacy engineering, security in context: economic, legal, behavioral, and ethical.*

2.10. Imperial College London

IC London offers a postgraduate program in Computing (Security and Reliability), providing insight into the topics of advanced security, cryptography engineering, information, and coding theory, large-scale data management, network and web security, and privacy-enhancing techniques, see (Imperial College London, 2021).

2.11. Summary and comparison

1. *The software and Systems Security* Master program at the University of Oxford can be characterized as technologically oriented, focusing on infrastructures (networking, wireless, buildings, clouds). It also features risk management and the role of people.

2. Stanford University educates undergraduate computer science and security experts based on a solid STEM and electrical engineering background.

3. MIT offers a professional (postgraduate) program on *information security and cybersecurity* as a well-balanced, universally applicable set of theory, technology, and business-oriented courses, not overlooking ethical principles and cyber law.

4. The Cyber Security Master program at ETH (Swiss Federal Institute of Technology) Zürich is rather technologically oriented and offers two professional programs on cybersecurity.

5. Master of Science in *Information Security* program at *Carnegie Mellon University* features defense against online media assets thefts and identity protection.

6. *The Computer Science* program of Cambridge University is constructed substantially from the well-founded theoretical background.

7. *The cybersecurity Graduate Certificate* at Harvard is comprehensive in scope, including national and international security aspects.

8. *Bachelor of Computing in Information Security* provided by the National University of Singapore is strongly oriented at principles, technology including up-to-date trends but also covers legal and ethical aspects.

9. UC Berkeley School of Information's *Master of Information and Cybersecurity* is based on a holistic approach to cybersecurity, gaining technical expertise and understanding the behavioral, economic, legal, and ethical concerns.

10. IC London offers a postgraduate *Computing (Security and Reliability)* mainly in network, web, and advanced security and applied cryptography and privacy.

Altogether, many of the provided programs at world-leading computer science teaching institutions are positioned at the Master's level, requiring, among others, fundamental prerequisites in computer science, while some of them also provide undergraduate cybersecurity programs or professional

(postgraduate, lifelong) programs. Thus, all of the levels and forms are relevant and needed – from Bachelor to postgraduate levels. Due to our focus at BSc and MSc levels, we have not included Ph.D. studies in general.

3. US Digital Service Academy

US Digital Service is a government agency overseeing federal issues in digitalizing government services to transform critical, public-facing services, expand the use of common platforms, services, and tools, and rethink how the government buys digital services.

To bring top technical talent into civic service, a *US Digital Service Academy* (USDSA), see (Mervis, 2021; Schmidt, 2021), is planned to meet the federal government needs for workers being similar to existing military academies in providing students with a tuition-free education in exchange for five years of government service. However, the graduates will join the civilian workforce at federal agencies.

Though all the details are not known at the date of publishing, the core model of the study has already been briefly presented. The students of this 3-4 years program should start with curriculum basics, a summer interim in the private sector, then selecting a major during its second year together with essential security clearance, continuing through a government agency interim, followed by a focus on major and commitment to a government agency. The third year should be finished with a summer internship in the private sector, and the fourth year is mainly focused on job placement in government agencies.

To sum up, the USDSA initiative should help the US keep pace with the growing needs for technology experts working for the government through huge investment to compete with industry to attract top talents for IT, namely AI and cybersecurity and other disciplines.

4. Digital Innovation Hubs

European Digital Innovation Hubs (EDIHs) are central pillars of the Digital Europe Programme, (Rissola & Sörvik, 2018). They aim to foster the adoption of Artificial intelligence, High-performance computing, cybersecurity, and other digital technologies by industry, particularly SMEs and public sector organizations in Europe. By providing access to technical expertise and experimentation, as well as the possibility to test before investing, EDIHs will help companies improve business/production processes, products, or services using digital technologies, see Crupi et al. (2020). The first "generation" of EDIHs will be settled during 2021. The process primarily included nominations from EU Members countries – EC gave frame indicators about the foreseen number of Digital Innovation Hubs supported by the EC as EDIHs. Therefore, the candidates must have submitted their applications to the responsible national body, such as was the *Cybersecurity Innovation Hub (2018)*.

5. Qualification Frameworks

5.1. General Initiatives

To provide a stable background and reference point for the growing demand for cybersecurity expertise, many national- and international initiatives have been launched to define qualification frameworks describing profiles, expected knowledge, skills, and attitudes to fulfill specific professional roles of the cybersecurity-related workforce, see Schaeffer et al. (2017).

The *USNational Initiative for Cybersecurity Education* (NICE) has developed a comprehensive cybersecurity qualification framework called NICE, being published by the National Institute of Standards and Technology (NIST). The organizations and individuals should be able to use the framework to (NIST, 2017) *map or assess their cybersecurity workforce and understand the strengths and gaps in Knowledge, Skills, and Abilities (K.S.A.) and Tasks performed, identify training and qualification requirements, improve position descriptions selecting relevant K.S.A.s and Tasks, identify the work roles and develop career paths to guide staff in gaining the requisite skills for those roles, establish a shared terminology between hiring managers and human resources team for the recruiting, retention, and training of a highly-specialized workforce, provide a reference for educators to develop curriculum, certificate or degree programs, training programs, courses, seminars, and exercises or challenges that cover the K.S.A.s and Tasks described and, finally, allow a technology provider to identify the cybersecurity work roles and the K.S.A.s and Tasks associated with hardware and software products and services they provide.*

Analogically, many related or unrelated activities develop similar frameworks, such as A.C.M. et al. (2017). All the pan-European H2020 Networks of Excellence in Cybersecurity (SPARTA, CyberSec4Europe, Concordia, and ECHO) have cyber-qualifications and education as their tasks at least mapping of the current industrial and public sector demand as well as the educational offer by universities and professional education providers.

5.2. **Czech Cybersecurity Qualification Framework**

The Czech National Cybersecurity Qualifications Framework is highly inspired and compatible with the European Qualification Framework (see CEDEFOP (2008). Due to its position among the e-skills, it is strongly influenced by the European e-Qualifications Framework (CEN, 2016).

According to (Ministr et al., 2019), it is to be developed in the following phases:

- *Creating a Taxonomy of Qualifications* – analysis of existing solutions and research results abroad, investigation of needs within the security forces in the Czech Republic, and identification of the character and structure of relevant entities in the Czech Republic. The necessary qualifications in both technical and non-technical fields at both private organizations and the state will be offered in a structured manner.

- *Design of a Competency Model* – professional competencies will be assigned to the individual roles/qualifications – those should be considered prerequisites for performing the appropriate position in cybersecurity.

- *Cybersecurity Qualifications framework* – the Qualifications Framework will include proposed taxonomy and competencies of individual qualifications, extended to identify the required training capacities based on the existing demand for capabilities.

- *Analysis of available education in the Czech Republic* – based on surveys and questionnaires, the current offer of public educational programs, courses, and cybersecurity exercises will be identified, which can be used to build the necessary capacities described in the framework.

- *Gap analysis* – the training requirements described in the framework with the existing offer will be compared. Based on this comparison, quantitative and qualitative gaps in terms of available cybersecurity education should be identified.

- *Action plan on building educational capacities* – to effectively implement the project results, the aim will also be to develop an action plan to inform users and target groups about the practical application of research results at the level of support and development of cybersecurity training and recruitment and evaluation.

- *Interactive Database for Qualifications Framework* – to effectively implement the Qualifications Framework, an interactive software tool will be created to provide a knowledge database.

6. Carrier-oriented Cybersecurity Education

So far, we have identified several sources of inspiration and templates for developing relevant, up-to-date, and viable models for cybersecurity education for the modern society and its public services. We have shown program profiles from top world universities in computer science and a U.S.-specific but highly imperative foreseen model of Digital Service Academy.

We will continue with a unique study program sharing a similar mission as the US Digital Service Academy – provides the public and private sector with experts on cybersecurity who are educated in a multidisciplinary fashion based on broad research and study areas available at Masaryk University.

The novel Bachelor carrier-oriented study program *"Cybersecurity"* piloted in 2020 at Masaryk University, see Masaryk University (2021), reacts to a growing demand for experts and builds upon experience and model gained from constructing the Czech Cybersecurity Qualification Framework. It is specifically aimed at students enjoying looking at computer systems "under the skin," learning as much as possible about their nature, properties, and behavior is motivated to study the legal environment of IT and geo-political-political background of cybersecurity as well as critical infrastructure protection, similarly to Oliver & Haney (2018).

The architecture of the program consists of a solid professional knowledge and skills fundament in computer science combined with the law and social sciences, namely it contains compulsory courses on *foundations of computer systems and informatics, methodology, operating systems, computer networks, basics of IT security and applied cryptography, fundamentals of (secure) programming but also IT law and regulations, data protection law, geo-political-political and systemic context of cybersecurity* among others.

The program belongs among so-called *carrier-oriented Bachelor-level programs* featuring in-depth connection with the practice, including a 600-hours guided professional internship in a company, healthcare, or public administration organization. It prepares students to get a job right immediately after graduation.

After successful completion of the studies, the graduate will be able to:

- immediately get a job and continually adapt to changing processes and technologies.

- Work in positions related to the deployment and operation of secure IT systems and infrastructures in companies and organizations of various sectors such as IT, public administration, services, industry, or healthcare.

- Recognize, understand, and recognize opportunities and risks of intelligent systems and cybersecurity risks globally and in an organization.

- Understand the essential elements of computer systems, hardware, and software, focusing on their reliable operation and cybersecurity, including their vulnerabilities, and managing to install, set up, manage, and operate these systems.

- Explain and use fundamental techniques and technologies to ensure the cybersecurity of entrusted IT systems and infrastructures.

- Understands ethical and legal principles of working with data, including commercially confidential, classified, and personal data, and can apply them in specific procedures.

- Describe the basic parameters of the legal environment in cyberspace, identify legislative requirements for the organization's activities and the relevant professional roles.

- Explain and apply the basic principles of analysis, design, implementation, and quality control of computer systems.

Facilities of the Faculty of Informatics and Masaryk University with critical strategic partners at the national and international level such as the National Agency for Cyber and Information Security and in the region, companies in the CERIT Science Park, industrial partners, the faculty and NC3, and other entities. Those interested can continue in the follow-up Master study program *Management of Software Systems, Services, and Cybersecurity* at the Faculty of Informatics or other programs. This Master's program fits well for those wanting to establish and conduct their SMEs or start-ups.

For the academic year 2021/22, the number of applicants grew well over 300 while up to 150 students can be admitted for the studies, which can be considered the first indicator of success.

7. Conclusion

Based on the needs of Digital Europe's strategy on cybersecurity, we studied the cyber security-oriented programs at world-leading universities and planned to establish US Digital Service Academy. Then we presented European Digital Innovation Hubs as instruments to help the public and private sphere digitalize securely. After introducing cybersecurity qualification frameworks as important steppingstones to improve cybersecurity education, we showed concrete, recently established carrier-oriented Bachelor study program on Cybersecurity at Masaryk University as a promising way to implement a modern multidisciplinary program on cybersecurity.

8. Acknowledgment

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PREDICTION MODEL OF STUDENTS ENTREPRENEURIAL SPIRIT

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Keywords

Entrepreneurial students spirit; entrepreneurial intention; risk; carrier motivation; prediction; data mining

Abstract

The presented paper aims to explain university students idea about their perception of entrepreneurship. The analyses of their thoughts and opinions contribute to the authors defining essential factors of the so-called entrepreneurial spirit. The authors used these factors for the development of the prediction model. In this developed model, the authors used the results from international research in 2016 and 2018. This survey is called GUESSS, and it aims to analyse the university entrepreneurial spirit of students. The authors examined the obtained data with the data-mining methods. The explained model can evaluate entrepreneurship's perception in terms of young students' intention and attitude. Therefore, the model can help in the education and training process of students' entrepreneurship.

1. Introduction

The business environment in society's development is exposed to many external impacts, such as natural disasters, industrial accidents, terrorist attacks, criminal acts, epidemics or pandemics, etc. Entrepreneurs are on both sides of the equation of relationships causes of these phenomena. On the one hand, the wrong evaluation of a situation or their risks of behaviour influences them. But, on the other hand, at the same time, they are exposed to their surroundings (e.g. industrial accidents, pandemic situation). The viral disease covid-19, identified by the WHO on 11 March 2020 as a pandemic, is one example. Therefore, the entrepreneur should be aware that there are risks associated with business and should identify, analyse and evaluate them to create a crisis scenario to maintain business continuity. Risk management is dedicated to this area to specify the initial immediate measures for infrastructure, cybersecurity, save communication, business and operational risks (Deloitte, 2020). In this context, the authors of the article ask themselves how university students prepare to deal with different crises, precisely perceiving the risks associated with business?

This paper explains a model of business spirit and risks based on mapping the perception of intention and attitude to entrepreneurship on university students' example. The developed model will then be used in the second half of 2021 to evaluate the impact of the epidemiological situation on university students' business activities (or graduates) compared to the Czech Republic situation and abroad.

2. Literature review

As mentioned above, in today's globally interconnected world, even in small and local business, it is necessary to look at the business environment on an international scale. Therefore, the literature review focuses on the business environment and the problems of risks in the broader context of international business - subsequently, two aspects influencing the choice of business before employment, i.e. intention and attitude.

2.1. Business environment and risk

In our society's historical development seems that the business environment is very dynamic and constantly changing. This fact directly affects individual economic entities in a given environment. Therefore, its analysis is essential for defining the necessary opportunities and threats when doing business activities. The business environment can be specified by space and time. Within the decision-making process of entrepreneurs, different factors emphasise the macro-economic level (confrontation with risk at the state level) and second on the microeconomic level (conflict with risk at the company level). The decisions are then influenced by the conditions under which they are made, whether under uncertainty/uncertainty/risk conditions. The observed concept of risk is connected primarily with the issue of decision-making under uncertainty. Rotariu and Ferer define uncertainty as a state in which the decision taken will bring future problems, but the probabilities and manifestations are unknown (2008).

Defining the concepts of uncertainty and risk is a broad topic. The presented research authors identify with Douglas's published article (2007) to explain the concept of risk. It defines risk as a state of uncertainty, where some of the options include loss, disaster, or another adverse outcome (Douglas, 2007). The issue of risk definition links to a type of uncertainty. In terms of time, we can divide business decision-making into two areas of processes: the start/end of business activities and striving for market success (Rotariu, Feder, 2008). In this context, it is necessary to draw attention to the findings of Gabriel Linton (2019), who, in his work, demonstrates the diversity of approaches to the assessment of business orientation through the dimension of process and outcome. Both measurements are then evaluated in terms of innovation, risk-taking and proactivity. In the presented text, we will focus on the decision-making process for starting (i.e. we excluded beginning entrepreneurs from the research) a young university student's businesses (concerning GUESSS research data Antlova et al. 2018). According to Lumpkin and Dess (1996), all firms deal with risks of various types and sizes, from "safe" risk with low uncertainty and small resource liabilities to high risk with existing high uncertainty and significant resource liabilities.

2.2. Intention and attitudes to business

As evidenced by studies (Belz,2001), Khelerova (2004) and Nollke(2015), the most important aspects of a young person's choice of entrepreneurship are accepting the social role in which they see themselves in future. In business, it is about taking the need to play a more or less dominant role. The ability to be a natural authority brings the ability to coordinate activities with others. At the same time, it assumes the ability to resolve conflicts constructively and find acceptable compromises. So here, we evaluate the intention.

A critical component is positive motivation, which defines the respondent's approach to business. It is necessary to start from the so-called intrinsic motivation (internal motive, internal cause of behaviour and experience). Intrinsic reasons for work include, for example, satisfaction from successful performance. Only that inherent motivation will enable the young person to realise his priorities, improve constantly, and it is based on the need to obtain new impulses and attitudes

(Hayes, 1993). Self-confidence is also part of motivation, and it means to believe that I will achieve my intention and prepare well for unexpected situations. The reason is closely related to acquired attitudes. We gain perspectives mainly in the primary family. Only much later, they are dependent on our personality structure, the acceptance of new information, our association with a particular group, our ability not to take inconsistent or contradictory attitudes. Attitudes are based on our personality and correlate with the primary family's attitudes (Pauknerova, 2006).

In defining entrepreneurship's intention and attitude, it is possible to supplement the study results by Lopez and Alvarez (2019). They analysed the influence of higher education factors on entrepreneurial intentions (EI). This study's main outputs include the finding that the implementation of business courses and favourable perception of the business university environment was positively related to students' entrepreneurial intentions. Although both variables directly affect the student's intention to do business, the university environment had a more substantial influence. In their research, Zhao et al. (2005) show that formal academic courses positively impact students' intention to start a business plan in the business process. Before starting a business, students expect and need to be more motivated, and after starting a business, they need more technical skills (Zhao, 2005). We can see that students' entrepreneurial intentions are positively associated with a tendency to risk. The research results show that the propensity for risk has a significant impact, especially in the early, pre-start-up business phase. Therefore, it is necessary to define a sample for research for our model construct in business risk concerning the stage of business activities.

3. Methodology and data

The model's input data results from the international survey GUESSS (see more http://guesssurvey.org), an acronym for the title of the "Global University Entrepreneurial Spirit Students' Survey". The survey monitors the environment, which influences university students' decision-making when choosing their career in employee or entrepreneur roles and the specification of the field of activity, various forms of business in selecting a business. Also, the startups' activities and continuation of the family business are searched. The Czech Republic joined the international survey in 2015 and participated in its first survey was in 2016 (the total number of respondents was 122 509). The number of respondents for the Czech Republic was 1135), and subsequently, in 2018 (the total number of respondents was 208 000). The number of respondents for the Czech Republic was 1254. Currently, in January 2021, a survey of the 9th year of this international research has begun.

The authors used the following research tools as the critical literature research of the topic, Data Mining Software for working with Big Data: IBM SPSS Modeler and IBM SPSS Statistics. Especially the method of decision trees were used. The development of the model divides into three sub-objectives; the last part will finish in 2021. The following paragraphs explain data in the developed model:

- Sub-objective 1: Perception of entrepreneurship in terms of intention and attitude, based on that specification of respondents' approach to risk. Complementary criteria are the branch/field of study, gender, and the state's standard of living. In the first part of the research, a model developed from GUESSS survey data (2016 and 2018). The study will supplement data from the GUESSS survey (2021); see the diagram in Figure 1.
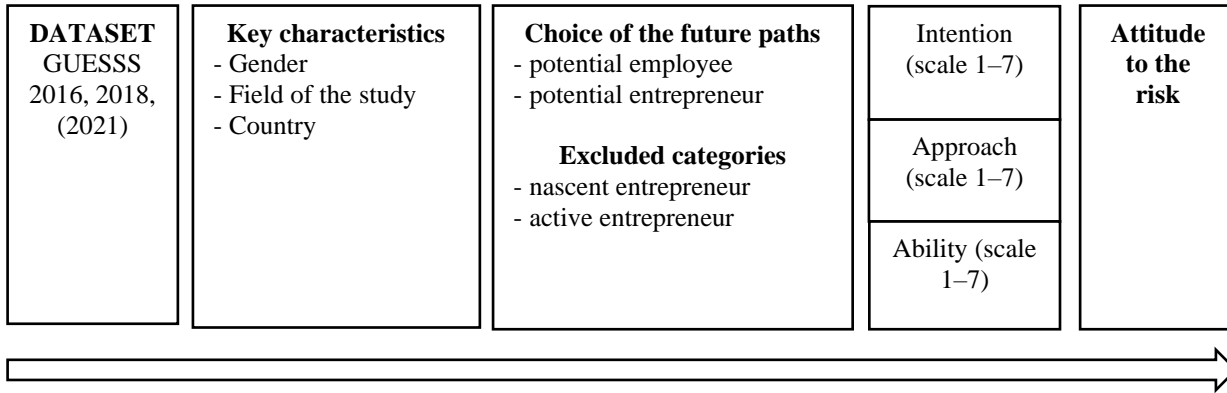
Figure 1 Development of research

- Sub-objective 2: The impact of the Covid pandemic on the perception of business risk and the emergence of new startup business activities (GUESSS 2021 data).

- Sub-objective 3: Comparison of the perceived perception with the pandemic's impact on the evaluated countries (universities involved in the GUESSS survey) regarding demographic indicators.

4. The career choice of university students

What is the perception of business risk by university students? The choice will first identify the preference of career path; see Table 1. Suppose we state that the risk and liability associated with potential damage are closely related to business. In that case, it assumes that students who plan to choose the entrepreneur's path perceive risk as part of their life path, and they accept it.

Table 1: Overview of the ratio of the chosen career

	GUESSS 2016				GUESS 2018			
	Directly		5 years later		Directly		5 years later	
	Czech Rep.	All countries	Czech Rep.	All countries	Czech Rep.	All countries	Czech Rep.	All countries
Potential **Employee (%)**	75%	80%	52%	47%	83%	79%	53%	50%
Potential **entrepreneur (%)**	7 %	12 %	32 %	43 %	9 %	11 %	37 %	39 %
Founder (%)	*6%*	*9%*	*28%*	*38%*	*6%*	*9%*	*31%*	*35%*
Successor (%)	*1%*	*3%*	*4%*	*5%*	*2%*	*2%*	*6%*	*4%*
Other/Do not know yet (%)	18%	8%	16%	10%	9%	10%	10%	11%

Comments to table 1: The respondents who stated that they want to be employees means that they could work in small businesses – with 1-49 employees or in medium-sized companies –with 50-249 employees or in large companies (250 or more) or a non-profit organisation; in Academia (academic career path); in public service). The founder (entrepreneur) means that these respondents want to start their own companies. Finally, the successors are the respondents who will work in their businesses or the family businesses. These two last groups of respondents(founders and successors) can suppose the "business spirit ".

4.1. Definition of respondents with the entrepreneurial spirit

We can assume that students who choose an employee's path (i.e. potential employees) have a higher feeling of risk perception, which they are not willing to accept at the moment. On the contrary, students considering their career path in business (i.e. potential entrepreneurs) take the given risk associated with entrepreneurship and have an "entrepreneurial spirit" in them. Therefore, as part of the GUESSS research, these respondents continue with questions focused on their business opinions. Table 2 presents the primary data for the examined sample of respondents in this part of the research.

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Table 2 Numbers of research respondents

Carrier path after graduation	GUESSS 2016	GUESSS 2018
Respondents, according to the future carrier	- potential employee - potential entrepreneur	- potential employee - potential entrepreneur
Number of respondents		
Czech Republic	802	817
All countries (52)	86 226	125 661
Number of women		
Czech Republic	541	499
All countries	53608	76 624

Comments to Table 2: Data for 2021 will not be available until August / September 2021.

As part of the 2016 survey, potential employees and potential entrepreneurs and those already starting a business (marked "nascent") had questions about evaluating respondents' relationship to entrepreneurship. The following seasons (2018 and 2021) focus on students, which does not start the business (i.e. only potential employees and potential entrepreneurs). For this reason, the data set from the GUESSS 2016 survey on students with the designation "born" entrepreneur for the given topic was humiliated/purified. Further modification of the data was performed after their control. The error rate was in students' data from China when the questions were answered by those who should have been excluded from other answers. Due to skewed results, all Chinese students were excluded from the following evaluation.

Furthermore, respondents who did not answer at least one of the evaluated questions (so-called NULL values) were also deleted. Finally, the authors unified the students' ideas of their future careers after graduation and five years after graduation. So the group "a business spirit" was created. This group includes those respondents who stated that they wanted to be entrepreneurs, i.e., immediately after graduation and five years after graduation.

4.2. Business spirit (intention of risk)

The GUESSS survey also has questions connecting with the respondents' comments on the intention to start a business and their attitudes towards entrepreneurship. The questions in the given area of the GUESSS survey follow up on the results of previous research focused on respondents' approach (university students) to business, see Liñán, F. and Chen, Y.-W. (2009). The authors used Ajzen's theory of planned behaviour to compile a business intent questionnaire (EIQ). Their model

derived knowledge about how cultural values change the way individuals perceive business in every society. The presented article aims to develop students 'intention to become entrepreneurs, and that is the respondents' attitude to risk. Zhao, Seibrt and Hills (2005) dealt with the ability to face risk in connection with assessing entrepreneurial self-sufficiency, so-called self-efficacy.

Students were asked to indicate their competence in performing several different tasks related to the entrepreneurial activity (1 = very low competence, 7 = very high competence). When comparing the answers of potential employees and potential entrepreneurs, we can say that potential entrepreneurs express themselves with greater certainty about the level of competencies in this area and feel their competencies at a higher level than potential employees. Therefore, building research skills seems to be a suitable way to strengthen students' entrepreneurial intentions (Sieger et al., 2016). The distribution of the evaluation of respondents' competencies incompetence in implementing selected tasks related to business is given in Table 3 (GUESSS 2016 survey) and in Table 4 (GUESSS 2018 survey).

As we can see from Tables 3 and 4, high competence evaluation prevails (level 5-7). Leaving aside the possibility of a middle answer (level 4), a positive assessment of the defined competencies lasts. Therefore, the article's authors were also interested in whether the university student's future focus (entrepreneur or employee) can estimate according to the evaluation of the examined skills in Tables 3 and 4.

Table 3 Answers of self-evaluation in 2016

1	6,26	6,62	6,69	3,57	5,15	5,98	6,94
2	9,92	10,44	8,62	4,99	7,26	8,19	8,02
3	15,47	15,94	13,33	9,18	12,8	13,01	11,4
4	21,92	22,33	20,39	16,14	21,39	20,54	19,86
5	24,48	23,47	23,5	22,65	24,37	23,65	21,59
6	15,18	14,33	18,29	24,73	18,76	18,65	19,33
7	6,78	6,87	9,18	18,75	10,27	9,99	12,86
Sum 1-3	31,65	33	28,64	17,74	25,21	27,18	26,36
Sum 5-7	46,44	44,67	50,97	66,13	53,4	52,29	53,78

Table 4 Answers of self-evaluation in 2018

	1	7,23	7,79	8,2	4,63	6,78	7,62	8,24
	2	10,51	10,85	9,25	5,83	8,45	9,18	8,57
	3	15,78	16,07	13,41	9,75	13,27	13,37	11,49
	4	21,74	21,58	19,6	15,74	20,32	19,68	19,08
	5	23,41	22,23	22,11	21,14	22,4	21,7	20,29
	6	13,73	13,65	17,09	22,79	17,42	17,12	17,78
	7	7,61	7,84	10,33	20,12	11,37	11,33	14,55
Sum 1-3		33,52	34,71	30,86	20,21	28,5	30,17	28,3
Sum 5-7		**44,75**	**43,72**	**49,53**	**64,05**	**51,19**	**50,15**	**52,62**

5. Results of research

At first, respondents' answers from the international GUESSS survey (2016 and 2018) about their behaviour were monitored according to individual questions (Tables 3 and 4). Especially for 2016 and 2018, with the criteria female/male, field of study, nationality, etc. Subsequently, in the second step, the prepared dataset (training set) was used to create a prediction model. Finally, a test set was used to test the models' success, where we know the predictors' values when predicting, but we do not see the value of the target variable, which we are trying to determine by the model. The target variable that the model should predict is to guess whether, according to the chosen answer to the

questions in Tables 3 and 4, it is a respondent of a potential employee or a potential entrepreneur. That is, whether the model predicts a respondent with an entrepreneurial spirit, determined to enter business immediately or five years after graduating from university. The target variable was balanced for model learning purposes. In the IBM SPSS Modeler, based on selected predictors (nationality, field, gender, statement defining eligibility for entrepreneurship), the authors created several models were to predict whether the respondent/university student has an entrepreneurial spirit.

The target variable (Target Field) was the choice of a career as an entrepreneur. The source data were divided into a training (50%) and a test set (50%). Four types of algorithms were selected to build the model, which is part of the IBM SPSS Modeler (see Table 5). When we let the newcomer respondent fill the answers of the nationality, gender, field of study, and questions in Tables 3 and 4, the developed models would predict with success shown in Table 5 whether the student would answer that he is a potential employee or entrepreneur.

For prediction, we used mainly decision trees. They are binary and general. General decision trees' features are the number of branches, more straightforward interpretation, typically fewer levels, algorithms: CHAID, C5.0. The features of binary decision trees are: two components lead from the node, faster calculation, naturally more levels, algorithms: C&RT, QUEST. The advantage of trees is that they can evaluate decision-making quality (Witten, Eibe, 2017).

Table 5 Prediction model of entrepreneurial spirit

Decision tree IBM SPSS Modeler	The success of the model with training set in %		The success of the model with training set in %		The most important predictor	
GUESSS survey	2016	2018	2016	2018	2016	2018
Neuron network	67,94	66,87	67,56	66,47	Nationality	Nationality
C5.0	72,74	71,12	66,94	65,94	Nationality	Identifying new business opportunities
C&RT	64,63	65,35	64,36	65,06	Successfully managing a business	Identifying new business opportunities
CHAID	68,3	66,73	67,44	65,5	Nationality	Identifying new business opportunities

Comments to Table 5: If we let the created models "vote" together, then the success rate of business spirit prediction on the test set will increase to 73% in 2016 and 71% in 2018.

6. Conclusion

The authors suggest using the research findings to adjust the content of professional educational subjects in starting-ups and develop the management of small and medium-sized enterprises. Following the results and prepared data, the developed model will be used in the second half of 2021 to monitor changes in students' attitudes to business concerning the external threat, namely the covid pandemic in the survey. These results will also help compare the parameters of business risk perception of the GUESSS survey from 2016, 2018 and 2021 with the perception of the impact of COVID on business activities in 2021. The authors also suggest deep analyses of the other factor as nationality and gender.

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SHADOW ANALYTICS

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Keywords

Business analytics, covid-19, data analytics, pandemic situation, shadow analytics, shadow analytics governance

Abstract

The term Shadow Analytics refers to data analytics delivered by business departments independent of the official IT and analytics departments. The field of Shadow Analytics is currently been facing the changing requirements that have arisen as a consequence of the current Covid-19 pandemic. The main aim of this article is to expand on Data Governance by including concepts for managing Shadow Analytics in a pandemic and to present a Shadow analytics management concept. The proposal of a Shadow Analytics management concept identified problem areas and extended the scope of Data Governance in relation to Shadow Analytics based on the results of a case study (including interviews with key stakeholders).

1. Introduction

In the current pandemic situation, organizations face immense pressure caused by rapidly changing external conditions, forcing them to operate more efficiently than ever before (Kraus et al., 2020). Such challenges can be addressed by data analytics innovations that can help organizations to respond to crises, such as the pandemic situation, and bring about new opportunities (Joyce & Paquin, 2016; Sheng et al., 2020). To adapt to the turbulent changes and the regulatory requirements of the current Covid-19 pandemic, organizations need to process data in new agile ways, utilize much fresher data and do so faster, ideally in real-time (Bauernhansl et al., 2018).

As a result, business departments might become responsible for delivering data analytics independently of official IT and analytics departments. In some cases, official departments fail to provide the required capabilities such as flexible data analytics with highly comprehensible information (Riesener et al., 2019), self-service data analytics (Clarke et al., 2016) or big data analytics (Novak & Pavlicek, 2021). Business departments therefore invest their own resources in data analytics (Riesener et al., 2019). This creates shadow analytics. Shadow analytics refer to data analytics delivered by business departments independent of IT departments (Koch & Peters, 2017) as illustrated by the following definition: *"Analytics initiative initiated by a functional department outside of the corporate information technology department (hereinafter IT) and deliberately kept under the radar of the corporate IT department"* (Koch & Peters, 2017). Shadow analytics can be considered an analytical service, which provides functionalities needed to perform business related tasks and is developed, provided, and maintained by a user from specific business department.

Shadow analytics may address the rapidly changing requirements that have arisen during current Covid-19 pandemic. Shadow analytics has been evolving without any coordination with official IT and analytics departments (Koch & Peters, 2017), especially in the current pandemic situation when the needs of the external and internal environments, and thus business as such, are changing rapidly and existing enterprise data analytics tools fail to deliver the required functionalities:, data is not available in IT data repositories, business departments do not have the time to go through the standard process of delivering a new data analytics solution, or governance is too complex and slow to meet current pandemic needs. Shadow analytics allows to overcome these limitations and can quickly bring about the desired effects.

However, shadow analytics may not be optimal from a governance perspective in the long run and with respect to its operation within the organization (Haag & Eckhardt, 2017). Shadow analytics causes the creation of analytics silos. Shadow analytics services are distributed across the organization through unofficial channels; they are not managed and developed in accordance with internal rules and do not have a clearly defined governance. Data created or derived from raw data for the specific purpose of such a shadow analytics service has no owner. Different consumers and different purposes for which shadow analytics services were created require building more analytics silos. This situation is especially critical because shadow analytics has an impact on data and should be handled by various aspects of Data Governance (Earley et al., 2017), from data quality, through data lineage, to shared definitions within the data catalogue and data analytics services. Unfortunately, there is lack of tools or methods to support the adoption (Choma et al., 2019) and consequent governance practices of shadow analytics.

The main aim of this article is to complement Data Governance with respect to manage shadow analytics in pandemic crisis with emphasis on the following areas: 1) Shadow analytics management concept; 2) Shadow analytics canvas proposal.

2.   Research method

This article is based on a case study, a qualitative research method (Myers, 2013). The case study addresses the sector of banking, specifically. The researchers cooperate closely with business users, the heads of Data Governance and Analytics departments, and information security specialists. First, the Shadow IT, Shadow Analytics and Data Governance theories were analysed based on a literature review; second, Shadow Analytics management concept and Shadow analytics canvas were designed in a case study and qualitative research.

3.   Shadow analytics management and governance concepts

The shadow analytics management concept (see Figure 1) is based on the results from the case study and a concept from Šedivcová and Potančok (2019), which uses the principles of the MMDIS (Bruckner et al., 2012) and (MBI, 2015) models and methodologies. Both concepts define the process, going from global goals to the design of individual projects.

As in the case of the widely accepted Data Governance Paradigm (Earley et al., 2017), shadow analytics governance is a fundamental part of proper shadow analytics management. Shadow analytics governance needs to move from the traditional approaches of Data Governance to a non-invasive and flexible governance framework, while eliminating negative effects on business processes and analytics needs (Kopper & Westner, 2016). For this purpose, suitable methods and tools should be available as part of a Data Governance framework, in order to manage the rapidly evolving shadow analytics services. Unfortunately, none of available Data Governance

frameworks explicitly reflect the specifics of shadow analytics governance (Earley et al., 2017; Yamada & Peran, 2017; Al-Ruithe et al., 2019).
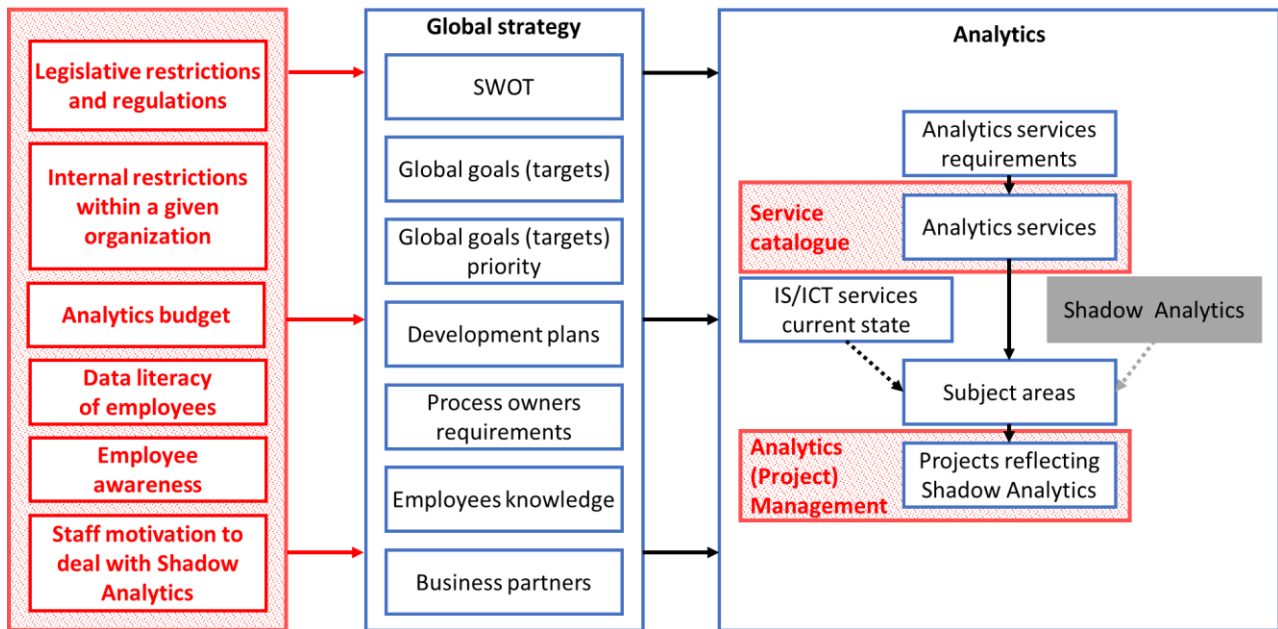
Figure 1. The Shadow Analytics management concept

Data is the most critical element from the point of view of shadow analytics. Shadow analytics offers a shadow way of using data to capture information. This information is then used for decision-making purposes (Potančok, 2019) or regulatory reporting (Al-Ruithe et al., 2019). Unfortunately, the relationship between business, the data used for decision making, and the support of business needs through IT is not always fully respected (Maryška & Novotný, 2013). As data and the information derived from data enter into business processes and can be transformed into the outputs of these processes, the Data Canvas is considered to be the main tool for understanding data in the business modeling process (Mathis & Köbler, 2016). The Data Canvas (Mathis & Köbler, 2016), as well as many other canvases (Kühne & Böhmann, 2018), was derived from the business model canvas, as proposed by Osterwalder et al. (2010). The business model canvas (Osterwalder et al., 2010) contains value propositions, customer relationships, customer segments, channels, key activities, key resources, key partners, cost structure, and revenue streams (Maryška, 2009). The business model canvas is widely accepted because it is easy to understand, facilitates communication (Sort & Nielsen, 2018), and supports business innovation (Fritscher & Pigneur, 2014). The business model canvas (Osterwalder et al., 2010), modified and adapted to the needs of data analytics, can be a useful tool for managing shadow analytics (Stecken et al., 2019). The business model represents the conceptualization of an organization (Joyce & Paquin, 2016), which can be simulated through shadow analytics, after some modification of this concept as proposed by (Osterwalder et al., 2010), using the following aspects:

- Key data, data sources, and shadow analytics services integrated to deliver value.

- Interconnection of individual data, data sources, and shadow analytics services.

- Value generated from the use of data, data sources, and shadow analytics services.

3.1. **Shadow analytics canvas**

The shadow analytics canvas proposed in this study (see Table 1) has been derived and modified from the business model canvas, as proposed by Osterwalder et al. (2010), based on a set of various

modifications identified by previous researchers (Joyce & Paquin, 2016; Kühne & Böhmann, 2018; Choma et al., 2019) and on the practical need to effectively manage the rapidly evolving shadow analytics in the pandemic times. The shadow analytics canvas can provide insight into shadow analytics and identify data, data sources, and the consumers of shadow analytics products. Providing an explicit description of shadow analytics services and their relation to data can reveal hidden benefits derived from shadow analytics and expand on the use of shadow analytics beyond the business department that created the analytics service. The shadow analytics canvas can facilitate future integration of shadow analytics into standard processes managed by the IT department, as well as reveal hidden opportunities for creating enterprise-wide value from the shadow analytics usage.

Table 1. Shadow analytics canvas

Strategic objectives				
Business objectives to be fulfilled by using shadow analytics. Use case delivered by using shadow analytics.				
Compliance Requirements and Related Risks Is sensitive data being processed? What standards, sector specifics or legislation affect usage of shadow analytics or its products? Is shadow analytics compliant to related regulations? Are shadow analytics products are delivered to externals (e.g., regulators) within the agreed and committed time?	**Solution** What insights are found out from the analysis? What material reports are delivered? What metrics are used to evaluate shadow analytics service and quantify value creation? Is shadow analytics product consider as predictive?	**Value Propositions** What value is delivered by shadow analytics? What is the purpose of using shadow analytics? What need is met / what problem is solved? What are the expected results / benefits? What is the possible future use of the analytics service?	**Data and Metadata** What data (raw, derived) is used? Which data sources are used (internal, external)? Are there any limitations in data or data sources? What new or derived data, is created? In what format data is stored? Are real-time data provided? Is data catalog (technical and logical metadata) available? What is the impact on automated business data lineage?	**Consumers** Who uses shadow analytics service (business departments, developers, data analysts, users)? What are data consumers of shadow analytics products (internal, external)?
	Key Resources Is shadow analytics developed internally or provided by external provider? What is the technology platform used? What are the operational requirements (e.g., regular backups)? What are the integration capabilities? Is shadow analytics future proof? Is a documentation available? What kind of people and skills are required to create and operate shadow analytics?		**Data Quality** What new business terms or KPIs are created? Who are Data Owners and Data Stewards of new or derived data? What are the business rules of newly created data? How is data quality measured?	

Cost structure	Revenue streams
What is the cost structure related to the shadow analytics implementation and operation?	What is the expected data monetization?
What is the cost related to amount, complexity, quality of data and real-time capabilities?	What is the expected cost avoidance or cost reduction?
What is the cost related to build necessary skills and experience of team, users?	How much does each stream contribute to business revenue?
What is the expected cost of future growth?	
What is the cost of a security breach or a non-compliance?	

4. Conclusion

This paper aimed to expand on Data Governance with the aim to manage shadow analytics in the current Covid-19 pandemic. The study was focused on shadow analytics from the perspective of flexible management of the rapidly evolving shadow analytics services, which support the turbulently changing and emerging requirements in the pandemic crisis. The development of shadow analytics can deliver positive and timely outcomes that ensure a dynamic data analytics capability for the business in the pandemic crisis times. To achieve the expected benefits in the long term, it is necessary to properly govern shadow analytics. Unfortunately, neither current research nor the available Data Governance practices provide any methods that would allow for flexible management of the rapidly emerging shadow analytics. This paper therefore proposes a new shadow analytics management concept and the shadow analytics canvas as a method that can be used to govern shadow analytics.

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BUILDING AND TESTING A COMPREHENSIVE DATA LITERACY MODEL FOR BUSINESS USERS

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Abstract

The upsurge of data production, digital transformation, and today's availability and accessibility of all kinds of data have affected our everyday lives, as well as the functioning of businesses. This paper argues for creating a data literacy measurement tool that represents the first step on the way to enhancing the data literacy of employees and university students. To fulfil this aim, a joint team of two universities constructed a data literacy competency model to be evaluated by a comprehensive questionnaire.

1. Introduction

The upsurge of data production, digital transformation, and today's availability and accessibility of all kinds of data have affected our everyday lives. At the same time, these trends have affected how businesses are run and data has acquired an increasingly prominent place in companies' processes, regardless of whether a company uses data for decision making, for mapping resources to objectives or as supporting arguments for a strategic orientation.

The phrase "data is the new oil" is therefore no longer surprising to anyone. However, to access the value of raw data, it must go through refinement processes just like crude oil. In general, data needs to be properly collected, managed, evaluated, and applied, in a critical manner (Ridsdale et al., 2015). These skills equal to data literacy and its poor quality represents "*the second-biggest internal roadblock to the success of and the ability to generate business value with data and analytics*" (Gartner, 2018). The research by Doucek, Kunstova & Maryska (2011) supported Gartner's statement, arguing argument that the low numbers of employees with adequate ICT skills may jeopardize the innovation capabilities of European countries. However, by adjusting study

programmes and focusing on the knowledge of tertiary education graduates, it is possible to overcome this deficit (Maryska, Doucek & Novotny, 2012).

In order to help companies bridge the skill gap of their employees and make individuals able to fully participate in the knowledge-based economy, this joint project by Prague University of Economics and Business and University of California Berkeley aims to define what constitutes this new type of literacy and how to measure it. Because in order "*to improve anyone's data literacy, it is necessary to determine what the start line is and what is to be achieved*". (Smolnikova, 2020)

2. The need for data literacy and ways to enhance and measure it

The McKinsey Global Institute (Manyika et al., 2017) predicts that by 2055, nearly half of today's job activities could be done by machines and that up to 41% of job activities can be replaced by new technologies in the information sector. With the rising automation of work and new sources of data streams, companies consume an increasing amount of data. Even though data is omnipresent in the professional landscape, research shows that "*only 32% of leaders feel able to create measurable value from data and just 27% believe their data and analytics projects generate actionable insights*". This discrepancy arises due to the fact that data is not yet incorporated into organizations' cultures. (Deloitte 2020) Only 25% employees can use and make sense of data and provide actionable recommendations at an entry-level position. A low level confidence in data literacy (21%) appears even in the digitally literate group of young people aged 16-24 and the confidence levels of C-level managers only rise up to 32%. (Qlik, Accenture, 2020) To overcome these extreme deficiencies, Gartner believes (2018a) 80% organizations will have initiated deliberate competency development in the field of data literacy by 2020.

However, in order to support data literacy enhancement activities in companies, it needs to be clear what data literacy is and what it is comprised of. Duncan and Logan (2018b) define data literacy by describing four key barriers of data literate society – the individual as well as organizational inability to derive insights from data, to understand the analytical methods, and to use analytical services to get the insights, or the inability to comprehend and to integrate company's data sources. According to Mandinach and Gummer (2013), data literacy is simply "*the ability to understand and use data effectively to inform decisions*". Frank et al. (2016) refer to data literacy as "*the ability of non-specialists to make use of data*".

Data literacy serves as a prerequisite for the closest types of other literacies. "Firstly, we need to learn to handle the volume and characteristics of data (discrete, objective facts) before we can draw information from it (make data useful, enrich them with meaning). That is where we demarcate a line between data literacy and information literacy." (Smolnikova, 2020) The difference arises from the relation between data and information, as articulated in the traditional DIKW (data – information – knowledge – wisdom) pyramid. (Rowley 2007) Even though statistical literacy had to develop before data literacy, considering the limited access to data in the past, the ability to prepare and manage data, which in the past used to be done through intermediaries (e.g., the press), still precedes the consumption of statistical products (e.g., the evaluation and critical assessment of tables or charts) (Gal 2002; Frank et al. 2016; Gould 2017).

While the data literacy of employees needs to be improved and it is clear that one cannot improve something that cannot be measured, not enough progress has been made in the measurement of data literacy. In 2020, the first preliminary studies of assessment instruments were published in the South Asian region by Pratama and his team (2020) or Lusiyana et al. (2020). While the first study focused on testing the initial levels of data literacy, the second one aimed to verify

the effectiveness of the MIRECAL learning model. Early this year, Suryadi et al. (2021) complemented this initiative in this region by performing a descriptive study of the high school students' level of data literacy after passing physics classes. Nevertheless, none of the assessments were comprehensive as they were focused solely on high school students and mostly in relation to a specific subject or a learning framework.

The data literacy development has also brought some commercial initiatives like QlikTech's (2018) Data Literacy Project which develops *corporate data literacy*, which comprises of both individual skills and the accessibility of the right data and assesses analytical culture. In cooperation with the Wharton School, QlikTech constructed the Data Literacy Index which associates levels of corporate data literacy to company performance results, in order to quantify the value that a company achieves with a measured level of corporate data literacy. Then there is also the Data Literacy Score, a team-based assessment tool developed by Jones (2020), which consists of 50 questions on the Likert scale and evaluates data literacy factors, such as the ethics of handling data (Novak & Pavlicek, 2021), the technology used in a company, or enabling a data-driven culture. Eventually, individuals can take part in a 10-minute test developed by the Data to the People research group (2020), based on a so-called Databilities framework, which delineates "*18 core competencies with up to 6 levels of capability across the dimensions of reading, writing and comprehension*". According to our review, most of the commercial tools for data literacy assessment available at the moment are rather subjective and based on the respondents' feeling (e.g., Jones' Data Literacy Score or Qlik's Data Literacy test for individuals) and they do not measure the whole spectrum of data literacy competencies.

3. Our approach to data literacy

3.1. Data literacy competency model

To define data literacy, we start from the purpose of the general concept of literacy – *to enable people to participate fully in society* (UNESCO 2020), which is currently impacted by the availability and accessibility of enormous volumes of data – and from Gartner's analogy, which specifies data literacy as the ability to '*read and speak data*' and which emphasizes the usage of data. Therefore, data literacy should specify what one needs to know (the knowledge part) or to be able to do (the skills part) in order to take advantage of data. In other words, it is *an ability to understand data and to make use of data*. Compared to other models of data literacy, we would like to point out understanding of the importance of data in a business context and the speak data part of Gartner's definition, which our model reflects with an individual area of competences (data interpretation, communication, and decision-making).

Simply put, data literacy includes all the competencies that are needed for the ability to work with data. Therefore, the first step in this project is to isolate and validate the competencies that are relevant for the assessment. Given our team's academic background and the aim to enhance companies' skills capital, we aim to define data literacy competencies for employees in economic fields, as well as soon-to-be employees – students of economics and business. As we assume that different job roles require different competencies for handling data in their work and that every company comprises of a different mix of job roles, the proposed competency model is defined as a set of capabilities of an individual. To enhance data literacy across a company, individual employee skills in relation to their job roles need to be improved.

When developing our data literacy competency model, we followed the method of card sorting used in Wolff et al. (2016) and consulted with a panel of experts. We synthesized several models of data literacy competencies (Prado & Marzal, 2013; Ridsdale et al., 2015; Grillenberger & Romeike,

2018) and evaluated their components in the context of usability in the economic fields of employment. Based on this research, we decided to divide competences into knowledge-related and skills-related areas, in order to measure them separately. While knowledge competencies measure the *understanding* of data concepts or approaches, the practical competencies measure the *abilities to apply* these concepts or approaches. Within these two sections we identified five categories of competencies:

- A. Data Concepts, Ethics, and Protection

- B. Analytical Principles and Methods

- C. Data Collection and Preparation

- D. Data Analysis and Evaluation

- E. Data Interpretation, Communication, and Decision-Making

We aim to measure two levels of proficiency within these competencies. The first level represents a *common business user* who is mostly a consumer of analytical outputs created by others. The common business user needs to be able to follow steps in order to solve a problem in an analytical manner, but they do not need to collect and prepare the data. On the other hand, Level 2 represents a *power user* level, which combines the knowledge and skills of the previous level with advanced abilities – especially in the area of data collection and preparation. The power user can solve a data problem from the beginning to the end, including data acquisition and transformation.

3.2. **Prototype of the measurement of data literacy**

Based on the proposed data literacy competency model, we constructed a prototype of the data literacy assessment. In creating the questionnaire, we also employed the principles of the PPDAC approach, which divides the inquiry process into stages: Problem, Plan, Data, Analysis, and Conclusion (Wolff et al. 2016). This method used in school subjects teaching statistical thinking allowed us to simulate a natural inquiry process, in which an inquirer first defines the problem they want to solve using quantitative data and then continues by planning what kind of data they need and how to get them. Subsequently, they collect the data, analyse them and eventually come to a conclusion about the originally defined issue. In addition, this helped us group questions into meaningful sections and give them a practical order.

Given the essence of the inquiry process, respondents of the test prototype had to work with a simple dataset in Microsoft Excel in order to prove their data collection and preparation skills as well as in Microsoft Power BI in order to analyse and evaluate data. The test comprised of 38 multiple choice questions which measures one competency or more at the same time. When creating the test, we followed the rule of including at least two questions per competency. In the first prototype, we were able to cover all competencies, except the E2 section of the competency model.

The aim of the prototype test, which was answered by 50 respondents, was to verify the validity of the questions and to identify trends, which could support the proposed competency model levels. It should be noted that the relationship between the model and the measurement goes in both directions. The testing tool developed on the basis of this model will serve as another level of the model validation as the results from the data literacy assessment will confirm or disprove the components of our view on data literacy.

So far, we have performed an explorative analysis of the answers from our 50 respondents. The test was submitted by 44 freshman students at a business university with several IT programmes and

by 6 data professionals. Including data analysts was intentional and aimed to check how difficult the questionnaire was. Even though the pool of respondents is not sufficiently large, we can draw some preliminary conclusions and validate certain assumptions.

Figure 1 shows the achieved score structured according to age, along with the time spent filling out the questionnaire. The histogram confirms our basic assumptions that with increasing age and experience, the score rises as well. However, the difference in scores between less and more experienced individuals does not seem to be substantial. Even though the group of older respondents was more likely to include data professionals. Given the second variable monitored in the histogram, the youngest group of respondents, which is also the most numerous one, did the test more quickly which may reflect the fact that they skipped questions or made guesses more often. The results of time needed for completing the test also suggest that spending twice as much time with the test does not necessarily bring twice higher scores. In other words, there is no direct proportion between these variables.
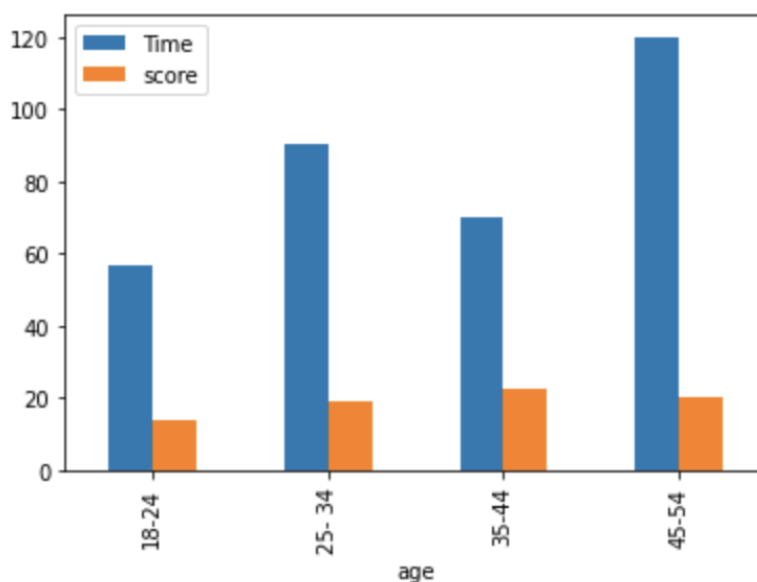
Figure 1: Histogram of score and time based on age

Figure 2, which depicts score ranges in relation to English proficiency, offers another perspective on the test results. The obvious hypothesis about the effect of the questionnaire's language is that a false response may not be caused by the respondent's knowledge or skills but by a misunderstanding of the wording if the test is not in the respondent's mother tongue. Nevertheless, according to our preliminary results as shown in Figure 2, respondents with a basic level of English typically performed better than respondents with a higher level of fluency in English. Unfortunately, this relation between a higher score and the basic level of English is not statistically significant as there are only 3 respondents with a basic level compared to 23 advanced or 10 fluent English speakers.
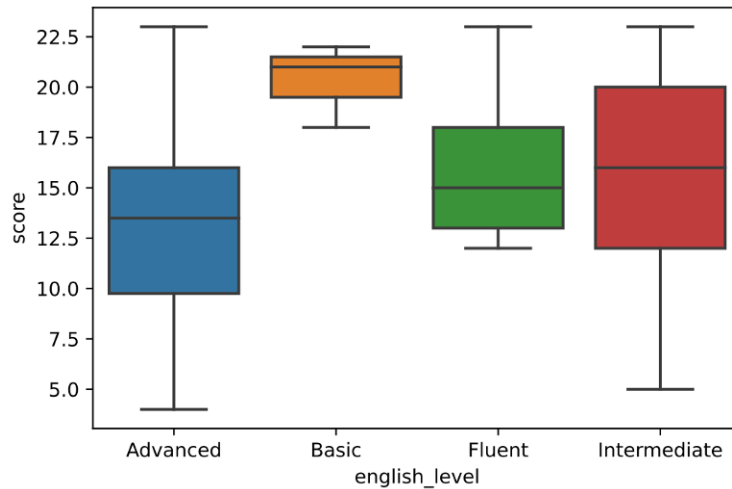
Figure 2: Boxplots of score ranges with respect to the level of English

In case of the level of skills in the auxiliary tools used in the test (Microsoft Excel and Microsoft Power BI), the results are not surprising. As shown in the Figure 3, respondents with a higher level of skills in Power BI (intermediate as well as advanced) range in an interval with higher scores.
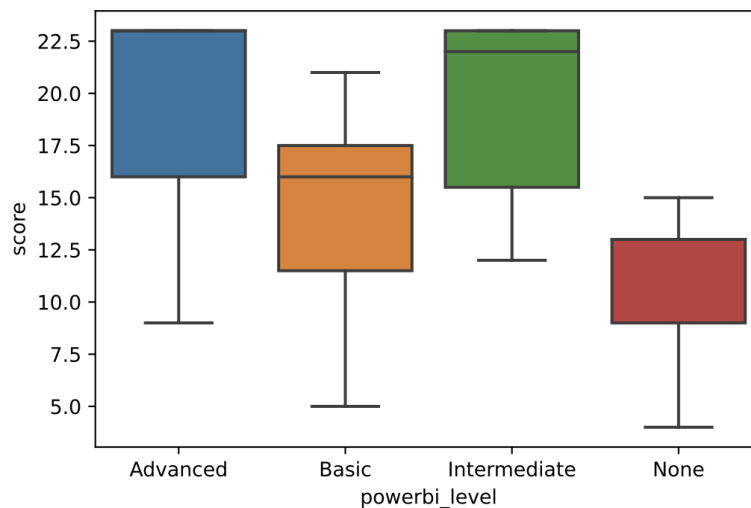
Figure 3: Boxplots of score ranges with respect to the level in Power BI

4. Conclusions

Data literacy is a must-have set of knowledge and skills in today's knowledge-based economy. Nevertheless, in order to be able to develop the data literacy skills of individuals as well as working teams, we need to be able to measure their current state and track their progress. To help bridge the skills gap in companies, this project by a joint team of two universities defined a data literacy competency model for business students and employees in economic fields. The model serves as a steppingstone of data literacy measurement for this specific group. So far, the first prototype of the measurement tool has been developed and requires a proper statistical analysis. In order to measure data literacy comprehensively, other versions of the test will follow, based on the statistical review. We expect that the constructed indicator, the measurement tool, will be suitable for measuring the data literacy of both individuals and organizations data literacy. It can serve as a tool for specifying data literacy competencies linked to different job positions, gaining

the required knowledge and skills, and eventually for developing an analytical culture. The data literacy measurement tool will serve as a critical assessment of where we are and where we need to go and its findings may be transposed into tailor-made educational programs, bringing a solution for the knowledge and skills gaps in data literacy.

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E-GOVERNMENT DIGITAL CZECHIA: E-TAX PORTAL MEDIA DISCOURSE

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Keywords

E-participation, e-society, e-tax portal, e-government, information technology, media discourse

Abstract

The introduction of new digital services of e-government brings challenges to countries worldwide in many areas. A major task of the state is to achieve a continuous understanding by society and thus facilitate a voluntary transition to e-society. In the Czech Republic, a low percentage of citizens use e-government tools on their own initiative, even though some of these tools have been available for more than 10 years. Positive media coverage and the debate process are considered key factors in the introduction of new technologies, as they affect the technology's acceptance by citizens. The paper aims to analyse the discourse in popular media focused on the newly launched e-tax portal MY taxes. The results of the content analysis are then discussed, highlighting interesting facts in the context of e-government. The results indicate that tax administrative burden and the notoriously problematic public projects of the government are the most frequently mentioned issues. To ensure citizens' understanding and increase the acceptance of e-services, various government and public institutions should consider conducting similar studies before developing new e-government applications.

1. Introduction

The digital economy is an important part of the fourth industrial revolution. For many states and researchers, the field of state administration and e-government is becoming a central theme. In addition to physical states, digital states are created; society acquires the status of e-society, and services are transformed into e-services. According to indices that compare the digital maturity of countries from the European Union and beyond, the Czech Republic has long been lagging behind. For more than ten years, considerable funds from the organizational units of the state, state funds of the Czech Republic on ICT and from EU funds have been continuously spent on the development of digitization in the Czech Republic. Nevertheless, the Czech Republic has not succeeded in establishing a digital state in comparison with other countries of the European Union. In the Digital Economy and Society Index (DESI), the Czech Republic ranked 17th out of all 28 countries of the European Union in 2020. In the area of digital public administration services, the Czech Republic even ranked 22nd, although the Czech digital penetration rate is 88%. The country fell below the European average in most aspects of the Government Benchmark (European Commission, 2020).

According to the results of the Supreme Audit Office's control activities, a low percentage of citizens use the applications and electronic services of public administration. Even though they have been available for more than ten years. The objective of the inspection was to examine the

economic effectiveness of the CZK 246.4 million spent in 2012–2019 on the electrification of public administration, especially in connection with the implementation of electronic identification. The certificate for electronic identification was activated in only 13% of the 1.76 million electronic ID cards issued in this period. Only 0.5% of the total number of 8.7 million Czech citizens over the age of 18 used the citizen portal when communicating with the authorities (Supreme Audit Office, 2020). Another example is the data boxes project, established in 2009 for online communication with the public authorities, which is underused by entrepreneurs. According to the data of the Ministry of the Interior of the Czech Republic, as of 21 June 2019, only 154,802 natural persons engaged in business had voluntarily applied for a data box, out of 1.031 million active entrepreneurs in the Czech Republic. Legal entities are obliged by law to use the data box (eGovernment Network News, 2019). Data from the Czech Statistical Office show that in 2020, 57% of citizens aged 16–74 used the internet in negotiations with the public administration. In comparison with other countries of the European Union, the Czech Republic achieves below-average values, especially with regard to the usage of downloads and the electronic submission of forms (Society Development Statistics Department, 2021).

Why do only a small percentage of Czech citizens use public administration e-services voluntarily? There are many reasons. Besides the legal obligations arising from the use of the new information system, problems occur due to their demanding technological adaptation and insufficient user-friendliness (Yu, 2008; Wimmer & Holler, 2003). On the other hand, great importance is attached to the media coverage of the topic of newly introduced technology. Information from the media influences the way people perceive change and how they think about different aspects of technology. Favourable reports on developed e-government technologies encourage citizens to use them (West, 2005). A communication process that generates a positive attitude towards e-government is considered a prerequisite for the technology's successful implementation. Yıldız & Saylam (2013) also emphasize the important role of discourse when justifying the presence of e-government applications to various stakeholders. Before launching the process of innovating public administration IT systems, it is important to properly identify the ideologies and understand the interrelated relationships of all stakeholders. This facilitates social acceptance of the system (Avgerou & Bonina, 2020; Kassen, 2020). The state of the digital transformation of the Czech public administration has been changing significantly since 2020, when some of the priorities of the Digital Czechia's strategic concept were met. Thanks to the amendment to the Tax Code, the long-awaited e-tax portal MY Taxes was launched (in Czech "MOJE daně": modern/MOderní and simple/JEdnoduchý). Its launch at the end of February 2021 provoked intense media discussion and reflection. The Ministry of Finance even invested CZK 5 million in a promotional campaign to raise citizens' awareness of the benefits of the online tax office and of the new flat tax collection tool. Fakhoury & Aubert (2017) consider the initial learning experience with the digital service to be essential for its understanding, acceptance, and dissemination. Society's transfer to e-services is facilitated, accelerated, and intensified when citizens' capabilities and experience are taken into account. Effective communication to understand how to control technologies also plays an important role in the implementation of e-services (Fakhoury & Aubert, 2017).

Following the important role of communication in the context of e-participation, the purpose of the paper is to empirically document stakeholders' discourses of the e-tax portal. In specific terms, this refers to discourses that enable citizens to make sense of the applications and policies. Particularly, the paper focuses on the following research questions: RQ1: What media discourses arose with the newly launched Czech e-tax portal MY taxes? RQ2: What possible lessons can be learned for future e-government projects as a result of the media discourse?

2. Research Method

An inductive analysis of the media discourse was performed to find out forms and contents in which e-tax portal is generating attention in the Czech media outlets. The dataset contains 138 articles, published during the period January 2016–March 2021, from ideologically different, nationally circulating media (online newspapers / magazines, print, internet). As the most relevant sources of articles were chosen:

- the 5 most frequently used Czech media brands in 2020 (according to Reuters Institute Digital New Report) (Štětka, V. & Reuters Institute for the Study of Journalism, 2020),

    o Seznamzpravy.cz, iDNES.cz, Novinky.cz, Aktualne.cz, Mladá Fronta DNES,

- Ministry of Finance website (mfcr.cz),

- Internet Info magazines (Lupa.cz and Mesec.cz),

- websites for entrepreneurs and personal finance (Podnikatel.cz and Penize.cz).

The media was selected based on the following characteristics: most read, online searchable, owned by different groups of investors, written by different type of author, entrepreneurs oriented. The analysis of e-tax portal discourses does not focus on discourses in the TV and radio because the significance of the information is influenced by factors related to spoken expression. In the case of TV, the prominence is also considerably affected by visual effects. Most of the articles selected for analysis come from the news website Podnikatel.cz (21%). The portals Mesec.cz (13%) mfcr.cz (Ministry of Finance, 12%) are also significantly represented. The remaining articles are evenly distributed (5–9%). Most articles were written by the journalist or reporter. News about e-tax portal MY taxes were identified by searching through the media database Anopress. The most used keywords related to the project were "MOJE daně" (in English "MY taxes"), "mojedane", "mojedane.cz", "daně online" (taxes online in English), "online finanční úřad" (in English "online tax office"), "virtuální finanční úřad" (in English "virtual tax office") etc. Among 261 read articles mentioning MY taxes, 138 relevant articles were selected according to their similar amount of information about MY taxes. From the other key text elements frequently studied in qualitative content analysis, metaphors and strong adjectives were selected (Macnamara, 2005).

Both content and titles of articles are analysed to find units of variables. Messages expressed as words or phrases are transformed to the categories based on applied arguments. Every statement evaluating the online tax office MY taxes and related topics is considered as an argument. The repeated arguments within the same article are counted as one incidence. Grouped arguments around similar themes represent discourses. Subsequently, these discourses are inductively developed and documented. In the same article, it is possible to find more than one type (positive / negative / neutral) of discourse. Neutral discourses are not analysed in detail for their lower informative value compared to extreme values.

3. Results

The arguments in 138 analysed articles were divided into 17 discourses (6 positive, 6 negative and 5 neutral). In total, 249 incidences of discourse are found, of which 142 positive (+), 61 negative (-) and 46 neutral (o). Since the first public presentation of the planned MY taxes project in 2016, citizens have not had much opportunity to learn more about the portal. Articles started to appear more frequently during 2019. Of the positive discourses, the Discourse of Tax Compliance Simplification prevails (72 % of the total 249 discourses). On the contrary, the most frequently mentioned negative arguments are summarized by Discourse of Tax Administrative Burden (6 % of

the total 249 discourses) and Discourse of Notoriously Problematic Government Public Projects (6 % of the total 249 discourses). The representation of neutral Discourses of Safety was also significant (10 % of the total 249 discourses). An overall list of the positive and negative discourse types, definitions and examples of arguments is presented in Table 1.

Table 1: E-Tax Portal Media Discourses

Discourse type	Definition / lessons learned	Messages and arguments
(+) POSITIVE DISCOURSES		
Discourse of Tax Compliance Simplification	To support the use of e-tax portal, it is important to motivate taxpayers.	taxpayer / user benefits; useful portal properties
Discourse of Tax System Transformation	It is important to inform citizens about intended tax changes to increase the likelihood of citizens' understanding and accepting changes.	new revolutionary e-tax system; radical change; tax evolution; client approach, pilot testing; key project
Discourse of E-Participation Simplification	To support the use of e-tax portal, it is important to facilitate online access for citizens and offer the most acceptable ways to login for e-services.	various login options; bank identity; online guide; future: mobile applications, special applications for the disabled
Discourse of Catching up with the North-Western Europe	The Czech Republic and its citizens will benefit from implementing European large experience with successful e-tax systems.	along the lines of the world best practice; the inspiration in Estonia and in experienced countries
Discourse of Tax Policy Effectiveness	To understand the reasons for the portal development and to justify the public finances spent, it is important to explain portal's advantages.	simplification; reducing: the number of tax audits, tax administration and error rate; streamlining
Discourse of Voluntariness	The use of e-tax portal tools should be optional without penalties in order to encourage citizen participation.	new form will only be voluntary; people can choose; only a possibility
(-) NEGATIVE DISCOURSES		
Discourse of Tax Administrative Burden	Success in e-tax projects cannot be accomplished without reducing administrative burdens.	tax compliance difficulties; bureaucracy; complicated law and tax payment
Discourse of Notoriously Problematic Government Public Projects	Success in e-tax projects cannot be accomplished without repairing the reputation of Government Public Projects.	problematic public procurement of IT systems; unsuccessful past e-government projects
Discourse of Political Distrust and Influence	Success in e-tax projects cannot be accomplished without trust in government authority.	influence: populism, new election period; system for election campaign
Discourse of E-Participation Problems	Success in e-tax projects cannot be accomplished without sufficient e-participation.	low number of electronic submissions, insufficient motivation, obligation
Discourse of Slow Digitalization	Success in e-tax projects cannot be accomplished without accelerating digitization and without taking into consideration changes in information technology.	digitization of the whole state failed; eGovernment did not do so well again; since 2009, not much digitization has happened
Discourse of Technical and Usability Problems	Success in e-tax projects cannot be accomplished without solving technical and usability problems.	a sophisticated gateway to an outdated and user-unfriendly EPO application

Source: Author

Table 2 shows the percentage of positive and negative discourses' incidence depending on the year of article publishing and on the number of analysed articles in a given year. For example, 83% of the 6 articles evaluated in 2006 contained Discourse of Tax Compliance Simplification. The percentage in the rightmost column of the table 2 summarize the average number of articles per one

year (counting 5 years and 3 months of 2021). For example, in a period of 5 years and 3 months, Discourse of Tax Compliance Simplification appeared on average in 91% of articles per year.

Table 2: Media Coverage of E-Tax Portal (January 2016-March 2021): Percentage incidence of discourses per number of analysed articles in a given year

Discourse type (%)	2016 6 a	2017 6 a	2018 11 a	2019 53 a	2020 31 a	2021 31 a	AVG/ yr.
(+) POSITIVE DISCOURSES							
Discourse of Tax Compliance Simplification	83	100	73	57	94	71	**91**
Discourse of Tax System Transformation	67	17	9	4	0	16	**21**
Discourse of E-Participation Simplification	0	0	9	4	16	16	**9**
Discourse of Catching up with the North-Western Europe	0	0	4	2	9	10	**5**
Discourse of Tax Policy Effectiveness	50	17	9	0	3	0	**15**
Discourse of Voluntariness	17	0	9	2	0	0	**5**
(-) NEGATIVE DISCOURSES							
Discourse of Tax Administrative Burden	17	33	27	11	13	0	**19**
Discourse of Notoriously Problematic Government Public Projects	33	17	27	11	3	10	**19**
Discourse of Political Distrust and Influence	17	0	18	9	16	0	**12**
Discourse of E-Participation Problems	0	0	9	4	3	6	**4**
Discourse of Slow Digitalization	0	0	0	4	6	6	**3**
Discourse of Technical and Usability Problems	0	0	0	2	0	10	**2**

Source: Author

Expressive metaphors and strong repetitive adjectives were found in the articles. Adjectives which give strong indications of a speaker's or writer's attitude: radical (tax radical change), revolutionary (self-assessment, tax collection system), breakthrough / key / big / flagship (project), unequivocal (priority), client-centred / human (approach). Metaphors and similes used: I) *The Ministry of Finance envisages modern and simple taxes as a house with solid foundations* (+). II) *The Ministry now wants to change taxes just as chaotically and complicatedly as a dog and a cat made a cake* (-). III) *Online taxes will be like electronic banking* (o). IV) *It is like taking an old plane, where everything works in analogue, and decide to change the wooden fuselage to titanium. But at the same time leave analogue control and do not use the option to build an autopilot. And the state does the same* (-). V) *Personally, I am guessing that it will turn out "as usual" – that almost nothing will happen in that four-year period* (-).

4. Discussion

The results of the content analysis provide several interesting stimuli for discussion. A broad view of the issue is supported by selected metaphors and similes. Demand for e-government services and justification for projects are closely related to the public value created by e-government (Yıldız & Saylam, 2013). Therefore, this article discusses discourses on e-tax-portal within the framework of public value. Yıldız and Saylam (2013) emphasize the contribution of e-government research focused on discourse analysis and media influence on the e-government domain. By understanding the perceptions of e-government's stakeholders, it is possible not only to better understand the whole system of e-government, but also to design a successful new technology. Specifically, to create an IT technology solution that citizens will be prepared to use, which they will understand, and which will be better accepted by them (Yıldız & Saylam, 2013). It is important to understand the factors influencing the adoption of e-government. Therefore, many researchers focus on the

technology acceptance model (TAM), trust and usability of e-government technologies (Abu-Shanab & Harb, 2019).

The percentage of Discourse of Tax Compliance Simplification and Discourse of Tax System Transformation shows that the Czech government has been preparing for the new e-tax portal for a long time. The benefits of the online tax office for users / citizens / clients / taxpayers have been communicated regularly since 2016. However, the media space could have included more diverse information multimedia and a more detailed description of the practical benefits. It is important to communicate the resulting benefits not only for citizens, but also for the Financial Administration and the state. Most articles bring repetitive arguments: taxes in a few clicks; simple; user-friendly environment; intuitive, intelligent, and understandable interface; fast and automated process; all tax obligations quickly and conveniently via the internet from the office or from home, without paper forms and visits to tax offices. Thorough processing and publishing of practical benefits for self-employed person (e.g., in the form of quantification of saved hours administrative burden) could counteract the negative Discourse of Tax Administrative Burden and Discourse of notoriously Problematic Government Public Projects. From this point of view, the author considers Discourse of Voluntariness and Discourse of E-Participation Simplification to be very important. The most frequent issues raised in media in the context of e-participation are: excessive complexity of the logging in methods for ordinary users, mandatory electronic filing of tax returns for taxpayers with a data box and the related relatively high sanctions for filing other than electronic form. In metaphors, these unfortunate government decisions in the field of e-government are referred to as "electronic whip" or "stab in the back" to the efforts of digitization.

Any effort for the e-government development is discredited by past unrealized projects, for which a large amount of public funds was used (for example CZK 3.5 billion per unrealized Single Collection Point). Disbelief in the progress of e-government and government promise has often appeared in metaphors: it will turn out "as usual" without anything to happen; we undoubtedly need to fulfil the promise of 2006; "simplification of taxes" forms the slogan that has enchanted almost all governments since the establishment of the Czech Republic. Trust is a significant factor in e-government projects, influencing not only the adoption but also the subsequent relationship's phases (Mäntymäki, 2008). Additionally, the use of e-government can rebuild or increase citizens' trust in government (Welch, 2005; Gracia & Arino, 2015; Arshad & Khurram, 2020).

An inductive analysis of content can suffer from some theoretical and procedural limitations. The assessment of suitable articles for the analysis and categorization of discourses is based not only on theoretical procedures but also on the author's personal point of view. Wide range of insights emerge from different ways of understanding words, phrases, contexts, and other linguistic elements of articles. The incorporation of scholarly articles into the research method could bring new significant interpretations, because the popular media often tend to take over official press release without any deeper analysis or criticism. Additional factors could be considered in future research, such as: categorization based on media weighting, page number or order in journal, use of photos or visuals, headline positioning, information in the first paragraph, text formatting, balance of supportive and opposing sources quoted, text / author credibility.

5. Conclusion

The paper reveals the occurrence of 17 media discourses appearing in 138 articles and mentioning the newly launched Czech e-tax portal MY taxes. For the successful introduction of new e-government services and for the subsequent possible increase in the level of e-participation, it is necessary to understand both positive and negative discourses and their interconnectedness. Governments should emphasize a continuous understanding of the interests, perceptions, and

awareness of all e-government stakeholders. The results of the analysis also indicate potential lessons learned for future e-government projects. By analysing media discourse and citizen needs, government decision-makers can influence the incidence of negative discourses. Content analysis offers a wide range of research that can support the appropriate introduction of new digital means of e-government. Following this study, it would be highly stimulating to compare discourses according to the specific type of media and according to the business relations and interests of its owner. A comparative discourse analysis of different digitization tools could be performed to better understand different media discourses during the development of e-government. Research could be complemented by multimedia, social media, and visual content analysis.

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THE FEATURES OF C2C BUSINESS REALIZATION UNDER THE CONDITIONS OF THE COVID-19 PANDEMIC IN RUSSIA

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Keywords

COVID-19, C2C business, Internet commerce, information and communication technologies

Abstract

A systematic analysis of the evolution of processes in C2C trading, which is carried out by individuals in the virtual space of Russia under the conditions of the COVID-19 pandemic, is realized in the article. Statistical processing of the relevant information allowed the authors of the publication to form model of participants in such a segment of the E-commerce market, as well as to forecast the course of events in the coming 1.5-2 years. Besides, an attempt to develop and substantiate the most probable and effective strategies for the development of this business direction was made.

1. Introduction

The Covid-19 pandemic has made significant amendments to the implementation of the most socio-economic processes around the world. In the new realities, various enterprises and organizations were forced to search for creative solutions to adapt the structure and change the content of their business projects. In particular, most of the trading companies have concentrated their activities in the virtual space, creating their own online stores, organizing trading platforms, and numerous Internet services for the delivery of various goods and services to the population. The relationship between individuals, who had to solve their problems, actively using accounts in social networks and on various Internet sites (including participation in online auctions), has also changed significantly. In the Russian Federation, the evolution trends in 2020 in the field of C2C trading are almost completely in line with global trends (Value Market Research, 2020). In particular, the volume of the Russian trade market between individuals on the Internet has increased by 87% over the past 18 months and has not only reached the level of 1 trillion rubles but, in fact, already exceeded it in 2020. And the number of transactions carried out between individuals increased by 70% (Data Insight, 2020). In 2021, the above trends have not changed, but have intensified. Most European countries have tightened measures aimed at struggling against the Covid-19 pandemic for four months of this year. The total lockdown introduced in February 2021 doesn't not contribute to the implementation of real business and services. The 2021 summer tourist season in Europe is at stake. Therefore, to prevent a profound world economic crisis new ideas are necessary regarding the intensification of business processes in any form. In this regard, the analysis of processes in the field of C2C trading is an urgent task.

2. The aim and research methodology

Analysis of the business processes around the world, including in the Russian, will make it possible to develop and substantiate effective scenarios for commercial activity recovery in general and E-commerce in particular (Doucek, 2019). The aim of this study is to analyze the state and prospects of C2C trading in the Russia under the conditions of the Covid-19 pandemic, as well as to form the elements of a strategy for the development of this direction in business. The research methodology is based on the realization of statistical processing and analysis of a large data set on the dynamics of the main indicators of the corresponding processes development, as well as the implementation of forecasting trends. In this article, the term C2C trading means trade transactions carried out by individuals with other individuals via the Internet concerning material objects (goods).

3. C2C E-commerce in the Russian Federation under the conditions of the COVID-19 pandemic

Under the conditions of self-isolation individuals due to the restrictive measures introduced by the governments of most European countries, are forced to look for ways to form their family budget, not expecting the restoration of business activity in the real sector of the economy in the near future. Therefore, boosting the activity of individuals in social networks, on various Internet sites, Internet auctions, where it is possible to sell new or used goods, as well as exchange them, is quite expected (Kuptsov, 2020). At the same time, the activity of both sellers and buyers has increased starting from the first half of 2019. This is caused by the synchronization of all socio-economic processes in the world (Yablochnikov, 2019). In 2020, the above trends have just intensified. However, the number of buyers on the C2C market of E-commerce in the Russian Federation continued increasing, while the growth in the number of sellers has stabilized. But, simultaneously,

the number of transactions per seller has increased (E-commerce, 2020). Today, the number of buyers and sellers of the Russian C2C market is 13.2 million and 13.3 million, respectively. At the same time, the number of transactions carried out by one seller per month increased. Statistical data show that in 2017 the seller carried out on average one transaction per month, in 2019 - 1.3, in 2020 - 2.3 (see Figure 1).
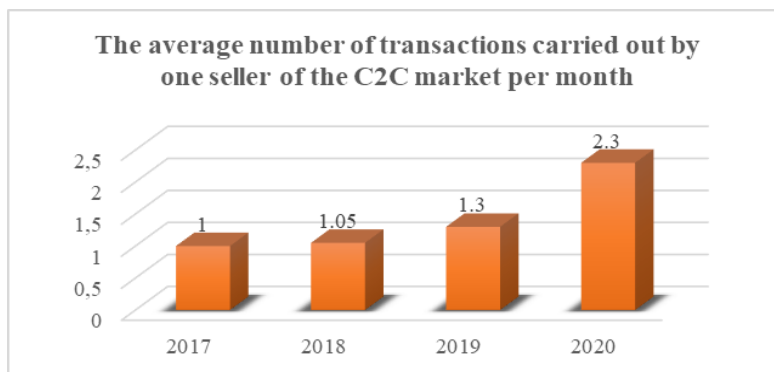
Figure 1 - The average number of transactions carried out by one seller of the C2C market per month

Thus, those who have already acquired the status of a seller on the C2C Internet trade market are carrying out more activity and, in fact, increase the volume of sales of goods. Moreover, for many citizens, such activities have become very regular. Over the past 18 months in Russia, the relative number of private sellers for whom this kind of commercial activity is the main or at least a significant source of income has almost doubled, reaching 11% in November 2020 (in the spring of 2019, this index was equal to 6%). At the same time, for the majority of private sellers on the C2C Internet market (about 76%), this type of activity is still an insignificant and irregular source of income (E-commerce, 2020). It should be noted that in 2020 the relative number of male sellers in the C2C trading increased significantly and reached the level of 63% (Figure 2).
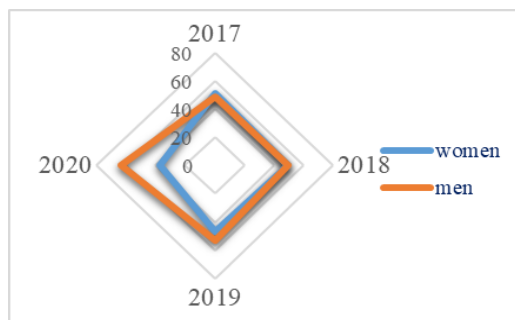
Figure 2 - Dynamics of the ratio of male/female sellers in the C2C market of E-commerce in Russia in 2017-2020

Such a change in the gender situation in this segment of E-commerce is due to the fact that under the conditions of the Covid-19 pandemic, it was the male able-bodied population that suffered the most in the labor market, since activities were ceased real production, which involved mainly male workers. Besides, the relative number of sellers in the C2C trading market, whose age corresponds to the 35-44 age range, has increased, and the share of sellers aged 25 to 34 has significantly decreased. The growth in the average age of sellers in the C2C segment of E-commerce was 5 years compared to 2019 and reached the level of 39 years. Information on the dynamics of the distribution by age groups of C2C Internet market participants in Russia in 2017-2019 is shown in Figure 3.
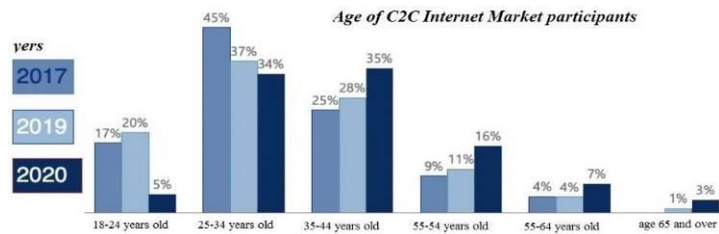
Figure 3 - Age of C2C Internet Market participants in 2017-2020

It is also interesting that in 2020, during the Covid-19 pandemic, more citizens with the average income started being engaged in this type of E-commerce. Their relative number increased by nine percentage points and reached the level of 87 % compared to 2017. Such redistribution was realized mainly due to a decrease of participants in this market segment with a high income (Fig. 4)
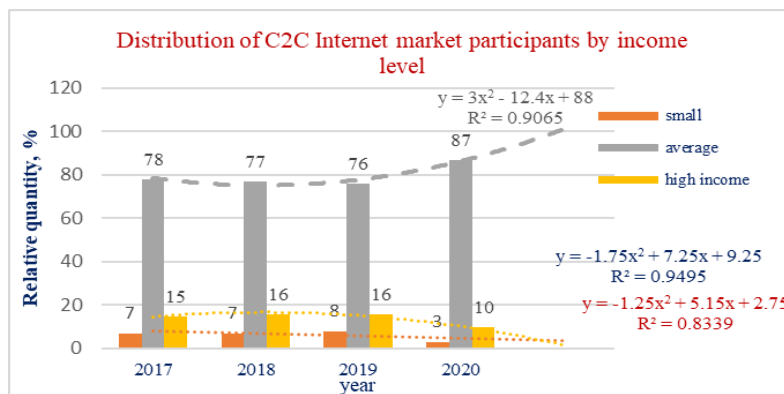
Figure 4 - Distribution of C2C Internet market participants by income level

Another trend that has formed over the past two years is an increase in the relative number of sellers who are engaged in the so-called resale of goods. This segment of the C2C Internet market in Russia actually increased by 1.5 and amounted to 12% of the total volume of E-commerce in 2020. At the same time, the majority of buyers (approximately 85%) preferred to purchase brand new goods via various Internet platforms, including virtual message boards such as AVITO, YOULA. And the volume of such transactions in the C2C format reached 15% of the total volume of this market in 2020. Thus, there is an actual reorientation of the C2C market from trading used items to new ones or goods discounted for certain reasons. A large share of the C2C market belongs to goods that were previously purchased by those who sell them today; however, according to the sellers' opinion, for some objective reason these goods were never used, but only kept for a certain time. Most of the transactions related to the purchase of brand-new goods in the C2C market segment in Russia are carried out in the following categories of purchase and sale objects, namely: goods for beauty and health, as well as various accessories. The largest assortment of goods offered by private sellers still corresponds to the following categories: household appliances, electronics and computers (almost a quarter of transactions), clothing and footwear (almost a fifth of transactions) and children's products (17%), as well as spare details for cars, household goods, goods for sports and recreation. Statistical data over the past three or four years indicate that the structure of the Russian C2C E-commerce market has hardly changed (E-commerce, 2020; Global C2C E-Commerce, 2020).

Significant growth in E-commerce in the C2C segment is typical for the period of the Covid-19 pandemic in quite large cities with a population of 100 to 500 thousand people (more than 1.8 times). But in Russian megacities, primarily in Moscow and St. Petersburg, there is a noticeable decline (by about 17%) in this type of commercial activity in 2020. The number of sellers of the

C2C segment of the Internet market who live in rural areas and small towns of Russia has remained unchanged over the past three years. Such trends can be explained by the fact that socio-economic relations in the province have not actually changed during the pandemic. Restrictions on contacts between people in 2020-2021 by the municipal authorities, in many cases, were not introduced or were implemented formally. And the persistent disregard of general recommendations on reducing the number of social contacts was mainly explained by citizens living in rural areas, the low population density, and, accordingly, the very low probability of infection with the Covid-19 virus. Consequently, the citizens did not have an urgent need to move to the virtual space to realize their activity and generate income. This trend apparently will sustain in 2021. According to the statistical data for 2019, the C2C segment market has reached a certain intermediate level of saturation, primarily in the Russian province. During the Covid-19 pandemic, the provincial Internet business is forced to look for new sales markets. Therefore, in 2020, a development trend of the C2C sector has emerged, i.e. a significant expansion of the geography of Internet transactions is being implemented. It is obvious a noticeable increase in the number of sellers in the C2C Internet business sector, who sell their goods to buyers who live not only outside a certain settlement but also in the region. This fact, in particular, is confirmed by statistical data on the relative number of those sellers of the C2C sector who sell goods only within their city. Their share has decreased by 19% since 2017. And the number of sellers realizing goods throughout the country increased by 11%.
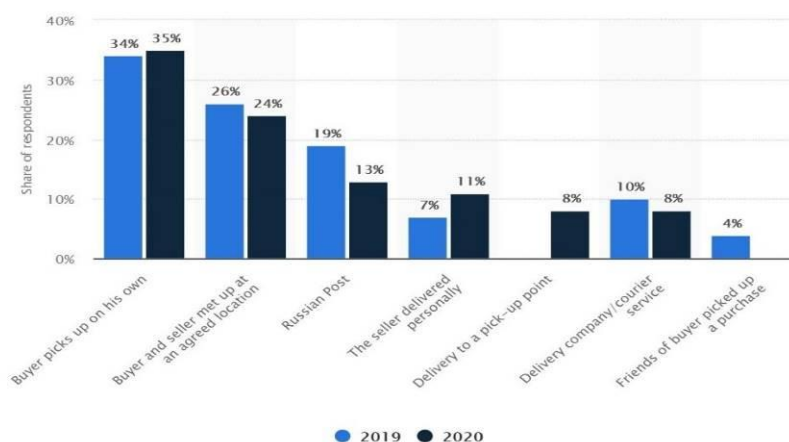
Figure 5 - Distribution of the total volume of transactions by methods of delivering goods from seller to buyer in the C2C segment of the Internet trade market in 2019-2020

The mentioned trends regarding the spatial redistribution of business interests of the participants in the C2C segment of Russian E-commerce are explained by the rapid development of the logistics sector, which not only demonstrated a significant increase in the volume of services provided in 2019-2020, but also expanded their range. Digital bulletin boards, which are preferred by the participants in the C2C segment of the E-commerce market, have organized under the new conditions not only their delivery services but, in fact, specific systems for the implementation of mutual financial settlements between registered buyers and sellers. Therefore, the number of C2C segment goods, which were delivered either by courier (in 2020 - 16%), or by the seller himself (in 2020 - 11 %), increased. However, according to the Statista Internet portal data, the most popular ways of making a deal between a seller and a buyer in 2020 were either a face-to-face meeting (24%), or the buyer picked up the relevant product from the seller on his own (35%). However, it is the last method of making real transactions on the C2C market that is traditionally the most acceptable for both parties of this type of socio-economic relations in Russia. Figure 5 presents the information on the distribution of the total volume of transactions by methods of delivering goods

from seller to buyer in the C2C segment of the Internet trade market in the Russian in 2019-2020 (Statista, 2020).

The above information also indicates that the confidence of buyers and sellers of the C2C segment in the work of the Russian Post is decreasing, due to the low quality of services provided by this logistics structure. And, consequently, confidence in the newly organized numerous private logistics companies and delivery services is growing. According to the authors, this trend will also sustain in 2021. The last thesis is already confirmed by statistical data for the first quarter of 2021.

4. Conclusion

Today the C2C segment of the Internet market in Russia is a huge independent conglomerate of social, economic and informational relationships formed between its many participants. The above relationships are characterized by specific principles, laws and trends. This market has its unique characteristics that are not congruent with (to) the B2C market. A kind of motivation for carrying out commercial transactions in the C2C segment is not so much the price of various goods, which, as a rule, is slightly lower than the average price of the corresponding B2C market for similar goods, but the availability of some opportunity to purchase something unique, rare or even antique. Such goods, as a rule, are not offered for sale in real or virtual stores. Thus, the C2C Internet business has its own rather specific segment in the market of goods and services. A set of trends, which indicate a significant reformatting of the structure of this segment of the Internet market and, in some way, the transformation of its essence has formed under the conditions of the Covid-19 pandemic. These tendencies and trends, as evidenced by statistics, in particular for the first quarter of 2021, will sustain. Especially as the situation regarding the evolution of the epidemic caused by coronavirus infection in the world in general and in Europe, in particular, has not, unfortunately, improved yet.

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COBIT 19 AND COVID 19: IS THERE ANY RELATIONSHIP?

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Keywords

COBIT 2019, COVID 19, COBIT tools, goals cascading, design factors, governance system design workflow

Abstract

The article explains how COBIT 19 publications and tools can be used in setting priorities of the Information and Technology (I&T) objectives, implementation of chosen components of governance system and applying best practices in the context of changes caused by the COVID 19 pandemic. The use is demonstrated on two use cases.

1. Introduction

The pandemic of the Corona virus or COVID 19 spread across the world rapidly and devastated humans and nearly all the services. This situation has never been experienced in the past and therefore it is difficult to find the best solution to this problem. With respect to the sometimes chaotic and unexpected changes in reaction of different government institutions on COVID 19 organizations have to react immediately and thus implement quick partial solutions of these emergency changes. The main aim of the article is to show, how COBIT 2019 (referred to as COBIT 19) can help organizations to develop more robust Enterprise Governance Systems (EGIT) that will be dynamic and flexible enough and each time when the core business factors are changed (e.g., a change in strategy or technology), the impact of these changes on the EGIT system can be considered.

The main research question of the article is: How can COBIT 19 help organizations adapt their EGIT to the changes brought about by COVID 19. The methods used within the research have a base in DSRM (Design Science Research Methodology for Information Systems Research) (Peffers, 2007). The research is based mainly on secondary research methods.

2. The Relationship Between COBIT and COVID

EGIT is concerned with value delivery from digital transformation and the mitigation of business risk that results from this transformation. It should help organizations to communicate and share responsibility over the digital transformation across the firm from board level across the executive levels up to individual IT professionals. EGIT is an integral part of the corporate governance. In (ISACAc, 2018, p.11) it is stressed, that it is complex and multifaceted – no „one solution for all". COBIT 2019 is a business framework that facilitates EGIT. It can be used to deploy new and

existing digital platforms and technologies to survive and thrive. It is based on the core framework of EGIT which covers all different components of EGIT and in the clear form presents users the best practices that relate to these components. The research presented in (ISACA, 2021) shows that the digital leaders (which means organizations that have a proven track record of disrupting traditional business models) are better prepared for continuous improvement of the strategic plans, and technology risk assessment. These abilities are based on best practices, lessons learned and goals metrics. According to the same research (ISACAd, 2021, p.13) 58% of the companies have identified COBIT as the most important industry framework for the assessment of the technology based risk. The mutual relationship between COVID 19 and COBIT 19 is thus apparent: COVID 19 has accelerated globally the digital transformation of all organizations and COBIT 19 is the methodology that should help organizations to implement and continuously improve and adapt their EGIT as the best practice for their digital transformation.

Basically COBIT 2019 offers two ways how to influence the design of an enterprise's governance system and position it for success in the use of I&T with respect to COVID 19. These ways are based on goals cascading and design factors. They are not mutually exclusive, but may be complementary.

2.1. Goals Cascading

The leading idea of COBIT 2019 governance system design is that the system must respect stakeholder needs that need to be evaluated and transformed into an enterprise's strategy. Enterprise strategy used to be described by the help of enterprise goals. COBIT 2019 submits examples of 13 standard enterprise goals EG01 – EG13. These goals are mapped to alignment goals which are examples of 13 standard IT goals (AG01 – AG13). Based on the setting priorities for alignment goals, relevant governance and management objectives can be selected. The description of the 40 governance and management objectives represents the core part of COBIT 2019. Objectives are standard general examples of I&T goals that are capable to contribute to enterprise goals. Different sets of objectives are able to support different sets of enterprise goals. Objectives are grouped into five domains: Governance objectives are grouped in the Evaluate, Direct and Monitor (EDM) domain and Management objectives are grouped in four domains (Align, Plan and Organize (APO); Build, Acquire and Implement (BAI); Deliver, Service and Support (DSS); Monitor, Evaluate and Assess (MEA). (ISACAc, 2018) provides detailed description of these 40 governance and management objectives. Each objective is furthermore described by the help of components. Components are factors that, individually and collectively, contribute to the good operations of the enterprise's governance system over I&T. COBIT 2019 recognizes 7 components: Processes, Organizational structures, Information flows and items, People, skills and competencies, Policies and procedures, Culture, ethics and behaviour, Services, infrastructure and applications. The impact is on Processes (Process component) and there is a rule that one objective relate to one process component (together there exist 40 processes supporting 40 objectives).

To summarize the COBIT goals cascade contains 13 enterprise goals, 13 alignment goals and 40 I&T objectives. All these artefacts are mapped to each other. Thus an enterprise's governance body should review, revise, reset and reframe the enterprise goals after considering the impact of COVID 19 on the enterprise. Based on the updated enterprise goals set by the governance body, the management team can select alignment goals. Based on alignment goals, relevant governance and management objectives can be selected, and for these, relevant components (guidance and best practices can be extracted and used to implement and improve relevant processes and practices as required. These can be further customized and integrated with other standards and frameworks as required.

(ISACAa, 2018) describes the proposed work flow for designing a tailored governance system. It consists of three steps each of them is divided into substeps. The different steps and substeps should result in recommendations for prioritizing governance and management objectives or related governance system components. Within the steps and substeps we are to combine the qualitative and quantitative approaches. The main parts of this approach are design factors (DF). Design factors are factors that can influence the design of an enterprise's governance system. COBIT takes in account 11 design factors (DF1 – DF11). They are listed in Table 1 and organizations can use any combination of them.

Table 1: List of design factors

DF1	Enterprise strategy: enterprises can have different strategies, which can be expressed as one or more of the archetypes
DF2	Enterprise goals supporting the enterprise strategy: enterprise strategy is realized by the achievement of (a set of) enterprise goals
DF3	Risk profile: identifies the category of I&T related risk to which the enterprise is currently exposed
DF4	I&T-related issues: should consider which I&T related issues organization currently faces.
DF5	Threat landscape: enables the classification of the threat landscape under which the enterprise operates
DF6	Compliance requirements: allows classifying the compliance requirements to which the enterprise is subject
DF7	Role of IT: The role of IT for the enterprise can be classified
DF8	Sourcing model for IT: allows classifying the sourcing model the enterprise adopts
DF9	IT implementation methods: IT implementation methods (agile, DevOps, traditional and hybrid) can be prioritized
DF10	Technology adoption strategy: enables classification of the IT adoption strategy
DF11	Enterprise size: takes in account the size of the company measured in the number of full-time employees

3. Tools Enabling Dynamic Redesign of the Governance System

In relation to the two approaches to dynamic governance system design described above COBIT 19 comes with two different tools enabling organizations to flexibly prepare materials for an enterprise's governance body goals review. Both the tools can force the different stakeholders to discuss change settings and priorities in governance system. The inputs of these tools are quantitative settings of different attributes of an enterprise, the output is the list of I&T governance and management objectives most relevant to the input settings.

3.1. COBIT 19 Top Down Tool

COBIT 2019 Top Down tool is the Excel table which simplifies the application of goals cascading described in Chapter 2.1. It consists of 5 sheets: Enterprise goals, Alignment Goals, Processes, Practices, Activities. The knowledge imbedded in this tool is the alignment between goals and process component. Using this tool you can discuss not only the priorities of process component, but the priorities of process practices and activities as well. Setting priorities depends on the assigned values to chosen relevant goals and using weights. Where it is reasonable, examples of metrics are available. Each sheet includes filters for results presentation. The needed input of this tool is setting priorities for enterprise and alignment goals. The output is the set processes (practices, activities) and metrics most relevant to the input settings.

3.2. COBIT 19 Design Guide Tool

The COBIT Design Guide tool is an Excel spreadsheet-based tool that facilitates the application of the governance system design workflow. It represents the second approach to quantify and rank

priorities for governance and management objectives (processes). It is more complex way comparing previous tool as it supports the assessment of the important design factors in three steps described in (ISACAa, 2018). The tool consists of

- A canvas tab that consolidates all results of the governance system design workflow
- One tab for each design factor (DF), where:
  - o Values can be entered and graphically represented
  - o Priority scores for governance and management objectives are calculated and presented in table format and graphically in two diagrams.
- Two summary tabs (one after Step 2 and another after Step 3 of the governance system design workflow) that graphically represent the outcomes of each completed step.

The tool also includes mapping tables for design factors that have input values used by other tabs, but these tables are hidden to increase the readability of the spreadsheet.

4. Use Cases for COBIT 2019 Adoption

The previously mentioned COBIT concepts and tools can be practically applied to redesign enterprise governance system to meet the challenges of COVID 19. Recently available research results about the impact of COVID on IT related risks from IT audit point of view (e.g. Deloitte, 2021, p.10; KPMG, 2020, p.2; ISACAd, 2021, p.19) agree that IT security (with impact on cybersecurity), business/operational resilience and regulatory compliance (with impact on confidentiality and privacy) are the top three issues most organizations face. Based on this conclusion the input data for the two tools were assigned.

4.1. Application of the COBIT 19 Top Down Cascading Tool

The recommended work-flow for Top down cascading tool is the next:

1. Identify the primary enterprise goals: EG06 Business service continuity and availability is the primary enterprise goal, EG3 Compliance with external laws and regulations, EG12 Managed digital transformation programs.

2. Identify the alignment goals (AG) with the highest rating according to imbedded mapping tables of the tool: AG7 Security of information, processing infrastructure and applications, and privacy, AG11 IT compliance with internal policies, AG1 IT compliance and support for business compliance with external laws and regulations.

3. Identify the governance and management objectives (Table 2).

Table 2: CASE1-Final list of related governance and management objectives

ID	Objective name
EDM01	Ensured Governance Framework Setting and Maintenance
APO01	Managed I&T Management Framework
BAI11	Managed Projects
DSS04	Managed Continuity
DSS05	Managed Security Services
EDM03	Ensured Risk Optimization
APO13	Managed Security
APO12	Managed Risk
BAI10	Managed Configuration

BAI02	Managed Requirements Definition
APO03	Managed Enterprise Architecture
BAI03	Managed Solutions Identification and Build

4. Discuss priorities of the recommended objectives in context of their current state (e.g. capability level) in your enterprise.

5. Summarize the changes required, obtain approval and identify the relevant performance measurement metrics to monitor and assess the result.

4.2. **Application of the COBIT 19 Design Guide Tool**

The precondition for the application of the tool is the quantification of the options offered in all or selected DFs. In this case the quantification of the DFs is partly fictitious and partly respects the impact of COVID 19.

The recommended work-flow (governance system design process) for COBIT 19 Design Guide Tool is the next:

1. Understand the enterprise context and strategy and set the values for DF1 – DF4.

2. Determine the Initial Scope of the Governance System. Initial scope of the objectives.

The values of individual DFs that have gained the highest importance and resulted initial scope of objectives with ratings higher than 60% are available in Table 3.

Table 3: Results after the Step 2 of work-flow

DF	DF settings	Initial scope of the objectives with ratings higher than 60%
DF1	Client service stability	APO13 Managed security (100%) APO12 Managed Risk (90%) DSS04 Managed Continuity (75%) DSS02 Manage Service Request and Incidents (75%)
DF2	EG06 Business service continuity and availability	
DF3	Enterprise/IT architecture, Unauthorized actions and Logical attacks (hacking, malware, etc.)	
DF4	Significant I&T-related incidents, such as data loss, security breaches, project failure and application errors, linked to IT	

3. Refine the scope of the governance system and set the values for DF5 – DF10 (DF11 was omitted).

4. Resolve conflicts and conclude the governance system design. The values of DFs and the final scope of the objectives with ratings higher than 60% is in Table 4.

Table 4: CASE2 List of DFs values and final scope of governance and management objectives

DF	DF settings	Final scope of the objectives
DF5	Threat landscape: High (75%)	APO12 Managed Risk (100%) APO13 Managed Security (95%) DSS04 Managed Continuity (80%) DSS02 Manage Service Request and Incidents (75%) DSS05 Managed Security Services (70%)
DF6	Compliance requirements: Normal (75%)	
DF7	Role of IT: Factory	
DF8	Sourcing model for IT: Cloud (50%), Outsourcing (30%), Insourced (20%)	
DF9	IT implementation methods: agile (50%), DevOps, Traditional (40%), Hybrid (10%)	
DF10	Technology adoption strategy: Follower (70%)	

5. Step is the same as in previous case.

5. Conclusion

The two examples of COBIT 19 application and their support by automated tools aim to demonstrate how to prioritize IT objectives in relation to the changing business strategy. In this way, it is possible to react relatively quickly to the changes in IT brought about by COVID 19.

The Top down cascading tool is a simple tool that only automates the logic of mapping tables between EG, AG, and objectives. Input data are the subject for discussion between IT and business professionals. The output is a relatively wide range of objectives that are global in nature (i.e. have links to several different EGs).

The Design guide tool is a more sophisticated tool that prioritizes objectives based on the evaluation of several different DFs. It therefore requires more intensive communication with various stakeholders, but the output is a more precise definition of the initial extent of governance system, which corresponds to the situation of the organization.

COVID 19 pandemic is certainly not an ideal opportunity to implement the governance system in its entirety. At the same time, however, it is not advantageous for organizations to respond unsystematically to the rapidly changing conditions of their business and its support by I&T. COBIT 19 makes it possible to select those goals and their components that are currently important for the enterprise and thus create a consistent basis for further adjustment and implementation of governance system.

6. Acknowledgement

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ENTERPRISE IT INNOVATION THROUGH EGIT AND COBIT® 2019

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Keywords

EGIT, COBIT, structure, process, relational mechanisms, business strategy, stakeholder

Abstract

As a result of the growing importance of IT, organizational decision creators are increasingly confronted with important IT-related decisions at all managerial levels. Strategically oriented IT management aims to ensure adequate control over current and future use of IT. The EGIT (Enterprise Governance of IT) is concerned with providing value from the digital transformation and mitigating the business risk arising from the digital transformation. The article deals with the connections between EGIT and the structure of COBIT® 2019 with respect to the effective innovation of enterprise IT.

1. Introduction

Gartner first introduced the idea of "improving IT governance" in its CIO management priorities for 2003. From the beginning, due to the focus on "IT", the discussion on IT government focused mainly on IT. However, EGIT clearly goes beyond IT-related responsibilities and extends to the (IT) business processes needed to create and protect the business value of IT as shown fig. 1.
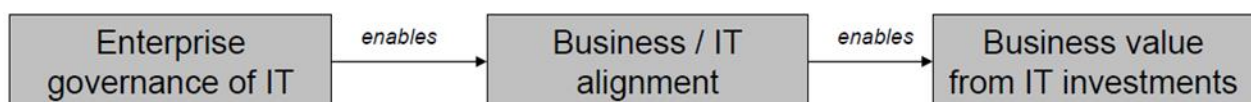
Figure 1. EGIT - Alignment value conceptual model

The International Organization for Standardization (ISO) has issued the EGIT ISO 38500 standard, which sets out six principles that guide the current and future use of IT, and addresses roles and responsibilities in business and IT. These are the following 6 principles (ISACA, 2018d):

1. Responsibility
2. Strategy
3. Acquisition
4. Performance
5. Conformance
6. Human Behavior

EGIT is an integral part of corporate governance and addresses the definition and implementation of processes, structures and relational mechanisms in the organization (Van Grembergen et al., 2009), as shown fig. 2.
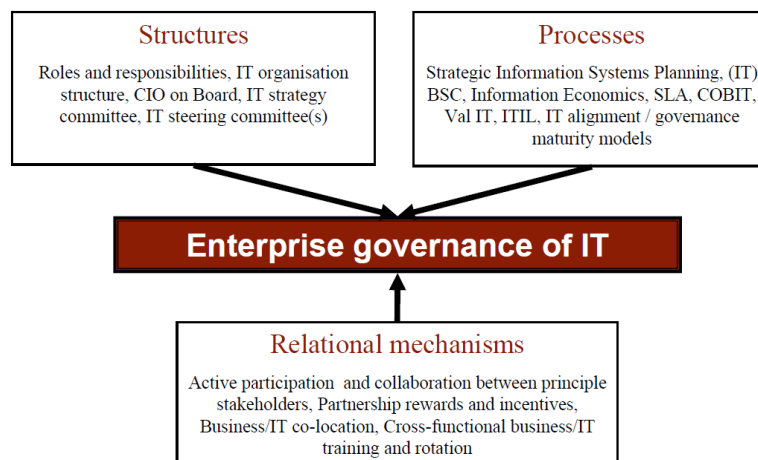
Figure 2. EGIT – Structures, processes and relational mechanism

The definition of EGIT explicitly emphases that the outcome of EGIT is the alignment of IT with the business. Venkatraman et al. (1993) described the relationship between business and IT in the Strategic Alignment Model (SAM), which is based on two building blocks (see fig. 3), namely:

- Strategic customization
- Functional integration, where there are two types of functional integration, i.e Strategic and Operational
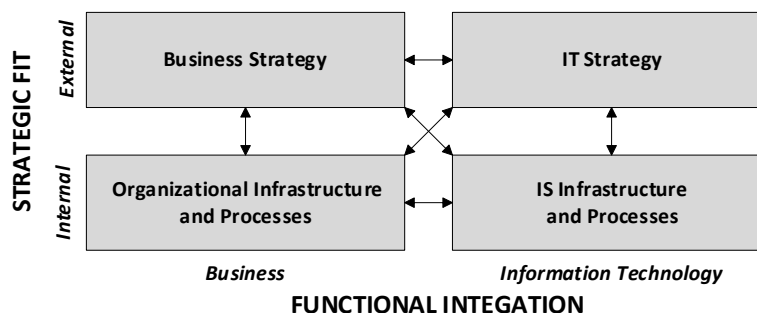
Figure 3. Strategic Alignment Model (SAM); Source: (Venktraman et al, 1993)

The external and internal domains have equally important, but managers have traditionally considered IT strategy in terms of the internal domain, because historically IT has been seen as a supporting function that has been less important to the business (ISACA, 2018a).

2. Potential benefits of innovation through EGIT

EGIT is concerned with providing value from the digital transformation and mitigating the business risk arising from the digital transformation. More specifically, 3 main results can be expected after the successful adoption of EGIT (ISACA, 2018b):

- Realization of benefits
- Risk optimization
- Resource optimization.

3. COBIT® 2019 as the methodological framework of EGIT

EGIT means all the technology and information processing that a business implements to achieve its goals, no matter where it happens in the business. The COBIT® 2019 clearly distinguishes between governance and management. These two disciplines involve different activities, require different organizational structures and serve different purposes (ISACA, 2018c).

The governance ensures that:

- Stakeholders' needs, conditions and capabilities were assessed to set balanced and agreed business goals.
- The direction of the company's development was determined through setting priorities and decision-making.
- Performance and compliance were monitored based on agreed direction and goals.

Management plans, builds, operates and monitors activities in accordance with the direction set by the management body to achieve the company's goals.

COBIT® 2019 was developed based on 2 sets of principles (ISACA, 2018d):

Six Principles that describe the core requirements of a governance system for enterprise information and technology:

1. Providing stakeholder value to satisfy their needs and to generate value from the use of IT.
2. Holistic approach when a governance system for enterprise IT is built from a number of components that can be of different types and that work together in a holistic way.
3. Dynamic governance system. This means that each time one or more of the design factors are changed, the impact of these changes on the EDGE system must be considered.
4. Governance distinct form management governance when is clearly distinguish between governance and management activities and structures.
5. Tailored to enterprise needs by using a set of design factors as parameters to customize and prioritize the governance system components.
6. End to end governance system which should cover the enterprise end to end.

Three Principles for a Governance Framework:

1. Based a conceptual model identifying key components and relationships between components to maximize consistency and enable automation.

2. Open and flexible governance should be allowing the addition of new content and the ability to address new issues in the most flexible way, while maintaining integrity and consistency.

3. Aligned to major standards should align to relevant major related standards, frameworks and regulations.

COBIT® 2019 improves on prior versions of COBIT in the following areas ISACA, 2018a):

- Flexibility and openness when the definition and use of design factors allow COBIT to be tailored for better alignment with a user's particular context. The COBIT open architecture enables adding new focus areas or modifying existing ones, without direct implications for the structure and content of the COBIT core model.

- Currency and relevance when the COBIT model support referencing and alignment to concepts originating in other sources.

- Prescriptive application when the models such as COBIT can be descriptive and prescriptive. The application of tailored COBIT governance components is perceived as a prescription for a tailored IT governance system.

- Performance management of IT when the structure of the COBIT performance management model is integrated into the conceptual model. The maturity and capability concepts are introduced for better alignment with CMMI.

3.1. Governance and management objectives of innovation EGIT

To achieve business goals through IT, a number of governance goals need to be achieved. The basic concepts related to the objectives of administration and management are:

- Each management or management goal always involves one process and a number of related components of other types that help achieve the goal (Ministr & Pitner, 2017).

- A governance objective relates to a governance process, while a management objective relates to a management process. Boards and executive management are typically accountable for governance processes, while management processes are the domain of senior and middle management (Maryska & Doucek, 2017).

The governance and management objectives in COBIT are grouped into 5 domains.

Governance objectives are grouped in the one domain:

- Evaluate, Direct and Monitor (EDM) domain. In this domain with 5 processes which the governing body evaluates strategic options, directs senior management on the chosen strategic options and monitors the achievement of the strategy.

Management objectives are grouped in 4 domains:

- Align, Plan and Organize (APO) domain. This domain has 14 processes which addresses the overall organization, strategy and supporting activities for IT.

- Build, Acquire and Implement (BAI) domain. This domain has 11 processes which treats the definition, acquisition and implementation of IT solutions and their integration in business processes.

- Deliver, Service and Support (DSS) domain. This domain has 6 processes which addresses the operational delivery and support of IT services, including security.

- Monitor, Evaluate and Assess (MEA) domain. This domain has 3 processes which addresses performance monitoring and conformance of IT with internal performance targets, internal control objectives and external requirements.

3.2. Components of the governance system

In order to meet the goals of administration and management, each company must implement, adapt and maintain a management system built from a number of components. Components:

- are factors that, individually and collectively, contribute to the good operations of the enterprise's governance system over IT (Danel et al., 2015);

- interact with each other, resulting in a holistic governance system for IT (Clopecký et al,2019).

- can be of different types which are:

  o Processes which describe an organized set of practices and activities to achieve certain objectives and produce a set of outputs that support achievement of overall IT-related goals.

  o Organizational structures which are the key decision-making entities in an enterprise.

  o Principles, policies, procedures, and frameworks which translate desired behavior into practical guidance for day-to-day management.

  o Information that is pervasive throughout any organization and includes all information produced and used by the enterprise. COBIT focuses on information required for the effective functioning of the governance system of the enterprise (Doucek et al, 2011).Culture, ethics and behavior of individuals and of the enterprise which are often underestimated as factors in the success of governance and management activities

  o People, skills and competencies which are required for good decisions, execution of corrective action and successful completion of all activities.

  o Services, infrastructure and applications which include the infrastructure, technology and applications that provide the enterprise with the governance system for IT processing.

Components of all types can be generic or can be variants of generic components:

- Generic components are in nature and generally need customization before being practically implemented.

- Variant components are based on generic components but are tailored for a specific purpose or context within a focus area (e.g., information security, concrete regulation, etc.).

3.3. Process of design governance system

The IT management system design process is generally divided into several phases, which include steps, as shows figure 4. The implementation of these phases results in recommendations for prioritizing governance objectives or related components of the governance system, for target capability levels or for adopting specific variants of the governance system component.
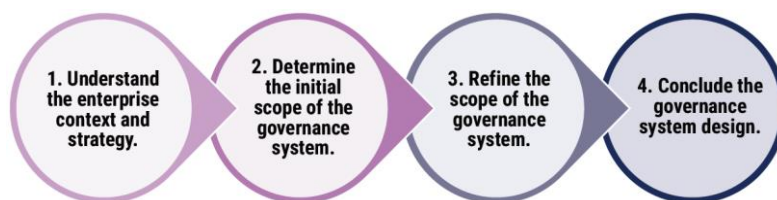
Figure 5. Governance system design workflow, source: (ISACA, 2018)

It is generally recommended to record and visualize any instructions that have been obtained. In the last phase, it proposes the need to resolve conflicts between the identified design elements.

4. Best practices and identified processes of EGIT

In previous EGIT implementations, next practices have been identified and subsequently published (De Haes et al, 2009). These practices can be divided into next areas:

- Practices identified and defined structures
- Practices identified and defined processes
- Practices identified and defined relational mechanisms

5. Conclusion

Research has shown that companies poorly design or prepare approaches to EGIT perform worse in aligning business and IT strategies and processes. As a result, these businesses are less likely to achieve their thoughtful business strategies and realize the business value they expect from the digital transformation.

EGIT can be implemented using many methodological frameworks. The COBIT® 2019 methodological framework seems to be very suitable, as it has built-in structures, processes and relational mechanisms that support the creation and implementation of effective EGIT.

According to the authors, the key principles of COBIT® 2019, which ensure the creation of effective EGIT, are the Dynamic governance system, Governance distinct from Management, and End-to-end governance system.

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DIGITAL TRANSFORMATION IN CRISIS MANAGEMENT

RISK, VULNERABILITY AND RESILIENCE ANALYSES FOR PANDEMIC MANAGEMENT: CHALLENGES AND PERSPECTIVES OF APPROACHES FOR THE FUTURE

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Keywords

Abstract

COVID-19 represents one of the greatest global challenges of the last decades in terms of medical, coordination and management aspects, but also on the societal and economic level. The borderline experience of dealing with such a complex, global event has shown that Austria – as the majority of countries and organizations – was inadequately prepared for a crisis of this kind in some areas. The call for a comprehensive, applicable and interoperable solution portfolio including evidence-based analysis of current processes/structures, tools and infrastructures as well as lessons learned from the current pandemic response, is evident. The "ROADS to Health" reflect this approach[7], a holistic solution set up aiming at developing a technologically supported, clearly structured

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[7] At the time of drafting the paper, the project reflecting the „ROADS to Health"-solution set is under evaluation by national funding agencies.

pandemic management for the future. Experiences from the current management will be processed and included in risk analyses to describe further, possible future pandemic scenarios in order to derive practical resilience strategies and develop connectable tool modules and a roadmap. "Strengthening strengths, bridging weaknesses" will be the overarching goal, taking into account specific, particularly relevant questions and tasks of the stakeholders as well as of other interested parties involved in management with regard to the actual prevention potential of current, isolated measures. Resilience is thus to be promoted in selected, particularly relevant areas and tools for reducing vulnerability are to be made available to decision-makers through a holistic approach.

This keynote paper will draft the frame of this model by presenting the underlying background and basis of the ROADS to Health-solution set and open the floor for a wider range of perspectives of optimization in pandemic and crisis management.

1. Framework and structure of pandemic management

Preliminary investigations within the European-funded project STAMINA (Nr. 883441) have shown that, from a generic point of view, the pandemic management in different countries follows similar structures (e.g. reflected in the CompCoRe network). In general, the pandemic management within a country can be displayed in a layer model, consisting of the following four layers: the legal framework, the stakeholders, the processes and the solutions (Figure 1).

The first layer describes the legal framework within which a state operates. Typically, the legal framework consists of laws, regulations and other acts (like recommendations) issued by different types of authorities both on the federal as well as on the regional level. The central authority in charge of pandemic issues is often a ministry concerned with health issues, but other authorities, such as the ministry of interior, may also play an important role. Simultaneously, regional governments may be involved in setting up the legal framework. Stakeholders form the second layer of the model.
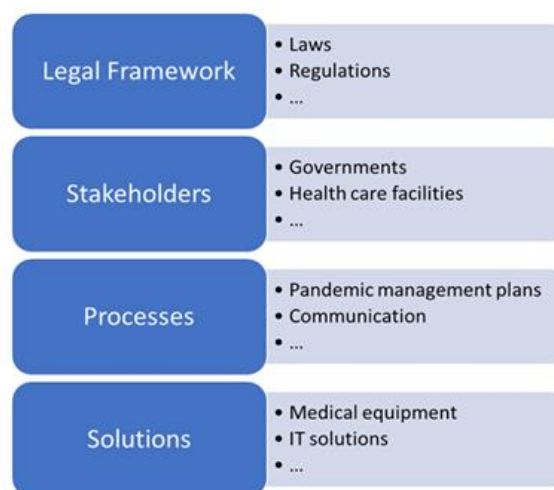
Figure 1 Layer Model for describing Pandemic Management

The stakeholders involved in pandemic management consist of medical support providers, for example hospitals, and first responders, such as the Johanniter. Moreover, multiple infrastructure providers, including food, water, energy and housing providers as well as the pharmaceutical industry, are key in pandemic management. Each of these stakeholders established processes enabling them to implement their specific mandates. In case of authorities, the legal basis of any

process must be ensured. For first responders, infrastructure providers or other companies, all processes must comply with the respective bylaws or company policies. Such processes compose the third layer of the model. Examples are pandemic management plans or communication processes.

Finally, in order to execute processes in an effective and efficient way, adequate solutions (e.g. medical products, messenger services, applications) may be applied (Richter et al 2020, Liu et al 2020). For example, in order to reduce virus transmission at service providers such as hairdressers, public libraries or restaurants the health authorities may require customers to be tested before accessing them. Solutions for this purpose would be testing devices, such as polymerase chain reaction (PCR) or antigen tests.

To underpin this layer model, some facets of the Austrian pandemic management are shown in Figure 2. The basic legal document in Austria for the management of pandemics is the Austrian Law for epidemics from 1950 (Epidemiegesetz 1950/186). As a reaction to the emerging pandemic, Austria issued the COVID-19 intervention law (BGBl I 2021/23) as well as a multitude of federal and state laws to implement adaptive protective measures (ibd.). These laws and regulations cover a multitude of aspects such as curfews, business hours and travel restrictions.

Before the COVID-19 outbreak, the Austrian Health Authorities had already established several processes to deal with future pandemics. A key document is the national Pandemic Management Plan for Influenza from 2005 (BMSGPK 2005). In reaction to the Ebola outbreak in West Africa in 2015, an emergency plan for Ebola was developed (BMSGPK ENP 2015) in the same year. Moreover, a publicly not available smallpox alarm plan from 2003 exists. On a regional level, similar plans exist for the management of influenza (BMGFJ 2007).

Figure 2 shows selected elements of the Austrian pandemic management. It focusses on the two main stakeholders: the Federal Ministry of Health and the Federal Ministry of the Interior. Each ministry established several committees responsible for pandemic management tasks (mandates) such as the Corona task force of the Austrian Ministry of Health.
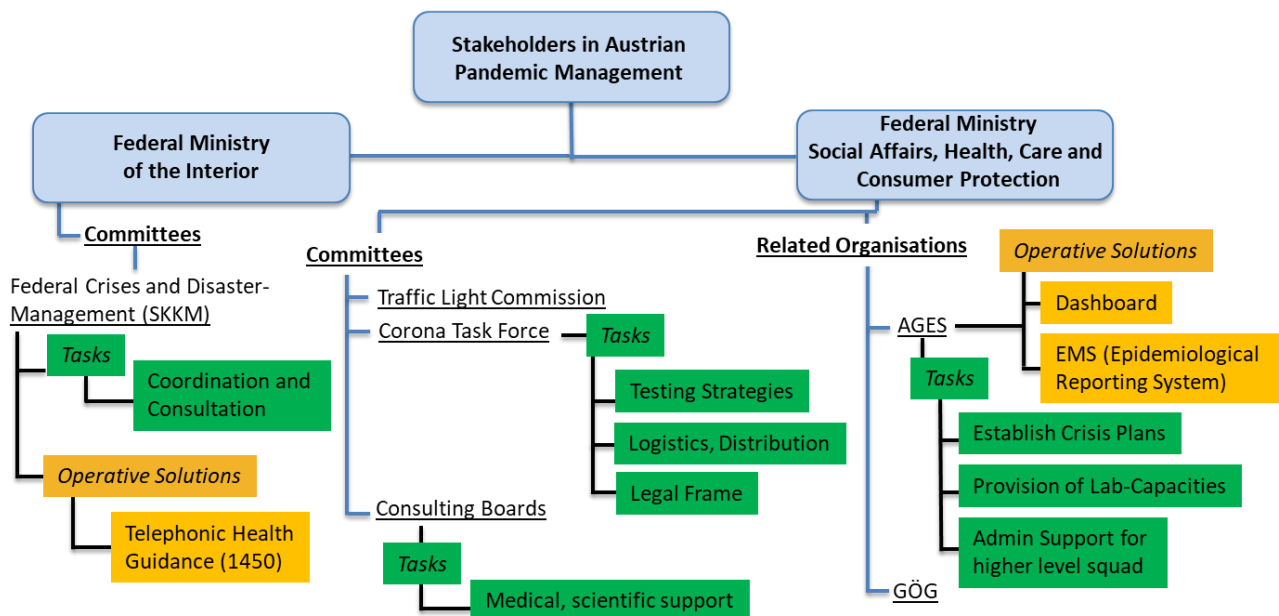
Figure 2: Exemplary view on stakeholders, tasks and solutions of the Austrian pandemic management

The Ministry of Health has also assigned pandemic management and operative pandemic response tasks to organisations such as the Austrian Agency for Health and Food Safety (AGES) or the Austrian National Public Health Institute (GÖG). In order to support the execution of their tasks the

different stakeholders operate solutions such as the EMS (Epidemiologisches Meldesystem or ERS Epidemiological Reporting System in English).

2. Background and status of pandemic management

2.1. Relevant aspects for successful mitigation measures: lessons learned from the COVID-19 pandemic

The experience of the current crisis caused by the severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2) and the associated coronavirus disease 2019 (COVID-19) yields important insights that will be relevant for successful action identification in future pandemic scenarios:

One of the difficulties that became apparent early in the pandemic was missing or uncertain medical and epidemiological information. Among other factors, there were major uncertainties regarding the actual mortality rate, the onset and duration of the infectious period, and the role of asymptomatically infected individuals (Anderson et al. 2020). These uncertainties hampered decision making regarding effective interventions and contributed to the multitude of different strategies that were applied, sometimes within the same country, leading to a trial-and-error approach (Mugnai et al. 2020). The emergence of new virus variants, such as the SARS-CoV-2 VOC 202012/01 (presumably more infectious) shows that even in advanced phases of disease outbreaks, new developments that require rapid adaptation of measures can emerge (WHO 2020c). Furthermore, the occurrence of events such as earthquakes (Croatia), a near blackout and animal diseases (Avian Influenza in Eastern Europe) simultaneously to the COVID-19 pandemic illustrates how multiple stressors may act on the system at the same time. Thus, strengthening the ability of the country to prepare for, but also to cope with, adapt to and learn from unexpected developments, i.e. its resilience (Thomas et al. 1997), is a crucial part of successfully conquering a pandemic.

At the legal level, the experience of the past months shows that the measures against COVID-19 interfere particularly intensively with fundamental and human rights (VfGH V363/2020). Quarantine obligations restrict personal freedom, exit restrictions limit freedom of movement, and prohibitions on entering stores restrict freedom of property and freedom of acquisition (ibd.). In addition, contact tracing (Kröpfl 2021), "free testing" (Gaigg et al. 2021) and any compulsory vaccination (Krasser 2020) raise a number of questions relevant to fundamental and human rights. Concerning the gradual lifting of restrictions, equality rights are also particularly relevant (VfGH V411/2020, Rz 89 ff.). The final political decision as to which goods have priority over others in a crisis (e.g. the right to freedom, the right to data protection, etc.) requires both factual and legal preparation in beforehand.

The COVID-19 pandemic illustrates that early identification and protection of vulnerable groups are important priorities to contain the spread and subsequent health effects of the virus, minimize consequential damage in other areas, and keep public acceptance high. These vulnerable groups include not only those at highest risk of becoming infected and severely ill, but also those groups of people who are particularly affected by pandemic management measures, both economically (e.g., food service, arts and culture providers) and socially (e.g., students, people living alone, single parents). The pandemic entails severe consequences especially for already disadvantaged population groups, such as people with a migrant background, children, elderly or disabled people, and widens the gap of social inequality. This distribution problem sometimes includes essential access to education, the labour market and the health care system. During a pandemic, accessibility and participation are increasingly determined by accelerated digitization and the technology and skills required for this; language barriers are also relevant in this context (Butterwege 2021).

With regard to the individual methods, measures and course settings for a road mapping approach for future pandemics, it is essential to consider the observed, varying effectiveness among different population groups and regions within a country. "Lockdown discipline" and compliance in rural communities or in urban areas, "lockdown discipline" among younger or older target groups, as well as the international comparison (e.g. Austria - Germany, Europe - Asia) are among the crucial factors for success. In this context, risk communication tailored to different target groups is also an essential factor/measure/tool. The importance of a multi-layered communication strategy is evident, for example, in the current vaccination issue (challenge: low willingness to vaccinate on the one hand, impatient vaccine advocates on the other).

The framework within which pandemic management of the future must operate also includes the existing infrastructures and resources for handling testing, contact and source tracing, measure implementation and vaccination. For example, the isolation of COVID-19 cases and their contacts as well as the identification of the latter are conducted at the district level in Austria. Particularly in the fall of 2020, at the beginning of the second wave, this led in part to major overloads of individual authorities, which made timely contact tracing impossible.

2.2. **Building on the experience from the SARS-CoV-2 pandemic**

As shown by Rainer et al. 2020 and the still ongoing developments, the spread of the novel Corona Virus, SARS-CoV-2, which causes different forms and levels of COVID-19, can be declared as the major critical event and coordination challenge of the year 2020 and 2021. The exact origin of this novel virus was not clear at the beginning of the crisis and it remains disputed in the scientific community up to date. For a long time, it was also unknown how infectious this new, rapidly spreading virus actually is. New issues, such as the occurrence of new variants of the virus, prolonged side effects of mitigation and counter measures in different areas of the societal and economic life as well as challenges surrounding the development and execution of a sensible and fair vaccination process (Ludwig 2020), are constantly arising.

The ROADS approach represents an additive and interdisciplinary research and management focus on the given challenges and gaps in pandemic management. The approach is aligned to the intended results on a technical, structural, conceptual but also strategic level (Richter et al. 2020). To cover the holistic demand represented by the Federal Ministry of Health, Social Affairs, Care and Consumer Protection and other relevant stakeholders and cooperation partners in Austria, a comprehensive expertise in the current, technologically framed prevention work in this sensitive and multidimensional area is necessary to sustainably find and implement solutions and enhanced management structures. Preliminary work and the background knowledge of the social sciences, legal experts and partners from the health care practice as well as additional stakeholders provide a valuable basis and starting point for the research and development work on ROADS-approach. In addition, the access to and exchange with renowned, national as well as international organizations in science and application practice are relevant aspects to be involved. An international perspective is necessary for a maximum benefit, an adaptive, easily applicable and adoptable solution mix and sustainable impact.

3. Specifics of pandemic challenges and potential management approaches

Factors such as travel, global trade, migration, increasingly limited wildlife habitats, and ongoing climate change are expected to increase the risk of the (re)emergence of a new "Disease X" or known (e.g. MERS-CoV, Ebola) pathogens that can cause epidemics or pandemics (IBPES 2020, WHO 2020b). This prospect highlights the urgent need for a crisis management plan tailored to the specific issues that arise in the context of infectious disease outbreaks.

3.1. Specifics of pandemic challenges

Pandemics or epidemics differ significantly from other crisis-situations, amongst others, in the following ways:

- Pandemics are dynamic and their evolution is often difficult to predict. They are no isolated events but ongoing and often suddenly changing situations about which usually insufficient information is known at the respective stage.

- Pandemics are not spatially limited, but spread rapidly and often unnoticed. Factors such as the incubation period, the contagiousness during the incubation period and the contagiousness of asymptomatically infected persons are decisive for their development.

- The risk for spatially limited epidemics, even though they may be more containable, is disproportionately higher. The challenges of regional and, in particular, cross-border events may be just as demanding for administration and politics as in the case of a pandemic, since there is a gap in the understanding and compliance of the population between affected and unaffected regions.

- Acceptance and cooperation of the population are crucial. In pandemic situations, the behaviour of individuals has an immensely large impact on the success of crisis management efforts, as it affects not only the individual's personal risk of contracting the disease, but also the individual's entire environment.

- It is impossible to predict the population groups for which the disease poses the greatest risk. Thus, preparations cannot be limited to, for example, a particular age group, but must cover a wide variety of scenarios to reach the respective groups at risk quickly and effectively.

- Medical personnel are exposed to a disproportionately high risk of infection and at the same time, they usually play an essential role in preventing severe courses of the disease.

3.2. Pandemics and inequalities

As in many crisis-situations, social inequalities are exacerbated by pandemics/epidemics. Although in theory, large parts of the population, or at least all members of medically at-risk groups, are equally susceptible to infectious diseases, in practice, it is often found that individuals of lower socioeconomic status are more likely to become both infected and more severely ill. This could be driven by e.g. living and working conditions; poorer access to information, masks, testing, and medical care; higher prevalence of pre-existing conditions, as well as a higher likelihood of being more affected by societal and economic consequences (e.g. greater risk of job loss, poorer access to digital infrastructure, less learning support for children, fewer opportunities for retreat, etc.) (WHO 2020a, Butterwege 2021, Zandonella et al. 2020).

The effects of pandemics and mitigation measures in context of gender and diversity are manifold, but hardly examined or considered. With regard to gender-specific aspects, in addition to medical differences between men and women in mortality and the course of the disease, social-structural mechanisms are relevant (Novel Coronavirus Pneumonia Emergency Response Epidemiology Team 2020). E.g. women are more often employed in areas with customer contact with increased risk of infection, they are usually responsible for caring for elderly and children, have high workload and often lower home office productivity. Measures such as home quarantine and lockdowns also lead to increased domestic violence, which mostly affects women (OECD 2020).

3.3. Communication

Given the great impact of individual behaviour on the development of a pandemic, maintaining the credibility of the entities that propagate and implement countermeasures through adequate risk communication strategies is essential for their success. Complicating factors are, amongst others:

- The abstract nature of the causative agent of the crisis: infectious pathogens are not visible to the naked eye, and their medical consequences depend on complex, usually not fully understood, biological processes and circumstances.

- A highly biased, tendentious media attitude, which narrows the scope for factual decisions and deprives a comprehensive public health approach of its scientific basis.

- Fake news, also in "mainstream" media.

- The long duration of the crisis and the accompanying restrictions: the pandemic shows that the acceptance of the measures remains stable with increasing duration of the crisis only in the risk groups like elderly or chronically ill persons and among people with secure income (pensioners, civil servants). The solidarity-based cohesion between the generations evaporates because of the unequal health risk compared with the economic risk or the risk of educational decline.

- The absence of a political discourse preceding the crisis and therefore a lack of political consensus towards the right course of action during the pandemic. The possibility of a pandemic was politically ignored for years in Austria. The gap between theoretical advice reflected e.g. in the flu preparation paper of the county of Styria (BMGFJ 2007) and the practical preparedness from official and private side with simple contagion mitigators such as FFP-2 masks or disinfectants became obvious. The COVID-19 measures were issued without mental and political preparation of the population as reflected in the long overdue remodelling of the epidemic law last reformulated in 1950, more than 70 years before. This also is the case for the new COVID-19 law (COVID-19 Gesetz 396/A).

3.4. Potential management approaches

Measures to increase resilience in the population and in society itself are an important part of a comprehensive catalogue of measures in the context of pandemics. The current situation has shown great weaknesses in the Austrian society in this regard, be it the problems connected with the switch to distance learning in schools, closing of primary childcare institutions or the discussion about home office among employees. Such measures may encompass educational initiatives in order to increase the risk competence of the population (Gigerenzer et al. 2003).

- A modern epidemic law that enables the state to quickly take proportionate measures in times of a pandemic in accordance with the precautionary principle and the state's duty to protect is needed. In doing so, democratic, constitutional (VfGH V411/2020, Rz 69 ff.), fundamental and human rights (EGMR 59909/00) mechanisms must not be suspended but highlighted. The actions of the state must also and especially in exceptional constellations be predetermined in a manner compatible with the principle of legality, which also includes that structural discrimination is not perpetuated.

- Adequate decision-making support for those who need it is an enormous challenge. This is because the processes to be taken into account are not limited to the medical field, but must, for example, consider socio-economic dimensions. This results in a large number of scenarios that can be employed to adapt the decision support to the respective situation.

Beyond the large number of scenarios, a comprehensive set of indicators is needed to provide the best possible decision support.

- Large amounts of data must be collected, stored and analysed safely and effectively. Another major difference to other crisis scenarios is the need to securely collect, store and promptly analyse large amounts of sensitive personal data, for which an adequate and legally compliant infrastructure is required in advance.

The clear distinction from other crisis situations illustrates the urgent need for further research on these and other pandemic-specific problems in order to identify resilience but also vulnerability factors. In addition, the parallels or similarities to classical crisis and disaster management have to be considered and used for efficient and valid situation tackling and strategic planning. Besides the creation of a scientific and evidence based setup of a stable and practice-oriented, applicable knowledge base, it is vital to derive resilience strategies that can serve as parameters for identifying measures in a future, evidence-based, legally compliant pandemic management strategy.

4. Possible approaches and solution paths: views on future pandemic management

As shown above, it is of key importance to involve the right players and stakeholders with a joint political will to initiate a thoroughly based but also dynamic set of solutions and approaches to a stable pandemic/epidemic management of the future. Several corner stones and basic perspectives are necessary to cover the broad needs of a successful and holistic pandemic management (Gibney 2020). They are outlined in short in the following section on the example of Austria.

4.1. Inventory

A comprehensive inventory and background knowledge of existing processes, structures, tools and infrastructures related to Austrian crisis management, involving all project partners and especially stakeholders have to be generated. This has to be an ongoing process which takes up latest information and developments on a global level. Knowledge processing from the current pandemic response should be provided by prioritized demand actors and stakeholders. The effectiveness of the measures and processes implemented during the COVID-19 crisis has to be evaluated with regard to future, possibly more critical events (e.g. physical distancing, masks, curfews, school closures, mass testing, crisis teams, commissions). Experience of researchers, practitioners and stakeholders have to be included, as well as iteratively evaluated, published studies.

4.2. Needs

It became clear in consultation with relevant stakeholders, that the needs and good practices of pandemic management have to be identified and incorporated in strategic solutions for pandemic management. Need providers and stakeholders thus have to be involved from the beginning on and should be supported by the obtained results in the development of a clearly structured, technologically based pandemic management of the future.

4.3. Identification of actions

The development of an evidence-based portfolio of crisis management measures for pandemics of different severity, including components for automated matching, can contribute to a future pandemic management and is key for further actions. It is also important to define decision parameters for targeted, optimized action settings that can be integrated into AI-assisted decision

support, alert, and threshold systems. For a further implementation of solutions, proposals for legislative measures/adaptation options should be collected in a comprehensive road mapping that ensures a technologically supported pandemic management which complies with EU, national, fundamental and human law, are necessary.

4.4. Tools as solution enhancement

Before tools can be implemented or even developed, to fill gaps and solve challenges, a thorough analysis of the existing legal framework is necessary. With consideration of governmental protection obligations and legal limits, all consequent tools can basically be applied in practice. The focus here has to be laid on the interface of technological input and legal consequences. There must be a special focus on the connection of technological input and legal consequences of their application. Integrating legal parameters into a technologically supported pandemic management is key to ensure legality by default and by design that is always relevant when creating technical solutions.

4.5. Future pandemics - connectivity and interoperability/validation

Relevant risk analyses from the experience and data of the current management have to be evaluated and used to elaborate and describe possible future pandemic scenarios. A developed methodological framework in form of a flexible roadmap has to be transferable to other crises and emergencies and has to be validated in close coordination with stakeholders. Ideally, this is set up between EU member states for a faster comparability and as an international model of actions. Templates and common database structures should be established.

4.6. Resilience strengthening as a key game changer

As indicated above, it is highly relevant to include resilience as a societal challenge and resource in all pandemic management strategies and planning. Generic risk and resilience factors, their practical manifestations for the ROADS approach and the inclusion of new findings as well as existing practical management and project experience have to be taken into account. Practical resilience strategies have to be identified, analysed, and finally enhanced by a set of selected measures, such as early preparedness and training initiatives.

4.7. Communication potential and needs

Networking and exchange opportunities in the course of pandemic management are of key importance not only in preparation and among strategic stakeholders but also for the community as a main factor of prevention work. Thus, with regard to the consequences of a pandemic, also gender- and diversity-relevant aspects have to be identified and included in the development of the catalogue of measures as well as in further adapted options for action.

5. Summary and discussion

The situation over a year after the onset of the initially rather diffuse, but quickly and dynamically evolving SARS-CoV-2 spread in Austria can be described as ambivalent. After a positive impetus at the beginning of the crisis, as shown by Rainer et al. 2020, a public fatigue towards the much discussed and criticized COVID-19 countermeasures that also manifests in problems related to compliance and acceptance can now be increasingly observed. Also, the insecurities surrounding topics such as vaccinations, the re-establishment of the former state of life and the reaction and

necessary adaptions to mutations, are highly challenging and waiting for a strategic inclusion in the management processes. The increasingly pressing societal, economic, and highly critical psychological side effects and impacts of some pandemic counter-measures (Metzler et al. 2020) contribute the growing controversy towards them in the scientific community and the general population. Many experiences from the current crisis, such as the occurrence of new virus variants, which may be less susceptible to existing vaccines, are also highly relevant in the development of a management strategy for future, potentially even more severe disease outbreaks with higher mortality, morbidity, and risk of contagion.

SARS-CoV-2 is an ongoing challenge that still has to be conquered in many ways. Potentials and gaps to be bridged for setting up a strategic, evidence based and still flexible tool set of solutions to foster preparedness in the future were shown in the course of this paper. Several approaches but also a lot of open questions and an ample field for further research and development, as well as for political and societal preparation and coordinated effort to prepare for a pandemic event of the future became evident.

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USE OF SOCIAL MEDIA AND OPEN SOURCE DATA TO ENHANCE SITUATIONAL AWARENESS IN THE AUSTRIAN CRISIS AND DISASTER MANAGEMENT

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Abstract

Advanced situational awareness is a central element of today's crisis and disaster management and the basis of improved decision-making. A prerequisite for optimised decision-making is to quickly obtain valid information about the specific crisis in the affected area. At the same time, a high demand for information arises from the media and the population. It is therefore necessary to collect, process and distribute valid information in the shortest possible time. In this context, the KIRAS project iLike focuses on the development of a demonstrator of an intelligent situation information portal that uses open-data information sources and channels for decision support. The demonstrator has two key central functionalities, namely event detection and sentiment analysis. This paper describes the architecture and key functionalities of the iLike demonstrator.

1. Introduction

In state crisis and disaster management (SKKM), the management organisations (e.g. Ministry of the Interior, police, civil protection and fire brigade) have the task of preventing both imminent and actual disasters, managing them as well as mitigating their effects. In this context, it is important to obtain valid information about the situation in the affected areas as quickly as possible in order to be able to make optimal decisions and initiate measures. At the same time, information is generated quickly and on a large scale in the media and among the population, which can be more or less helpful in managing the situation. In disaster situations, it must always be possible to assess the current situation under enormous time pressure and to include all available information in decision-making processes.

Social media, instant messaging and other online communication channels that are widely used today have changed the way we share information. Today's online media happens in real time and across a variety of devices. User-generated content blurs the distinction between publisher and consumer and makes the quality of information and its sources difficult to assess. So far, there are

hardly any solutions or concepts to efficiently and effectively integrate social media and other open data sources and channels into existing situational information systems.

This paper is based on an ongoing project called iLiKe. The aim of the project is to design an intelligent situation information portal that harnesses open-data information sources and channels for disaster management. The paper is structured as follows: Chapter 2 describes related work on which this paper builds. Chapter 3 presents the system architecture with some selected modules designed and implemented in the project. This is followed by Chapter 4, which shows results from two application examples. The paper concludes with a conclusion on the use cases and an outlook on further work.

2. Related work

Social media includes a broad range of social software platforms where people create, share, and exchange user-generated content. Social software are computer systems and applications that are facilitators or focus for social relationships (Shuler, 1994). User-generated content (UGC) is content that is made available online in a publicly accessible manner or to a group of people. (Vickery and Wunsch-Vincent, 2007).

Similarly, as mobile phone calls increase significantly during a disaster, Internet and social media usage also explodes. For example, Internet usage on the East Coast of the U.S. increased by over 114% in anticipation of Hurricane Sandy in 2012 (Whittaker, 2012). During the 2011 Japan earthquake, Twitter use in reference to the earthquake reached 1200 tweets per second (TPS) (Crowe, 2012); in 2012 during Hurricane Sandy, Twitter traffic in relation to the storm reached about 250 TPS; in 2013 after the Boston Marathon bombings, Twitter traffic in relation to the attack reached 700 TPS (Rovell, 2013) and in 2016 during the Munich attack twitter usage reached a max of 1400 tweets per minute related to the happening (Dyckmans, 2016). These examples show that social media can be an invaluable source of time-sensitive information during such a crisis. However, while disaster response, security, or humanitarian aid organizations have been seeking to leverage this information for more than a decade (cf. KIRAS QuOIMA), the increasing flood of social media platforms and messages remain a significant challenge, both for technical infrastructures, as well as our limited human capacity to process masses of information in a timely manner (Castillo, 2016), also known as the Data Rich, Information Poor (DRIP) syndrome (Goodwin 1996).

This is the reason why tools and methods are needed to support disaster response teams in taking advantage of the new opportunities offered by social media. Although researchers have explored various methods to summarize, visualize or use data for analysis, first responder organizations have not yet been able to take full advantage of research advances, largely due to the gap between academic research and deployed, working systems. The process from collecting social media content, to filtering relevant information, to presenting actionable results to the end user is the goal of iLike. The project aims to provide an indication of a possible solution to bridge this gap by introducing a concept of such a system, but also by building on prior work done in the field. The most relevant research work focuses on semantic integration of disparate information sources into a common operational picture (COP) (Ulicny et al. 2013), identifying of disruptive events from social media (Alsaedi et al. 2015), situational awareness enhancement through social media analytics (Snyder et al. 2019) followed by a report on using of social media for enhanced situational awareness and decision support (Homeland Security, 2014).

3. Implementation of the iLike PoC

3.1. System architecture

This section describes our overall vision of intended workflows for the proposed solution, from raw social media data collection, to methods for content filtering and analysis, to the interfaces, presentation modes and alerting mechanisms provided to the end user. It emphasizes the fact that the maturity of the proof of concept is currently reaching a Technology Readiness Level (TRL) of 4. Planned future developments after the end of the project iLike envisage a higher maturity of the system and are discussed in chapter 5.

Figure 1. represents the high-level architecture of the system, which is divided into three main parts. The first part is the harvesting of social media data, which in this case is done by using software from PublicSonar[8]. A set of customisable filters is applied to the entire search space (a defined set of social media and open news sources on the Internet) to pre-filter the data and prepare it for analysis. This is also the first step in the planned workflow – *data harvesting*. The second part of the architecture is the analysis of the harvested data by implementing advanced algorithms to extract information from a broader dataset on one hand and to apply sophisticated algorithms to extract the most relevant information from it on the other. A large amount of data is incomprehensible to a human user, so it must be made compact and easy to digest. This represents the second step in the planned workflow - *filtering the relevant data*. The final part of the architecture is the presentation of the analysis results to the end user, which is done using Hexagon[9] software. When designing such a system, it is very important to keep the user in mind and provide a robust and user-friendly interface. This is also the last step in the planned workflow - *providing analytics of the data*.
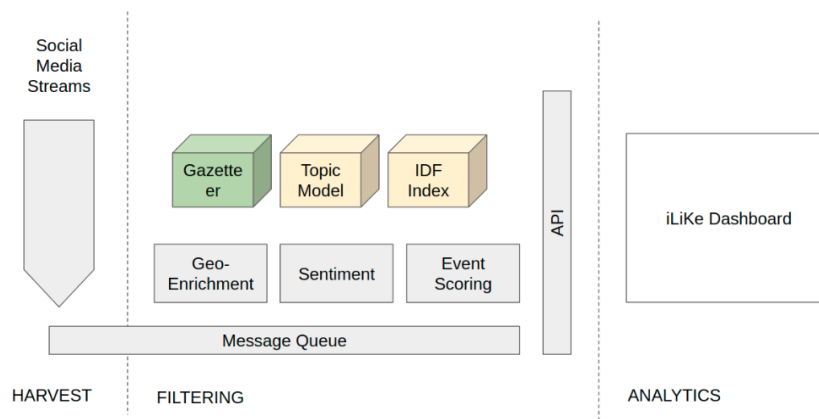
Fig.1. iLiKe high-level architecture.

3.2. Development approach

The iLiKe project follows an agile development approach characterised by incremental co-design and involves stakeholders such as crisis managers, authorities or representatives from LEMAs in several phases. In the initial phase, sample data was collected from the Ski World Cup slalom in Schladming 2020. The collected data was used to develop and train models for data analysis. In two

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[8] https://publicsonar.com/about-publicsonar/

[9] https://www.hexagonmi.com/

parallel streams of activity, initial requirements for the iLike PoC system were gathered in stakeholder interviews, while at the same time sample data was profiled in an exploratory analysis and a number of selected technical approaches were tested in response to the information gathered from stakeholders. In addition, both developers and stakeholders participated in a physical event in Kulm in Styria in Austria during the 2020 Ski Flying World Cup to gain a better understanding of network traffic and messaging dynamics during a large-scale event. The experience and information gathered during this event was used to define the technical requirements for the PoC, which were validated by the stakeholders in order to develop software that fits to the end user needs in real-life situations. The identified requirements were prioritised from both stakeholder and developer perspectives and implemented and reviewed in monthly sprints. The agile approach allowed for simultaneous development of software demonstrators to test specific filtering and analysis methods and validate them against the collected data. To further elaborate the proposed solution, the project also developed a conceptual user interface design, as a basis for discussion for how such a potential future integrated system could function from the end-user's perspective. To ensure that the user interface met the needs of the end users, the best practices for user interface design were followed, mainly considering the ten usability heuristics (Nielsen, 2005.). In addition, all design ideas were validated by obtaining feedback from the stakeholders involved, using their experience in the field.

4. iLike Functionalities

Two key functionalities were identified in conversations with stakeholders as the most useful to trial:

- **Event detection**, a functionality that, once activated, would perform continuous background monitoring of media traffic, and create alerts when a new topic trend emerges suddenly. Envisioned use cases for such a system are general incident alerting, or targeted monitoring of events that involve large crowds, and where social media use is prevalent, e.g. sports or music events.

- **Sentiment mapping,** a set of spatio-temporal visualizations (e.g. to complement an existing operations dashboard, in the form of printed reports) offering a picture of how the overall "sentiment" of social media discourse evolves over a geographical area, over time. Sentiment analysis has been used previously in the context of disaster management and has also become available as a product in the Open Source Intelligence (OSINT) market.[10] For a comprehensive overview of possible technical approaches, see e.g. Kaur et al. (2017). Such visualizations can be useful in different contexts, for example to assess the impact and public sentiment towards policy decisions or disaster response measures.

4.1. Event Detection

To implement event detection, our demonstrator combines two established natural language processing techniques: topic models and the *term frequency-inverse document frequency* algorithm (TF-IDF). Both techniques are *data-driven* rather than *rule-based.* This means that operators do not need to define specific alert conditions or query terms beforehand. Instead, the techniques rely on a *reference dataset* of social media messages that is harvested a priori, over an incident-free time. The reference dataset then serves as an example to the system for what counts as "normal" message traffic. In our demonstrator, an "event" is characterized by a burst of messages that deviate from the

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[10] See e.g. www.hensoldt-analytics.com/

known reference message corpus by some defined criteria, such as vocabulary used, traffic amount, etc.

Topic models are probabilistic models used to uncover underlying semantic structure in a document collection. The idea behind topic models is that each document in a collection can be represented as a vector of different *topics*, where each topic is defined as a distribution over a fixed vocabulary of terms (Blei and Lafferty, 2009). Our system generates a topic model from the reference dataset (using an open-source implementation of the *Latent Dirichlet Allocation* algorithm, cf. Blei et al., 2003) and compares incoming messages against the model. Do new messages match one or more of the topics that were common during the reference period? Or is there no good match with any of them? A sudden spike of "off-topic" messages may indicate a sudden change in theme in the social media discourse and will trigger a notification.

TF-IDF is a well-known algorithm for measuring the "importance" of a word to a document in a document collection (Manning et al., 2008). The basic premise is that the importance is proportional to the relative frequency of the word in the document (term frequency), and inversely proportional to the frequency of the word in the whole collection (inverse document frequency). Thus, words that are frequent in a document, but rare in the collection overall, receive high TF-IDF scores. Our system uses the reference dataset for comparison, and computes TF-IDF for words found in new messages. As a result, the algorithm automatically foregrounds words that did not occur (or occurred rarely) during the reference period, especially if they become more frequent during the observation period.

4.2. Sentiment Map

We implemented a sentiment mapping demonstrator, comprising two core components: sentiment analysis and automatic geo-coding. **Sentiment analysis** was realized using two of the most popular open-source software packages for this purpose: VADER (Hutto and Gilbert, 2014), and TextBlob.[11] Both assign a score to each message that quantifies whether message stance is generally positive (score between 0 and 1), or negative (score between –1 and 0). To determine the score, both VADER and TextBlob rely on term lexica and static rules. TextBlob additionally includes an alternative machine learning implementation, which uses a naïve Bayes classifier trained on movie reviews. Due to the nature of the implementation, different analyzers are required for different languages. In our case, we used TextBlob to process German-language messages, whereas VADER was only used in the experimenting stage, with a small sample of English messages.

To locate messages on a map, we obtained geographic coordinates from two sources. On the one hand, we relied on coordinates that some message sources (e.g. Twitter) embed into message metadata. On the other hand, we implemented a component for **automatic geo-coding** of message texts. The component applies *Named Entity Recognition* (NER), using the spaCy open-source natural language processing framework2 to automatically extract place names mentioned in message texts. Identified place names are then matched against a local index of the GeoNames dataset, a corpus of places, their names, geo-coordinates and other properties. It must be noted that granularity and reliability of both methods has limitations: coordinates embedded in messages often represent a pre-set location chosen by the user; while NER often works well on the city and regional level, but typically fails to yield exact results beyond that (unless, e.g., street names are mentioned in the message, and the system was set up with a street geocoding index).

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[11] https://textblob.readthedocs.io/en/dev/

4.3. **Demonstrators and Validation**

As mentioned above, the iLike PoC remains at a lower TRL level, which means that generally the individual system components were not integrated into a unified system. In order to validate the proposed approach, small-scale test setups were implemented and tested with the sample data collected earlier. The data collected at the ski race in Schladming provided a particularly good test opportunity for event detection: during the race, a prankster ran across the finish area, triggering timekeeping just before one of the racers crossed the finish line. Naturally, the event triggered corresponding social media reactions, not usually seen during normal skiing races.

We synthesized a reference dataset from messages recorded before the prankster incident and augmented it with messages from some time after the incident, removing all messages that referred to the prankster, in order to build our reference models. The technical test setup for the trial consisted of an ElasticSearch[12] index to store the messages and simulate the message traffic over time; a simple backend application (developed in the Python programming language) to match "incoming" messages against the reference models; and a graphical frontend showing key metrics from the event detector: the rate of off-topic messages vs. total messages; terms most common in the total messages overall; terms highest scored by the TF-IDF algorithm. In addition, the application also showed the images included in the off-topic messages, if any. Our initial tests revealed that the setup was useful in, first, identifying the fact that an unusual event had occurred, by measuring the ratio of off-topic vs. total messages; second, by exposing the most descriptive terms for the event and, thus, providing immediate insight into the nature of the incident. This was especially useful in the period immediately succeeding the event, where social media traffic was still characterized by a mix of "normal" reporting on the ski event and posts about the incident. Only in a later phase, the incident had received sufficient attention, so that it dominated the discussion as a whole; and additional filtering would no longer yield significant benefit over, for example, simply plotting the most frequent terms in all messages.) Sentiment analysis was evaluated with a second test setup. A dataset was collected separately, over a period of time, by harvesting messages containing terms from a list of keywords related to extreme weather conditions, such as storms, heavy rain, flooding etc. In our demonstrator, sentiment analysis and NER were connected through a message queue which picks up batches of incoming messages for processing; and a web application which visualizes the result as an interactive map and as a timeline in a browser-based user interface. As a showcase, raw result data was also exposed through a RESTful API, and imported into the Hexagon system, where it is made available to the end user for additional capabilities such as documentation, ranking of the analysed data, and so on.

5. **Conclusion and Outlook**

The work presented in this paper reflects the development of the demonstrator at TRL level 4 achieved in the project iLike. Further development, evaluation and refinement beyond the project is needed to be able to finally assess the extent to which the approach of using and combining social media and open source data can improve situational awareness in crisis and disaster management. There are many solutions to extract data from sources like Twitter (PublicSonar, SYNYO[13]), but only a very limited number of them extracts information that is suitable for decision support. Therefore, we plan to explore more use cases with different stakeholders in different domains such as pandemics and terrorist situations. In the next step, we want to expand the functionalities and

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[12] https://www.elastic.co/

[13] https://www.synyo.com/

maturity level of the demonstrator on the one hand and use it for international use cases on the other hand. For this purpose, we want to work closely with national stakeholders to identify suitable international funding opportunities, such as the EU's Horizon Europe funding programme. Of course, each iLike functionality and further developments have to comply with the legal standards of the General Data Protection Regulation and – with regard to the processing of personal data for the purposes of the prevention, investigation, detection or prosecution of criminal offences or the execution of criminal penalties – with the national provisions in the Austrian Data Protection Act (DSG), based on the Directive EU 2016/680. As far as personal data is affected, the procession has to be lawful, for example according to reasons of Art 6 General Data Protection Regulation.

6. Acknowledgment

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RISK ANALYSIS OF A MUNICIPAL PROJECT FOR THE CONSTRUCTION OF WASTE TREATMENT FACILITIES

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Abstract

The paper presents a risk analysis of the municipal project CEVYKO prepared for implementation in the Moravian-Silesian Region. An innovative semiquantitative PNH method (P – probability of risk occurrence, N – probability of consequences, H – opinion of evaluators) was chosen for risk analysis, where individual areas were evaluated by a ten-member expert group. Based on the results of the analysis using the PNH method, measures were proposed to eliminate the identified risks. The EIA (Environmental Impact Assessment) process was identified as the main risk of the project. Another output from the risk analysis of the CEVYKO project is a draft recommendation for projects of a similar size and scope within the municipal waste management solution.

1. Introduction

One of the solutions for the efficient management and processing of municipal waste, in addition to direct incineration, can be provided by the pilot project CEVYKO, which aim is to build a modern facility for the treatment of not only mixed municipal waste. This purely municipal project has a specificity in financing without private investors. The CEVYKO project responds to the approved circulation package of the European Union, with the aim of directing EU countries towards the circular economy. Implementing the requirements of the EU and Czech directives is not easy, because these changes are very complex, technologically and investment-intensive. The CEVYKO project represents an opportunity to efficiently process waste for a large part of the Moravian-Silesian Region. It can also serve as an example to other regions of how to address the new legislative conditions of waste management conditions. As the CEVYKO project is an innovative idea of how to manage waste and not all risks in its implementation have been described yet, the aim of the paper is to define approach to risk governance in the field of waste management. The results of the analysis will be further deepened by the author's team so that a comprehensive

document can be created for other municipalities implementing projects of similar size and using the same technology.

2. Literature Review

The last decade brings with it significant technological advances in waste treatment methods, which means improvements in the recycling process (Rogoff, 2014). A significant part of waste ends up in landfills and the current system requires a large amount of funds and space for waste management (Chlopecký, 2020 and Kozel, 2018). Waste must be seen as commodities and secondary raw materials, and the shift away from landfilling supports the transition to a circular economy (Stahel, 2017). Vilamová (2019) state that the principles of circular economy are already entering into waste processing in the Czech Republic. Responsibility for the principles of the circular economy must be taken over not only by municipalities, but also by companies and organizations. The basis for efficient processing and overall waste management is the implementation of information systems and the introduction of modern waste treatment facilities. The purpose is the modernization of individual operations and more consistent compliance with legislation in the circular economy (Kozel, 2018, Liubarskaia, 2018 and Hančlová & Ministr, 2013). Even today, more attention should also be paid to political, financial and cultural categories in the field of construction (Edwards, 1998).

3. Current Situation

Waste management in the Czech Republic is regulated primarily by Act No. 541/2020 Coll. The objectives of waste management are specified in Waste Act, the purpose of which is to ensure a high level of protection of the environment and human health and the sustainable use of natural resources by preventing the generation of waste. This law aims to achieve the goal of waste management and enable the transition to circular management. The objectives of waste management are shown in Figure 1.
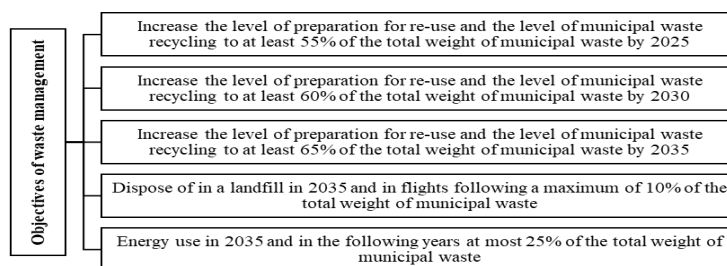
Fig. 1. Objectives of waste management according to Waste Act

The circular economy is a method of production and consumption that recovers existing products and raw materials through sharing, reuse or recycling. The aim is to increase the life cycle of products and minimize the waste generated. The EU legislative basis for the circular economy is as follows:

- Directive No. 2018/850 of the European Parliament and of the Council of the EU, amending Directive 1999/31 / EC on the landfill of waste and, Directive No. 2018/851 of the European Parliament and of the Council of the EU, amending Directive 2008/98 / EC on waste and Directive No. 201/852 of the European Parliament and of the Council of the EU amending Directive 94/62 / EC on packaging and packaging waste.

4. Methodical Approach for Risk Analysis

Risk analysis is a basic and necessary step for managing all risks in society (Vaněk, 2013). It combines technical, scientific and humanities disciplines, and when risk assessment is used in decision-making processes, economic, psychological and political aspects are added. The authors propose an innovation of the application of already published PNH method (Fotr & Hnilica, 2014) and recommend its implementation in the CEVYKO project. The failure and effect analysis (FMEA) method, which is also identified as the Risk Priority Number (RPN) method (Kiran, 2017), was used as an inspiration for the PNH method. The innovation of the PNH method involves adjusting the 'probability of consequences' component to capture risks arising from the project management. For the risk assessment and the resulting recommendations for municipalities and local governments that would implement a project of a similar scope (Figure 2). The PNH method has four phases (based on the W. E. Deming concept known as PDCA cycle). The first phase is the data and documents for the given risk analysis obtained mainly from the company's internal resources. The second phase - project risk identification - is based on the defined information base on the identification of individual risks that threaten the project (Fotr & Hnilica, 2014 and Edwards, 1998). In the next phase, the individual risks are quantified according to a preselected method. The last phase defines the overall risk assessment for a given project.
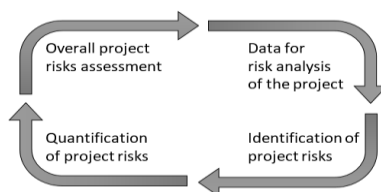
Fig. 2 Phases of the risk assessment method used in the paper based on the Deming PDCA cycle

4.1. Expert Group

Due to the objectivity and relevance of the results and their applicability in practice, an expert group was established at the beginning of the research work. The expert group of 10 evaluators was composed of members of the company's management, technical project guarantors with experience in the field of waste management - a Chairman of the Board of Directors of CEVYKO, a.s. Member of the Board of Directors of CEVYKO, a.s., Chairman and Member of the Supervisory Board of CEVYKO, a.s., Director of CEVYKO, a.s., Deputy Director of CEVYKO, a.s. (head of the expert group) and a head of the technical and economic departments of Technical Services, a.s.

4.2. Risk Assessment

Risk assessment can be carried out using various methods. In the risk analysis presented in this paper, the semiquantitative PNH method was used. This method has been modified to capture the risks arising from project management.

Tab. 1 Point scales for evaluation by PNH method

Probability of risk (P)	Influence	Probability of consequences (N)	Influence	Opinion of the evaluators (H) - (expert group)	Influence
Random	1	No effect on project implementation	1	Negligible impact on the degree of danger and threat to the project	1
Unlikely	2	Delay in project implementation	2	Little effect on the degree of danger and threat to the project	2
Probable	3	Change in project implementation	3	Greater, non-negligible impact on the degree of threat and danger of the project	3
Very likely	4	Suspension of the project	4	Large and significant impact on the degree of threat and danger of the project	4
Permanent	5	Stopping the project	5	More significant and adverse effects on the severity of the threat and danger of the project	5

The part regarding the probability of consequences has been adjusted to reflect the principle of project management (Fotr & Hnilica, 2014). Table 1 defines the point scales for individual factors. The risks do not include wherewithal due to hardly comprehendible project costs, which are currently estimated at CZK 400 million, so the individual risks cannot be quantified from a financial point of view. All three factors, in the interval of 1 to 5 points, were determined and quantified by an expert group defined in subchapter 4.1. The expert group worked together on the first two phases of the analysis, where they compiled the material and data base and then jointly identified the risks of the project - activities P and N. Each member of the expert group then performed its own multiplication of factors according to the PNH evaluation point scale. The specification recorded in columns P, N and H was then used to assess and evaluate the sources of risk (Table 2 in Chapter 5). The multiplication was calculated on the basis of the evaluation of each member of the expert group for individual factors. The result was the average of the expert evaluations, which was then recorded in Table 2 and rounded to the whole numbers. Mathematically, this relationship is captured in Equation #1.

$$R = P \times N \times H$$

(1)

5. Discussion of results

The stated risks and their point evaluation using the semiquantitative PNH method are listed in Table 2.

Tab. 2 Risk table - administrative part

Type of activity	Source of risk	Hazard identification	Risk importance assessment				Type of activity	Source of risk	Hazard identification	Risk importance assessment			
			P	N	H	R				P	N	H	R
1. Project preparation	EIA process	Delays in the EIA process due to the incorporation of objections	4	3	4	48	**3. Tenders**	Tender for project and supply of technology	Delay of the tender for the project and delivery of the technological part	3	2	2	12
	Tenders for the processing of construction project documentation	Delay of the tender for project documentation	3	3	4	36		Tender for complex construction	Delay of the tender for the project	3	2	2	12
	Documentation for territorial proceedings	Delay in documentation evaluation	3	2	2	12		Tender for the supply of machinery	Delay in the tender for the supply of machinery	3	2	2	12
	Documentation for building permits	Delay in the evaluation of documentation for building permits	3	2	2	12	**4. Technological and construction area**	Realization of construction	Construction activity of the project	4	2	2	16
	Documentation for the construction	Delay in the evaluation of documentation for the construction	3	2	2	12		Realization of project documentation and installation of technology.	Delay of the tender project documentation and installation of technology.	2	2	2	8
	Territorial proceedings	Opposition to territorial proceedings	3	2	2	12		Delivery of machinery	Delivery of machinery according to the competed conditions	2	2	2	8
	Building permit	Refusal of a building permit	3	4	4	48		Human resources	Human resources for project operation	1	1	1	1
2. Project financing	Applications for grants from the EU and the Czech Republic	Subsidy support from EU and Czech programs	5	1	2	10	**5. Area of operation**	Test operation	Test operation of the technology	2	1	1	2
	Project loan	Obtaining loans from commercial banks	5	1	1	5		Full operation	Full operation of the technology	1	1	1	1

Due to the scope of the contribution, only one source of risk from each group of activities is described. In the area of Project preparation, the riskiest process appears to be the EIA with 48

points after the PNH risk analysis, according to the expert group. Project financing is a type of activity in which the expert team finds the riskiest financing the one from the EU and Czech programs, with 10 points. Risks for tenders are identically evaluated as a risk activity using the PNH method with a result of 12 points. As this is a project financed from public funds, the tenders are required by the legislation of the Czech Republic. The performed analysis defined a significant source of risk in the type of activity Technological and construction area, specifically Realization of construction with 16 points. It is a complete realization of complex construction and all construction activities related to the construction. The Area of operation is the last type of activity of the entire project implementation. The Test operation of the technology is not assessed as risky, because the results of the test operation will be reflected in the setting of parameters for real operation in the future.

6. Suggestions and recommendations

Based on the performed analysis, the basic types of activities and related risks were identified. This result is based on defined steps and objectified by the evaluation of the expert group. Subsequently, the situation can be further specified and measures to eliminate risks can be proposed. The submitted proposals and recommendations can be an inspiration for projects of a similar scale. Suggestions and recommendations in individual areas are shown in Table 3.

Tab. 3 Areas of proposal and recommendations resulting from the analysis

Preparation	Financing	Tenders	Technological and construction area	Area of operation
Ensuring ongoing communication with stakeholders	Ensuring that the conditions for subsidy programs are met	Ensuring the support of the tender administrator	Realization of construction and correct project documentation for the technology	Correct setting of processes within the test operation

There is considerable scope for obstruction, more or less relevant, of individual stakeholders, as some laws do not define the timing of the processes that need to be implemented in project preparation activities. Another recommendation is to incorporate the parameters of financing and construction so that they meet the announced calls of EU and Czech programs as much as possible. Further co-financing can be provided by the municipalities involved in the project or in the form of a loan from commercial banks. In the area of tenders, it is important that the possibilities of administrators of individual processes are used as much as possible. The reason is the transfer of responsibility in complex processes and the elimination of delays in project work. The same approach can also be used in the technological and construction part, where it will be important to have the right conditions set for the implementation of the construction and the supply of technology for waste treatment. The operational area will be under the direction of the company's management and correctly defined and set parameters of the test operation can eliminate possible operational outages in full operation. Outages in live operations would pose financial and legislative problems for the company and all actors involved in collecting the waste for incorporation.

7. Conclusion

The aim of the paper was to define the risks and based on the analysis, to propose recommendations for other entities that would like to build similar facilities. The character of the CEVYKO project is in the uniqueness of this type of facility in the Czech Republic. The company CEVYKO, a.s., which will deal with the implementation, will have to pay attention to the careful and quality preparation of the project to minimize the risks of construction and subsequent operation of the

facility. The implementation of the project is particularly demanding in negotiations with other partners because it is not only a negotiation based on market mechanisms, but to a significant extent the project will also be influenced by municipal policy.

The analytical part of the paper specifies the risks of the project and their importance using a modified semiquantitative PNH method. Based on the evaluation of the expert team, the EIA process was identified as one of the main risks of the project. This risk was assessed with a score of 48 points. This process is then continuously followed by other preparatory project activities. Already during the compilation of the information and material base, this activity was defined as the most risky. Another significant risk is identified in the Technological and construction area of the project, namely in the activity Realization of construction with a score of 16 points. Based on the recommendations of the expert team, the authors defined in the last part of the paper proposals and recommendations for the implementation of projects of a similar type, size and similar scope of legislative and investment requirements.

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SECURING FOOD PRODUCTION & LOGISTICS IN CRISIS SITUATIONS: THE NUTRISAFE PROJECT APPROACH ON CHALLENGES AND PERSPECTIVES OF SUPPLY CHAIN SECURITY

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Keywords

Crisis management, supply chain stability, food distribution, coordination of logistics, block chain technology, use cases, lessons learned

Abstract

The objective of the KIRAS security research project NutriSafe is to develop and evaluate Distributed Ledger Technology (DLT) for enhancing the resilience of value chains in the Food Industry. Different use cases about the application of DLT was dealt with comprehensively. The focus for Austria was identified mainly in the fields of food security: logistic challenges, disruption of transfer, processing or packaging, pandemic animal diseases or crop failure due to climatic change effects. For the German partners, food safety focused on contamination of foodstuff with germs, diseases or foreign particles that require a retrieval action. In this way, new insights and training tools are created in cooperation with international practice partners to improve food security in the course of the upcoming digitalization and to secure the supply in case of emergency.

This paper will give an overview[14] of the dynamic work in progress of the project and its challenges by summarizing the findings nearly. Examples will show lessons learned, good practice, but also challenges and open questions or gaps in the wake of complex crisis scenarios and events as the still ongoing COVID pandemic, natural or man-made incidents, or criminal acts represent.

1. Introduction

Distributed Ledger Technologies (DLT) such as blockchain, is still a booming topic. Particularly within the field of Financial or Insurance Technology, multiple successful applications and implementations are actively used. Nevertheless, a wide range of possibilities for further application exists to improve complex operations and procedures by the usage of DLT. Production volumes in the food supply chain have seen a continuous increase over recent years through digitalization and more efficient processes. The goal of the bilateral, Austrian-German research project NutriSafe is to closely investigate potentials, risks and impacts of implementing DLT on the resilience of food supply chains and food security in general. Increased occurrences of natural hazards, cross border crises, accidents, human errors as well as criminal activities, terrorism and security issues in information technology put food operations and related critical infrastructure at risk, resulting in a direct impact on food security for the public. Due to the pertinence of food industry and the consequent supply chain, possible impacts of innovative technology have to be considered. As shown in pilot projects by major industry players (e.g. Walmart, Maersk), improving traceability of good flows in complex food supply chains is of great importance.

With DLT, processing steps and actors in the supply chain can be identified more easily. Additionally, DLT allows supply chains to secure operations if IT security of critical production or Enterprise Resource Planning (ERP) systems are not guaranteed. To achieve such benefits, innovative approaches to evaluate and develop DLT for applications in food industry are required.

NutriSafe identified highly relevant use cases and studied the impact of DLT implementation in the food industry, e.g. countering shortcomings of packaging material, dairy plant failure, animal diseases, crop failures, contamination of food products, transport disruptions, which have direct consequences on food supply and security. Developed methods and solution procedures were tested and evaluated together with decision-makers and industry. A serious game for training activities and major insights were developed to improve food safety and security of supply in crisis settings.

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[14] The basis of this paper is enhanced, already published material and updated information. Sources are mainly Kummer et al. (2020), Kummer et al. (2021) and internal project descriptions and information material.

2. Methodology and selection of the use cases

The NutriSafe research project analysed and represented the value chains of three selected use cases (pork, drinking milk and table potatoes for human consumption). The examples were represented by using the method of business process modelling and notation (BPMN 2.0). Subsequently, the security properties and risks in the value chain of these models were examined. This document serves to present these three scenarios as well as a description of the identified critical nodes. Firstly, it discusses the methods used to determine the use cases and then the exact scenarios and their preparation. The focus was set on selecting foods that have an important influence on the supply chain as staple foods. In the first step, it was decided to look at one plant product and two animal products, resulting in defining drinking milk, pork and the table potato as use cases. The decision-making basis for drinking milk and pork is based on the fact that the products have to be utilised, transported and consumed in very short periods of time. The table potato, on the other hand, can be stored for more than half a year under optimal process conditions and is therefore one of the most important staple foods globally. After the definition of the use cases, the system boundaries for the business process modelling had to be drawn. In order to support the modelling, interviews were conducted with actors in the value chain of the respective use cases.

3. Short introduction of the NutriSafe Use Cases

3.1. NutriSafe Use Case: Pork

The system boundaries of the pork use case were defined with the birth of the animals and the classification of the meat within the framework of the rough cutting. Upstream and downstream areas such as feed production and further processing of the meat were not included in the business process modelling. The material flow of pork can be divided into seven processes: breeding, piglet rearing, fattening, transport, slaughter and ongoing controls and monitoring. The seventh process is the link between the specialised rearing and fattening operations, which are referred to as closed and combined operations (figure 1). On "closed farms", all work steps take place in one farm, from breeding to piglet rearing to fattening. "Combined farms" obtain the breeding animals from a specialised breeding farm. The process in a combined farm for piglet production starts with the birth of the piglets and ends with the weaning of the piglets. A "subsequent" farm would be the piglet-rearing farm, which also raises the piglets after weaning. These then either go on to fattening or become breeding stock in the reproductive cycle.
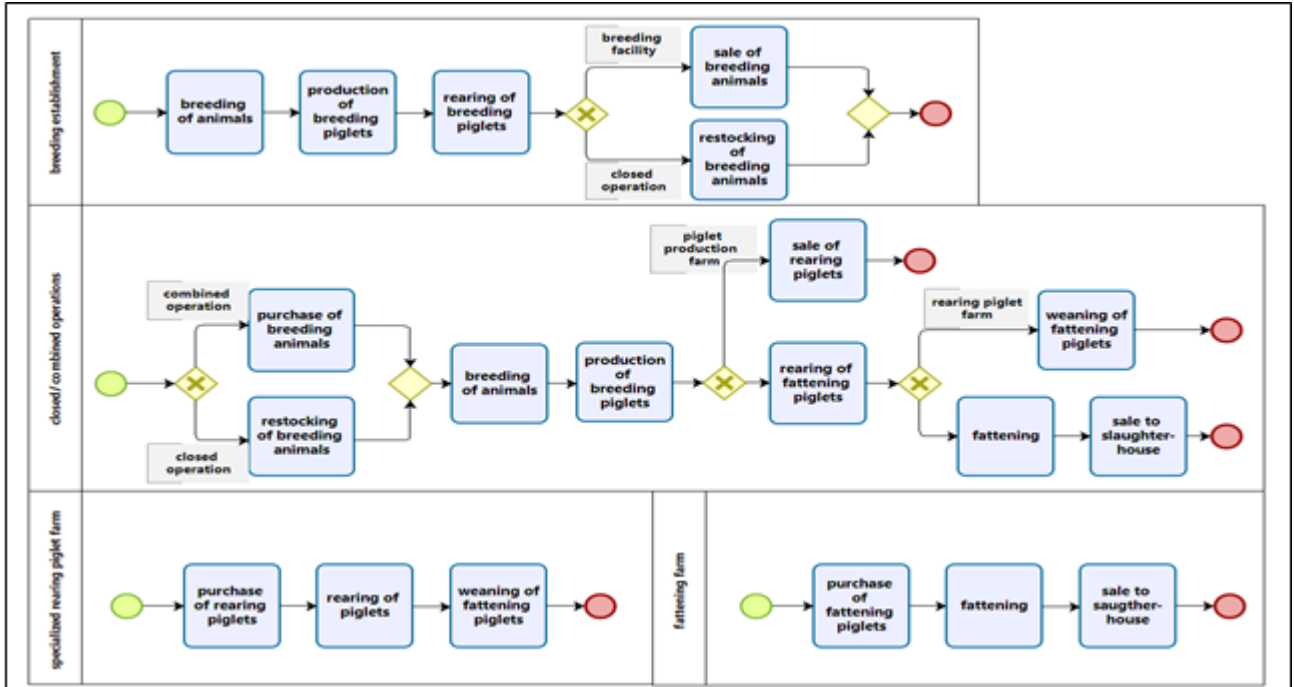
Figure 1 Material flow of pork, overview of operating types (modified Berner, 2020)

During the fattening phase, the animals are checked daily until they are taken to the slaughterhouse. Before slaughter, an ante-mortem inspection and after slaughter a post-mortem inspection are carried out by a veterinarian. Here, specified data must be recorded and samples taken for examination. Afterwards, a classification of the slaughtered meat and further examination of the meat is carried out, which is done by sworn, independent classifiers of the ÖFK (Österreichische Fleischkontrolle GmbH). Figure 1 shows an over-view of operating types in pork production as a schematic example.

3.2. NutriSafe Use Case: Milk

The value chain from the farm to the food retailer for milk was also analysed. Feed production for dairy cows was not taken into account, due to the inherent complexity of this topic. The processes examine the path that the milk takes through various nodes of the value chain and are divided accordingly: farm (milk production farm), transport, collection point, dairy and point of sale.

Starting with milking, the milk must then be stored cooled in a milk tank on the farm in order to limit germ multiplication until the milk collection truck (Tröger, 2003) picks it up. If direct marketing is chosen as the sales channel, further processing and sale takes place ex farm. In 2017, 3.07% of raw milk production was used for own consumption or sold directly from the farm as part of direct marketing (Statistik Austria, 2018). Due to this low share, direct marketing is not considered further in the ongoing description of the milk value chain.

Another marketing channel is the sale via a dairy. Usually, milk is collected from the farm by a milk collection truck and delivered to the dairies. Alternatively, the milk can be transported to a milk collection point beforehand (usually for small production volumes). Before filling up at the dairy, the driver of the milk truck must register. This automatically transfers the results of the inhibitor sample and the temperature of the milk. If contamination is detected during this process, refuelling is not possible (Lehner, 2019). In the dairy, depending on the production process, critical control points are to be defined by the producer, which are to be monitored by continuous self-monitoring. The produced milk is routinely subjected to microbial testing. If the results do not comply with the regulations, the delivered batches must be recalled and the competent authority

informed immediately (Gerhard, 2016). In this scenario, the value chain ends when the milk packs are delivered from the fresh food warehouses to the food retail outlets.

3.3. **NutriSafe Use Case: Potatoes**

In the third use case, the value chain of the table potato from the farmer to the supermarket shelf is considered. The necessary steps that have to happen before the potato is planted are not considered in this model. The appropriate framework conditions (temperature, condition of the soil, precipitation...) that are necessary to plant potatoes are assumed to be given. The material flow looks at the path the potato takes through the different stations of the supply chain. It is subdivided according to the actors who are part of this value chain. The material flow is intended to provide an overview of the tasks that have to be carried out for the product potato. The steps of planting, care during growth, tuber sampling, pre-harvest measures, harvest and transportation of potatoes to the storage are handled by the farmer. There are three options after harvesting:

- The potatoes do not meet quality requirements and cannot be marketed as food. They can still be used in animal feed or a biogas plant. The potatoes are no longer part of the value chain.

- Either early table potatoes were grown for immediate consumption or tubers show damage making them unsuitable for storage and thus are processed and sold immediately after harvest.

- Potatoes that are suitable for long-term storage are either stored on the farm or externally.

Farmers usually have warehouses with the capacity to store a year's harvest. In the course of the winter, they are delivered to the packing centres. The packing centres are companies that buy, store and/or process and resell goods. The packing stations handle all production steps up to the sale, along with commissioning and transport. This includes professional long-term storage, preparation before sale (sorting, washing, polishing) and packaging of the table potatoes.

4. **Summary of critical processes**

4.1. **Pork**

In the pork value chain, critical structures occur at each process step. Due to the crisis potential, the occurrence of African swine fever (ASF) in all above mentioned processes is possible and various options where ASF can occur will be considered. In this respect, rendering plants represent a bottleneck resource due to limited capacities. It is to be analysed how the disease spreads and, furthermore, whether and when food supply shortages may occur. The handling of ASF was presented in a business process modelling. This contains all measures in chronological order at operational and official level. It also includes legal obligations, deadlines and actions. Main processes of ASF outbreaks are supported by the sub-processes: epidemiological investigations, culling, measures against vectors, derogation Slaughter ban, and closure investigations.

The COVID-19 pandemic has also shown that agricultural production and downstream processing operations rely heavily on labour from abroad. The availability of this labour has been severely limited at times by border closures and travel restrictions. Compensation with domestic labour is only possible to a limited extent, as the necessary qualifications and physical prerequisites are usually not available. Another consideration that resulted from the research activity is the dependence on feed imports. More than half of the soy imports are fed to Austrian pigs (Land schafft Leben, 2021). The majority of the imports come from North and South America and are

therefore, transported over long distances. The pig farmer produces the remaining components of the feed entirely in Austria, mostly directly.

4.2. **Milk**

At the farm site, milking and milk storage were identified as critical processes in terms of hygiene regulations and temperature specifications. EU Regulation VO (EG) 853/2004, with specific hygiene regulations for food of animal origin, does not specify a legally regulated maximum storage period, provided that the quality parameters and temperature conditions are complied with.

Nevertheless, it was found that even in the event of failure of the automated milking systems (in Austria only 3% of the production), the cooling in the milk tanks or if cell counts are exceeded in several batches, the supply of raw milk in Austria is covered by surplus quantities. In the further processing of this use case, raw milk production and availability is therefore, not considered a critical process. The market supply of carriers who carry out milk collection transports is seen as highly concentrated by the interview partners. In the further course of the project, milk collection transports are seen as a bottleneck resource with a high crisis potential. Packaging material is seen as another bottleneck resource. The system of delivery to the dairies is based on "just in time" planning. If disruptions were to occur in a packaging plant, the packaging in storage at the dairies would not be sufficient to fill all the milk. This would then have to be processed elsewhere or destroyed. In the further course, the dairy node is seen as a critical point where total breakdowns or restricted operations can occur due to crises.

The possible triggers of these crises can be manifold and are not defined more precisely. The consideration of failures and disruptions on the main traffic routes will represent a possible crisis scenario in all use cases.

4.3. **Potatoes**

Contrasting the use cases for pork and drinking milk, the crisis scenarios chosen for potatoes focus on long-term changes. Developments due to climate change cannot be fully assessed yet, but an increase in pests and dry periods is predicted. The preventive handling of such crisis scenarios should help to be able to react to high quality losses or increased crop failures and thus continue to guarantee food supply security. There are some influences that have negative impact on the quality of crop as well as the quantity of the harvest. Processes such as climate change, changes in precipitation, pest pressure are very slowly progressing and difficult to measure. Therefore, they cannot be examined in detail in this project. Nevertheless, it is assumed that the combination of several such restrictive events will become more likely in the future. Therefore, it will be analysed how harvest volumes, quality and consequently stocks change when high losses are expected.

5. **Potential of DLT implementation**

In the case of pork, the implementation of a DLT should contribute to keeping the transmission paths as small as possible in the next step, based on the described crisis case ASF. By means of tracking, sick pigs are to be traced quickly and efficiently and all their intersections with potential vectors such as transporters and personnel are to be identified. In this way, it will be analysed whether and to what extent a DLT can limit the spread of ASF and contribute to efficient control. In addition, the remaining capacities of both the non-infected farms and the rendering plants can be estimated on the basis of the recorded quantities in the DLT.

Independent from the specific crisis situation under consideration, the use case of drinking milk will be examined to see to what extent distributed ledger technology (DLT) can contribute to a

faster solution and more efficient distribution of resources. DLT is to be used in particular for quantity logging, to plan the handling of bottleneck resources more precisely and, if necessary, to control the internal quantity flows in the event of a crisis. For food provision in general, DLT can be used as a supporting tool for recording stock levels and their quality. It can be used to find out how long the Austrian stocks will last in order to balance the stock with imports in time. The quality of the tubers is decisive for their storage period. The fact that the qualities can be recorded in the DLT makes it possible to plan the stocks more precisely.

6. Challenges and open questions

Factors such as global trade, increasingly complex interactions in supply chains and also increasingly complex disruptions and crisis situations that have to be considered, request a high level of stability, quality assurance and documentation for consumer safety and security of production and distribution lines. As there are many persons on different levels and steps involved the risk of human error has to be considered, as it will influence the quality of the whole chain of data. On the interface between industry and nature as in the case of ASF standard models like DLT try to compete with and control a chaotic natural system, which is quite a challenge. To integrate relevant data in the DLT along the chain is a challenge, less in agriculture, as technical advancement is present there already, but more in wildlife and hunters, which plays a role in ASF.

7. Approaches in the NutriSafe project and solution paths

In the course of the NutriSafe project, the research focused on the use cases of milk, potato and pork as foodstuff identified as highly relevant but also representative and additive examples of supply chain elements. Regarding the examples it was verified, that a frictionless and stable documentation of quality parameters and related data is key for a secure and resilient food supply chain. Although technology is already in place in food industry, a cross-sectoral and cross border, timely exchange of data is still required. DLT would represent one solution to close this gap and enhance the security of international food supply chains. The implementation of DLT in certain areas and for individual cases is already in place, e.g. fisheries, but a global inclusion of this technology is still to be facilitated. A joint political and economic will –also supported by consumer awareness of benefits delivered by DTL- enhance and speed up this development process.

8. Acknowledgement

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THE BENEFITS OF TRIALS FOR PANDEMIC MANAGEMENT

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Abstract

Evaluations in the frame of the EU research projects DRIVER+ and STAMINA revealed that, aside from the multitude of solutions that can be applied to manage a pandemic (restraining measures, protective equipment, tests for epidemiological observations, therapies and vaccines, tools for predictions, resource planning and monitoring, IT solutions for public services), there is also a need for procedures on how to systematically evaluate such solutions. End users, e.g. in medical services have to ensure that new solutions fit to their established pandemic management processes in order to avoid unexpected side effects on the execution of their tasks. In this paper we show a

new methodology designed to examine pandemic solutions and provide insights based on the different national trials of STAMINA.

1. Introduction

The analysis of national and international surveys conducted in 2020 as part of the European flagship project DRIVER+ (DRIVER+ 2019) has shown that there is a multitude of very different challenges in the ongoing management of the COVID-19 crisis. This is including not only aspects of resource availability, but also issues of data management and communication (VISUAL CAPITALIST, 2020). At the beginning of the pandemic, the requirements to facilitate mitigation measures and their effectiveness were mostly unclear. Specifically, in regards of transmission ways and infectiousness, the knowledge base rapidly changed and developed as a requirement of the changing/mutating virus (RKI 2021). Due to the very large number of potentially available solutions, stakeholders worldwide and also in Austria were exposed to an information overload of proposals for solutions such as tests, masks or IT solutions and of approaches for implementing measures, especially in the early phase of the COVID-19 crisis (John Hopkins University, 2020).

This shows the complexity of the challenge: the stakeholders involved in pandemic management, such as state and federal authorities, operators of infrastructure such as hospitals and emergency organisations, need optimised processes and appropriate solutions to carry them out. However, there was and is no systematic overview of the very heterogeneous set of solutions such as suitable diagnostic options, masks but also IT solutions. There is also no possibility to automatically check the suitability of the solutions for the specific requirements and to compare them with other offers. And finally, in case of identification of one or several solutions potentially suitable to close gaps and needs according to the available descriptions, the end user faces the problem on how to systematically validate the efficacy and efficiency of the solutions.

In September 2020 the H2020 project STAMINA (STAMINA 2020) was started. The purpose of the project is to support overcoming the challenges arising from infectious diseases that may result in serious cross-border public health threats represented by e.g. COVID-19. STAMINA has multiple goals such as the provision of novel monitoring and decision support tools, encompassing an early warning system, crisis simulation tools, real time web and social media analytics as well as a Common Operational Picture platform. Moreover, new rapid tests for increased diagnostic capability for Point of Care (PoC) application and smart wearable devices for health monitoring are provided. These solutions are all going to be the tested in trials according the STAMINA Demonstration Methodology (STADEM) Methodology, which is based on the Trial Guidance Methodology (TGM). In order to address the need for enabling practitioners to systematically and objectively investigate the performance of solutions, the TGM was developed in the frame of the European flagship project DRIVER+, Driving Innovation for European Resilience (DRIVER+, 2020). The methodology is described in detail in the CEN Workshop Agreement 17514:2020 (CEN Workshop Agreement 2020). The introduction of new solutions can be risky for practitioners, because they are often associated with significant costs and in case they are not appropriate, significant workflow disruptions. The objective of the Trial Guidance Methodology is to investigate the impact of new solutions on existing processes and will be described in Section 2 of this paper.

2. Method – the STADEM Approach

The Trial Guidance Methodology (TGM), created by the EU research project DRIVER+ is designed to develop a rigorous, yet pragmatic methodology for the assessment of innovative

solutions in the area of crisis management (Fonio, Widera 2020). It follows three ambitious objectives:

- enable practitioners to systematically assess the added value of an innovative solution,

- enhance dialogue and co-operation among solution providers and practitioners, and

- support the goal to have a more objective assessment in the procurement process.

The TGM was already executed and validated in multiple trial events (see tgm.ercis.de). A summary of the key phases of the TGM for the application and further development in the domain of pandemic management is given below. After that, necessary adaptations of the TGM towards the STADEM methodology of STAMINA are discussed.

According to the TGM a trial takes three dimensions into account (Widera et al. 2018), which need to be considered in order to allow the evaluation of a trial. The solution dimension states the objectives and functions that the individual solution tries to reach in the trial context. The crisis management dimension states the objectives for the improvement in the activities to address the situation and the roles, responsibilities and processes needed for that. The trial dimension states the objectives for the overall trial and the sessions it is composed of. All three dimensions contribute to dedicated performance measurements to assess their individual influence on the overall achieved outcome.

2.1. Overview on the phases and steps

The trial guidance methodology consists of three phases: preparation, execution and evaluation. The goal of a trial is the systematic assessment of an innovative solution's added value to a specific crisis management (CM) context and gap or need. Hence the evaluation phase is the most important phase and should be taken into account from the beginning.

One of the most central element of a trial are the gaps that should be addressed by conducting an assessment. Every gap is based on the underlying need to improve the current situation and is thereby directly related to CM functions (DRIVER+ Project Public Reports 2019). A gap should be reasoned by formulating the need to improve and describe current deficiencies, as this facilitates the understanding for non-CM professionals. Hence, it is recommended that CM professionals are involved in the identification and formulation of the trial gaps.

As the gap depicts a potential for improvement, it is linked to roles, responsibilities, situations, equipment etc. that describe the situation in which this specific gap occurs.

Based on a proper identification of gaps and the trial context, the trial design is developed in a six step approach (Fonio, C. and Widera, A. 2020). The six step approach is an iterative process in which individual steps, in follow up iterations, might not require an update and hence can be skipped.

The process is co-creative, which means that all stakeholders should be involved. The six steps consist of setting up trial objectives, identification of research questions, establishment of a data collection plan, setting up evaluation approaches, making a scenario formulation and finally selection of solutions.

The execution phase also foresees preparation, rehearsals and tests in order to assure a smooth event. This will also allow for the possibility to adjust and check that all that is needed for the trial is in place and is functioning properly.

A trial integration meeting is the first joint physical meeting of the CM practitioners, the technical test-bed and the solution providers. This trial integration meeting is essential to align the perspectives of the practitioners, the solution providers and the trial committee.

A first dry run one is a technical rehearsal, and its main purpose is to test the technical set-up (the trial design and the technical test-bed), the connection of the solutions to the test-bed and the information exchange between solutions as well as the data collection set-up. The training on solutions should also be validated.

The second dry run two is a full rehearsal possibly still with a limited number of participants. This is the final possibility to adjust the trial set-up. The data collection plan and the trial script should be approved after dry run two, otherwise the trial owner might setup another dry run before the trial itself.

The trial run aims at collecting all the data necessary for the evaluation of the solutions by comparing the baseline with the use of the innovative selected solutions. The total duration of the trial run depends on the complexity of the scenario, as well as the number of gaps and solutions to be assessed.

The main objective of the evaluation phase is to make sense of the data collected during the trial. This sense making process is key to understand if and to what extent the solutions are relevant and innovative for a CM organization. The evaluation phase is dedicated to analyse the quality of the data and the data, to synthesize it and finally to disseminate the results.

2.2. Adaptations towards STADEM

The development and evaluation of the TGM was so far carried out in the context of the DRIVER+ project. While the TGM (Fonio, C. and Widera, A. 2020) is a very good starting point as methodology to be used in STAMINA, some changes are necessary and potential further improvements could be evaluated. This section discusses first steps in the development of the STADEM methodology (STAMINA 2021). During the first steps of preparing the STAMINA trials, practitioners presented a national pandemic management map for the respective country the trial is planned in. This map is a schematic representation of the pandemic response units and authorities in a country and how they are linked to each other. Such an overview can evidently support the definition and description of the trial context in the preparation phase. It was therefore suggested to all trial owners to prepare such a pandemic management map in the trial preparation. Later evaluations will show if such a tool can effectively support the trial design and whether this is a pandemic specific utility. A pandemic management map is intended to become a new outcome in the step zero. One clear difference from the TGM to STAMINA objectives is the omitting of a solution selection process. STAMINA foresees a predefined solution set for the trials, which means that the solutions to be assessed are already known.

On the one hand, this limits the openness of the methodology since the solution selection is not based on the trial context, on the other hand this should accelerate the iterative six step approach and allows trial owners to directly assess one or more already predefined solutions. The first iteration can already consider solutions in the trial context and no later changes due to newly identified solutions are required. Yet, this demands that the trial scenario considers the capabilities of the solutions right from the beginning, in order to conclude on achievable trial objectives. Evaluations will result in necessary changes to the phases for STADEM. The TGM and STADEM both focus on CM practitioner interests and support the collaboration of trial owners, practitioners and solution providers together with CM experts. The pragmatic applicability of STADEM for the involved stakeholders is therefore a key performance indicator.

3. Setting of the STAMINA Trials

A central goal of STAMINA is to validate if the solutions provided in the project can close pandemic management gaps specified by end users. As the current practice shows, this is a highly relevant step in the process of optimizing the current, mainly organically grown structures adapted from other management practices and thus not always suitable for the highly dynamic and fluid demands of a global or cross-border event as pandemics or epidemics. The methodology applied is described in the previous chapter. In this chapter we give an overview on the different trials of STAMINA and describe the Austrian trial in an exemplary way in more detail.

STAMINA does not focus on SARS-CoV-2 only, but also deals with influenza, the West Nile Virus, measles and e.Coli as well. For the trials, this means that the test scenario should be elaborated in such a way that at least one of the above-mentioned pathogens have to be involved. Additionally, each trial focuses on one or more types of gaps arising during a pandemic.

Different types of solutions are provided in STAMINA, namely (the numbers in parenthesis are used in table 1 to indicate if these types of solutions are intended to be applied in the trials):

- (1) STAMINA predictive models,
- (2) a portable health status monitoring device
- (3) rapid tests for diagnostic capability at Point of Care
- and the STAMINA toolset encompassing an
    - (4) Early warning system
    - (5) Crisis simulation tool
    - (6) Real time web and social media analytics
    - (7) Preparedness Pandemic Training tool
    - (8) Common Operational Picture application

In a similar manner as with the pathogens each trial needs to be designed by the specific trial coordination team in such a way that the performance of several of the solutions can be investigated. In total up to 12 national trials and one cross border trial are going to be executed in STAMINA. Table 1 gives insight about the planned trials. It should be noticed that all trials are in the early planning stages, therefore all parameters are potentially a subject to change. In particular the degree of specification of objectives as well as gaps is going to be continuously sharpened.

Table 1: Overview on STAMINA trials objectives and gaps as well as potentially applied solutions

Country[15]	Objectives/Gap(s)	Applied solutions
Austria	Back tracing of potential infected persons	2,3,7,8
France	Rapid diagnostic to identify West Nile Virus, identify people at risk	3,4,6,7
Czech Republic	Training of control of pathogen, situational awareness	3,4,8,7
Greece	Cooperation between federal institutions	2,3,4,7
Lithuania	Evaluation of health threats a point of entries	3,8,7
Romania	Management of the outbreak of an unknown pathogen in parallel to an earthquake	5,8
Slovenia	Hospital resource management, rapid testing	3,4,5,6,8
Spain	Coordination between authorities and first responders	4,6,8
Turkey	Prediction of shortage of hospital resources	1,2,4,8

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[15] Two additional trials are being considered to be held in the Netherlands and Tunisia

A highly pertinent cross-border trial will be also implemented in the frame of the project that will be prepared. It can be seen from Table 1 that the application of the different (types of) solutions is not balanced, e.g. the predictive models are only involved in two trials so far, whereas the Common Operational Picture (COP) is intended to be applied in 80 % of the trials. So far, there also exists also a predominance of the pathogen SARS-CoV-2 across trials, whereas other pathogens are so far not in the focus of the trial committees. It is intended to balance the selection of pathogens, too. In order to get a better insight in the planning of a specific trial, the Austrian trial is described in more detail here.

The Austrian trial is planned and executed by the Johanniter Österreich Ausbildung und Forschung gemeinnützige GmbH, who are part of the STAMINA project as a medical first responder. During normal operation the Johanniter have 62 ambulances with more than 700 paramedics on a 24/7 basis in Vienna in action. Lately the transport of infected patients is of increased concern, due to COVID-19. If an ambulance is transporting an infected patient without prior knowledge, this leads to a potential spreading of the infection in the organization as well as the later approached hospitals, because the ambulance car is not disinfected sufficiently concerning the special infectious disease (e.g. MRSA; Scabies) after every transport. Therefore, the fast and efficient tracing of the contact points of the ambulance car is the identified gap of the Austrian trial. To test the relevant solutions (2, 3, 7, 8) addressing this gap, four different trial objectives were identified:

1. Information processing and visualization through a new situational awareness and decision support system in the control center of the Johanniter Vienna;

2. New tools for the preparedness, early detection and control of pathogens and diseases in the patient and emergency transport should be assessed;

3. Establishment and testing of new communication guidelines and a documentation system in the organization of the Johanniter;

4. Assessment of innovative contact tracing solutions with portable PCR devices and wearable diagnostic devices in the organization of the Johanniter in Vienna.

Within the trial, the contact points of the respective ambulance car should be identified by the command center through the documentation and contacted via a predefined procedure which was already tested and trained with the Preparedness Pandemic Training tool. The ambulance team and close contacts of them will get a health monitoring device and are tested with the rapid diagnostic tools at different times. The whole situation should be monitored using the COP-Tool.

4. Conclusion and Outlook

The main purpose of trials is to investigate whether solutions can satisfactory fill gaps of practitioners and end users in pandemic management. It is important to keep in mind that gaps can occur at different levels of pandemic management, operational, tactical, strategic, or even legal or political. For each of these areas, different types of solutions may be helpful to meet existing requirements and needs. In any case, the processes used must be considered when discussing gaps and solutions dedicated to those gaps (see also Rainer et al. 2021). In addition to validating the suitability of solutions, it is necessary to have a comprehensive overview of solutions. To achieve this, all solutions tested in the STAMINA project will be systematically documented together with the results of the validations in an already existing platform, the Portfolio of Solutions (PoS). The Portfolio of Solutions is an online knowledge management system that stores information about gaps in crisis management, solutions, and experiences in using these solutions, and makes this information available to end users through a web interface (Ignjatović et al. 2019). The PoS is used

and adapted for the purposes of STAMINA to describe pandemic management solutions as well as to match the characteristics of these solutions with specific management gaps via a specific taxonomy of pandemic management capabilities. This type of matching between solutions and gaps is very useful for end users to identify solutions that are potentially suitable for their needs before their suitability is investigated in the context of the trials described earlier.

5. Acknowledgment

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SOCIAL MEDIA, FAKE NEWS, MYTHS AND ETHICS

EDEMOCRACY AND ITS IMPLEMENTATION IN SELECTED EU COUNTRIES

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Digital democracy, eDemocracy, education, eGovernment, EU, GDP

Abstract

This paper deals with the topic eDemocracy, especially factors and their influence on the level of eDemocracy implementation in 14 countries of European Union. We have focused mainly on factors such as population of the country, education and gross domestic product (GDP). Using statistical methods, such as correlation coefficient has helped us to evaluate whether these factors have influence on the level of implementation of eDemocracy. This paper provides a statistically verified answer whether factors, such as education or GDP, influence the level of eDemocracy implementation in countries of European Union.

1. Introduction

Each country has its own population and this population has its own characteristics, such as education, socioeconomic status, age, race and ethnicity. And all of these traditional stratifiers of political engagement can affect "electronic" illiteracy. It is understandable that these factors divide the population within all countries and affect acceptance of eDemocracy implementation.

Another thing that could affect acceptance of eDemocracy implementation is that in general the older and more highly educated individuals are more likely to participate than others. (Chadwick, 2009) Therefore countries with older and more educated population should have higher level of eDemocracy implementation.

Şendağ & Toker (2016) claim, that younger age and higher levels of education increase ePolitical involvement. It means that generally the higher level of education positively affects the level of participation and involvement.

The barrier of successful implementation of eDemocracy tools can be the low access to information and communication technologies. There is naturally a relationship between low access to ICTs and low income. Other barriers could be low-income, low levels of education, low skilled jobs, unemployment and lack of technology skills. But not only socio economic factors can affect negatively the adoption of eDemocracy tools. Socio personal factors are also very important. These factors include low levels of awareness, interest, understanding and acceptance of ICTs. (OECD, 2004)

In Sweden the research was conducted and according to the following picture it is clear that it is not possible to say that there the direct correlation between average income and level of eDemocracy exists. (Lidén, 2012)

Table 1. Correlation between level of eDemocracy and average income. (Lidén, 2012)

Case	Level of e-democracy	Population size (2011)	Voter turnout (2010)	Average income (2010)
Ockelbo	Low	5907	81.7	243.5
Älvkarleby	Intermediate	9089	80.9	256.0
Ovanåker	High	11 404	84.8	239.6

Sources: Statistics Sweden (2012); Swedish Elections Authority (2012).

The goal of this paper is to provide another view and results on this topic and verify whether the correlation between different factors (such as GDP, level of education and other) and level of eDemocracy implementation exists, or not.

2. Definitions

2.1. Definition of Democracy

Democracy, literally, rule by the people. The term is derived from the Greek dēmokratiā, which was coined from dēmos ("people") and kratos ("rule") in the middle of the 5th century BCE to denote the political systems then existing in some Greek city-states, notably Athens. (Dahl, 2020)

Democracy is the dominant modern form of the political system that is guided in many countries all over the world. This concept is based on liberty and equality, but these two had a different meaning in history. Modern democracy is based on principles of freedom in voting our representatives. Democracy also has its rules that need to be followed, otherwise there is a risk of sanctions. (Barber, 2003)

2.2. Definition of eDemocracy

eDemocracy (abbreviation of electronic democracy), also known as a digital democracy or Internet democracy, is the system that is based on people's competence to form and enhance political situations and processes through the information and communication technologies. eDemocracy includes a variety of different tools, such as eVoting or eParticipation. (Chadwick, 2018)

2.3. Difference between eDemocracy and eGovernment

Before we focus on the implementation of specific democratic tools, it is important to understand the difference between eDemocracy and eGovernment. Although these terms may sometimes be confused or interchanged, there is a difference in their meaning. While some scholars are of the opinion that eGovernment can be a path to eDemocracy, there are various definitions that clarify the differences and similarities between them. In paper which examines whether eGovernment can be a way to eDemocracy we can find this definitions: "The Organization for Economic Cooperation and Development defines eGovernment as the use of information and communication technologies (ICTs), particularly the internet, as a tool to achieve better government (OECD, 2003a). eGovernment is the use of information and communication technologies in all facets of the operations of a government organization. Having studied eDemocracy for several years, Clift defines it as "the use of information and communication technologies and strategies by democratic

sectors within the political processes of local communities, states/regions, nations and on the global stage." (Kardan, 2011)

2.4. eGovernment

Another definition of eGovernment that we can use is in the paper by Meer, Galderm and Rothier and reads as follows: "eGovernment can be defined as "the major initiatives of management and delivery of information and public services taken by all levels of government […] on behalf of citizens, business, involving using multi-ways of internet, website, system integration, and interoperability, to enhance the services (information, communication, policy making), quality and security, and as a new key (main, important) strategy or approach" (Meer, Gelders, Rotthier, 2014). eGovernment includes the administrative and political subsystem and is used in two strands of society, the connection between the political system and society, and the other is the connection between the administrative system and society such as interactions in the use of public administration services between government, citizens and government, and between government and business (Bataineh, Abu-Shanab, 2016).

Basically we can describe eGovernment as the aspects of public administration such as administrative tasks or service delivery using the ICT that have to do with tasks of the executives. This means that eGovernment can use ICT with the aim to optimize internal processes or it can be used for international processes where ICT helps with international political issues in the EU such as cultural collaboration to combine efforts in crime prevention and detection or exchange of statistics and other matters. eGovernment also provides accessibility of the administration to citizens. It is possible to notice that the public administration dealt mainly with administrative and bureaucratic tasks, therefore when using electronic public administration they use innovations mainly in the ways of providing services to citizens and the use of technology is focused mainly on administrative decision makers. When we are talking about eGovernment in this paper, we understand this as democratic government (Stahl, 2007). eGovernment stakeholders include journalists, civil servants, academics, politicians, the business community, the international environmental movement and voluntary organizations. New ICTs are creating a new eGovernment infrastructure. The great challenge of self-management is the interaction and influence of various aspects, and therefore it is necessary to take it as a developing and integrated organism when designing part of eGovernment. In Western democracies, it leads government and citizens to reconcile the fundamental aspects of representative democracy. However, ICT in public administration raises concerns about their impact on democratic values such as inclusiveness, transparency, personal privacy, openness.

eGovernment includes the following objectives:

- improving government performance
- obtaining free dissemination of information to overcome the shortcomings of the traditional physical process
- improving democratic processes in the country
- improving access to and delivery of government services (Bataineh, Abu-Shanab, 2016).

2.5. eDemocracy

Many eGovernment models involve phases of information, interaction, and transaction, which we refer to as the development of electronic services. In many models, eDemocracy is the final stage of eGovernment. eDemocracy involves the involvement of citizens and this phase can only be achieved after the other development phases have been completed. The first stages of development

are called descriptive, because they are carried out mainly by government procedures and those that follow the theoretical ones (Meer, Gelders, Rotthier, 2014).

In democracy it is about empowering citizens to choose politicians. It aims to use new techniques to achieve various goals, such as empowering citizens by encouraging their participation, involving their views and achieving transparency in the political process. The main core is actually the transfer of supreme power to the citizens (Bataineh, Abu-Shanab, 2016).

Sometimes these two concepts can be mixed up but we will show the difference on the example of voting using technology. If the use of technology in voting were to reduce governments' voting costs, we could say that this is an example of eGovernment. But if it were a matter of voting influencing who votes are counted or who is voting, it would be electronic democracy (Schnider, 2001). "While an important goal of eGovernment is to improve citizens' lives by providing faster and more efficient services, there is a wider goal of increasing citizen participation in the process of governance and administration (Bolgherini, 2007)".

Clift expresses the view that eGovernment goes hand in hand with eDemocracy and eGovernment helps to improve eDemocracy by enabling citizens to participate more in public government by having more information about laws, policies, and regulations (Clift, 2004).

In reality, however, eGovernment is highly desirable for government officials, and on the other hand democratization may be not so desirable. While eGovernment uses technology to make public administration more efficient, eDemocracy aims to increase the accountability of government officials to the public (Schnider, 2001).

3. Methodology

Following two main hypotheses have been tested:

- The higher level the education is in a particular country, the higher is the level of implementation of eDemocracy.
- The higher the GDP is in a particular country, the higher is the level of implementation of eDemocracy.

Country selection

To know exactly which eDemocracy tools are implemented in selected countries we needed to have data preferably from all countries of the EU. So we divided the EU into 7 geographical regions (Western, Southwestern, Southern, Southeastern, Eastern, Central, Northern) and our minimum was to get the date from at least one country from each region.

In view of the fact that we had quite a lot of criteria to know about all the countries (18 in total as it is mentioned above), it was very important to set the methodology for country selection very carefully. Together with that we decided to get the data from following 14 countries of the EU as it is more than a half of EU members:

Western Europe: France, Germany, Netherlands (representative of Benelux countries) **Southwestern Europe:** Spain **Southern Europe:** Italy, Slovenia, Croatia **Southeastern Europe** Greece **Eastern Europe:** Bulgaria **Central Europe:** Austria, Poland, Hungary **Northern Europe** Finland, Estonia (representative of Baltic countries)

We use the Pearson coefficient because it measures the linear relationship. In order to evaluate the level of eDemocracy in selected countries we have come with eDemocracy implementation index, which examines the countries' readiness for eDemocracy. For parameters we used the Boolean values.

To decide whether we can confirm or decline our hypothesis, the correlation coefficient was not sufficient. We have also employed Student's T-test for statisticaly significant difference between the groups.

4. Results

4.1. Current state of eDemocracy in Europe

First of all, we need to evaluate relevant information about countries to get a whole picture and to valorize the hypotheses. In the following table, you can find the number of population, level of education, internet access and GDP of each state that we have chosen. All of the data are from 2020. The ranking of education is dependent on various learning factors such as completing the primary school or graduating the high school. (World population review, 2020) Internet access is represented by the percentage of the households that reported they are connected to the Internet. Gross domestic product (GDP) measures the value of a state wealth. It shows the production of goods and services during a determined period of time in a country. (OECD, 2020)

Table 2. State characteristics (OECD, 2020 & World Population Review, 2020) and e-democracy implementation

State	Population (million)	Level of education	Internet access	GDP (USD/person)	Elements	Partial elements	Years of implementation	Index value
Austria	8,8	1460	89,90%	58 943	3	1	15	0,38
Bulgaria	6,9	1296	67,90%	24 505	5	1	8	0,77
Croatia	4,1	1422	79,10%	28 103	5	0	6	0,89
Estonia	1,3	1541	90,40%	38 968	11	0	18	0,79
Finland	5,5	1631	94.4 %	51 414	10	0	21	0,69
France	66,9	1491	90.2 %	49 145	4	1	20	0,44
Germany	82,9	1530	94.8 %	56 305	3	0	19	0,35
Greece	10,7	1419	78,50%	30 698	2	2	14	0,35
Hungary	9,8	1487	86.2 %	34 503	3	1	17	0,38
Italy	60,4	1458	85.2 %	44 218	3	0	18	0,35
Netherlands	17,2	1556	98.4 %	59 512	4	0	21	0,4
Poland	38,4	1458	86.7 %	34 055	3	0	5	0,65
Slovenia	2,1	1496	89.0 %	40 962	6	0	17	0,52
Spain	46,7	1452	91.4 %	42 171	5	0	14	0,5

Furthermore, it is necessary to determine the general level of eDemocracy maturity in selected countries. For this purpose, we have created a scale that takes into account the implementation of individual elements of eDemocracy in the countries. If the government implemented the eDemocracy element, it gets one point. As part of this data preparation, it was necessary to resolve a few inconsistencies in the data, especially for countries that have some of the elements

implemented only partially. A concrete example can be Austria, which has implemented ePetition, but without the possibility to sign it online.

Table 3. Implementation of eDemocracy tools in selected EU countries

	Austria	Bulgaria	Croatia	Estonia	Finland	France	Germany	Greece	Hungary	Italy	Netherlands	Poland	Slovenia	Spain
Implementation of eDemocracy elements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
eDemocracy Implementation start year	2005	2012	2014	2002	1999	2000	2001	2006	2003/2011	2002	1999	2015	2003	2006
eID card	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes
eID card since	2006	-	2015	2002	1999	-	2010	-	2016	2006	2006	2019	-	2006
eVoting	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No
IVoting	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No
Ballot scanners	No	No	No	No	No	No	No	No	No	No	No	No	No	No
eRulemaking	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes
ePetitions	Yes	No	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
eForum	No	Yes	No	Yes	Yes	No	No	Yes	Yes	No	No	No	Yes	No
ePolls	No	No	No	Yes	Yes	No	No	No	No	No	No	No	Yes	No
Personalised survey tool	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
eReferendum	No	No	No	No	No	No	No	No	No	No	No	No	No	No
eConsultation	No	Yes	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	Yes
eCitizen juries	No	No	No	No	No	No	No	No	No	No	No	No	No	No
eComplaint	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
eServices	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
eInformation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

In addition, it was necessary to include in this index also the time for which eDemocracy is implemented in individual states, from two perspectives. First, it was necessary to take into account and positively evaluate the states that have been striving for implementation for a long time. At the same time, we wanted to take into account the time that states had to implement partial elements. To find a balance between a positive evaluation of a long period of time and at the same time a certain degree of penalty. In this case, we considered several different approaches. Most of the approaches considered encountered the negative fact that the overall informative value of the generated index would be greatly distorted. In the end, we managed to find a balance, so the calculation is as follows: each state gets 1 point for the implementation of one element of eDemocracy (0.5 points for partial implementation), the number of points obtained is divided by the number of years since the implementation of the first element. In addition, each state will receive 0.01 points for each year that has elapsed since the implementation of the first component of eDemocracy. The amount of points thus obtained is added to the points mentioned previously. The formula to calculate the index is:

$$\frac{\text{\# elements} + (0{,}5 * \text{\# of partial elements})}{\text{\# years since implementaton}} + 0{,}01 * \text{\# years since implementaton}$$

The specific points and the values obtained by the index created by us are shown in the table 2.

We can already draw some basic conclusions about the level of eDemocracy in individual states on the basis of the index created by us. According to the obtained score, we can say that Croatia achieved the relatively most advanced implementation of eDemocracy. Mainly due to the high number of fully implemented elements (5) in a relatively short number of years (6). In the second place is Estonia, which is generally considered to be the pioneer of eDemocracy in the world. According to our assessment, it ranks the second place and it supports the correct setting of the calculation of our index - the relevant consideration of the time period for which the eDemocracy states use it. Estonia, although it has a high number of elements (11), has also been involved in

implementation for 18 years. At the opposite end of the evaluation is Italy, which has implemented only three elements. The first one was implemented in 2002 - at the same time as the mentioned Estonia, which is in second place. The remaining results can be seen in the tables 2 and 3.

Furthermore, we subjected the obtained state scores to statistical research, namely by calculating the correlations of index values and factors mentioned in the introduction of the chapter - the population of the country, the level of education, internet access and last but not least the wealth of the state.

First of all, we examined whether the score of individual countries correlates with the population and thus whether our hypothesis that countries with a higher population also have a higher level of eDemocracy implementation is correct. We first calculated the correlation coefficient between the value of our index and the population of a given country. We obtained a negative correlation coefficient with a value of 0.48. The next step was to calculate the test statistics. We obtained a value of 1.93 (in absolute value).

To determine whether the degree of development of eDemocracy really depends on the population, the correlation index alone is not enough, so we performed a T-test at a significance level of 1%, 5%, 10%, and 20%. This was followed by the determination of the degree of freedom, which is obtained as the number of examined elements, in our case 14 minus two - 12. Subsequently, we obtained critical values from the T-test table for the above-mentioned degrees of significance, namely values of 3.055; 2,179; 1,782; 1,356.

The first two selected rates of significance 99% and 95% - were too ambitious, the test statistics are smaller than these values and it is concluded that the population has no influence on the degree of development of eDemocracy in individual states. On the other hand, even with an accuracy of 80%, which is lower than the commonly accepted rate (95%), we can say that the level of development depends on the population => smaller countries being better in eDemocracy.

Table 4. Calculation of the dependence of the index on the population of states

	Points	Population				
Austria	0,38	8,8		Correlation coefficient		-0,487266488
Bulgaria	0,77	7		Number of states		14
Croatia	0,89	4		Test statistics (T-test)		-1,932933524
Estonia	0,79	1,3				**1,932933524**
Finland	0,69	5,5				
France	0,43	66,9		Degree of freedom		12
Germany	0,35	82,9				
Greece	0,35	10,7		**Statistical significance**		**Critical value**
Hungary	0,38	9,8			1%	3,055
Italy	0,35	60,4			5%	2,179
Netherlands	0,40	17,2			10%	1,782
Poland	0,65	38,4			20%	1,356
Slovenia	0,52	2,1				
Spain	0,50	46,7				

Another of the examined dependencies is the dependence of eDemocracy development on the level of education.

The second of the presented hypotheses, the dependence of the level of education and the degree of development of eDemocracy, is the only hypothesis that we did not confirm. According to the performed correlation analysis, we found that the correlation coefficient between the value of the index and the level of education in individual countries reached only the value of -0.15. It would be therefore possible to conclude directly from this value that there is almost no connection between the mentioned quantities. Despite this, we also calculated test statistics, which reached 0.56. We can therefore state that the hypothesis was not confirmed both at the normal level of accuracy (95%) and at lower selected rates, such as 80%.

Table 5. Calculation of the dependence of the index on the level of education of states

	Index	Level of education				
Austria	0,38	1460			Correlation coefficient	-0,159777752
Bulgaria	0,77	1296			Number of states	14
Croatia	0,89	1422			Test statistics (T-test)	-0,560689539
Estonia	0,79	1541				0,560689539
Finland	0,69	1631				
France	0,43	1491			Degree of freedom	12
Germany	0,35	1530				
Greece	0,35	1419			Statistical significance	Critical value
Hungary	0,38	1487			1%	3,055
Italy	0,35	1458			5%	2,179
Netherlands	0,40	1556			10%	1,782
Poland	0,65	1458			20%	1,356
Slovenia	0,52	1496				
Spain	0,50	1452				

The last of the examined relations is the relationship between the development of eDemocracy and the GDP of individual states. Here, we assumed that richer states would have a more developed state of eDemocracy. Again, we used the calculation of the correlation index and then the T-test to determine the degree of accuracy of our findings.

The correlation index for this part reached -0.62. The test statistic subsequently reached a value of 2.76 in absolute value. In this case, we were able to confirm our hypothesis that richer countries (in terms of GDP per capita) are at a higher level of development of eDemocracy than poorer countries. This statement can be considered correct with an accuracy of 95%, thus with a generally accepted degree of accuracy => rich countries being better in eDemocracy

Table 6. Calculation of the dependence of the index on the GDP of states

	Points	GDP				
Austria	0,38	58943			Correlation coefficient	-0,623767647
Bulgaria	0,77	9272			Number of states	14
Croatia	0,89	14909			Test statistics (T-test)	-2,764543685
Estonia	0,79	38968				2,764543685
Finland	0,69	51414				
France	0,43	49145			Degree of freedom	12
Germany	0,35	56305				
Greece	0,35	30698			Statistical significance	Critical value
Hungary	0,38	34503			1%	3,055
Italy	0,35	44218			5%	2,179
Netherlands	0,40	59512			10%	1,782
Poland	0,65	34055			20%	1,356
Slovenia	0,52	40962				
Spain	0,50	42171				

5. Discussion

If we conclude our results with information obtained by literature research, it is possible to say that we can confirm that level of eDemocracy implementation and development is influenced by population size. Same result was presented in Sweden research, but there were only 3 cases, whereas in this paper there have been 14 countries taken into account.

The hypothesis: *The higher the GDP is in a particular country, the higher the level of implementation of eDemocracy in this country* was also confirmed to be true. It might look that this is absolutely clear that GDP (or let's say wealth) of a country influences the level of eDemocracy implementation. But we did not find resources to confirm. There were just resources telling that

wealth, GDP, etc. might affect the level of eDemocracy implementation, so this paper confirms this information statistically.

The second hypothesis: The *higher the education is in a particular country, the higher the level of implementation of eDemocracy in this country* was not confirmed. The relationship between level of education and level of eDemocracy was not found. During the literature research, we found a resource that tells, then low level could be a barrier of adoption of eDemocracy and adoption is crucial part of being eDemocracy tools successfully implemented.

6. Conclusion

New information and communication technologies are already used in various sectors, making them easier to operate in numerous aspects. In many countries, ITCs are already being used to make the relationship between citizens and the state in which they live more efficient. The involvement of ICTs in democracy should help countries increase interaction between citizens and political representatives or parties together with promoting democratic legitimacy.

Today, the goal of their strategies is to put into practice and support eDemocracy. However, not all countries are really working on implementing democratic tools and technologies. But in general it seems, that small and rich countries are in general doing better in this matter.

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PERCEPTION OF FAKE NEWS BY UNIVERSITY STUDENTS

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Keywords

Fake news, Interview Survey, Pearson Chi-Square, Research

Abstract

Fake news is actual problematic, because of impact and increasing number of this type of news. The paper is focused on perception of fake news by university students. In this case, Faculty of Economics of VSB – Technical University of Ostrava students. The study is proposed like questionnaire research provided in February and March 2021. Pearson's Chi-square Test, Independence Test, Fisher Test, and other statistic methods are used then. In the case of belief of fake news, it doesn´t which gender it is. But in the case of awareness of webpages for fake news validation depends on gender. Problematic of fake news and perception of it focused on Covid-19 pandemic will be provided next study.

1. Introduction

Fake news is not new term. Term Fake news can be define like news that are purposely false or bad and could mislead purposely people (Allcott & Gentzkow, 2017). They were there from the evolution. But now, with using internet – namely webpages, social nets and so on, it is quick, more visible and have bigger impact, mainly for young people, because they prefer this media (Figueira & Santos, 2019). Number of fake news are increasing also. Reasons why people create fake news and share them is different. It should be because of influencing target groups of people, creating of different image of key problematic or other obvious reasons. Problem with fake news is people´s credibility to this type of news.

People with most internet skills are young people study regarding digital skills by Eurostat (2021). So, study is focused on perception of the young people. Students from Faculty of Economics of VSB – Technical University of Ostrava are chosen like research group. Students are between 18 and 25 years, both genders are included. 81 students are included. The study is provided by research, namely questionnaire research. The questionnaire research was provided between February and March 2021. Because it was during the pandemic of Covid-19, the questionnaires were distributed online via Google Forms. The questionnaire contains 30 questions regarding fake news. 3 hypotheses were found out from the answers: dependance between gender and belief of fake news, dependance between gender and interest on fake news seminar and dependance between gender and awareness of webpages for fake news validation. Pearson's Chi-square Test, Independence Test, Fisher Test, and other statistic methods are used then. The main dependency was founded between gender and awareness of webpages for fake news validation. The impact of this dependance is middle.

Fake news is key problematic in these days, mainly fake news regarding Covid-19 pandemic and other international topics. So, the authors of the paper will be focused on this problematic in their future work.

2. Data and Methodology

The data were obtained from a questionnaire survey among students of the bachelor's and follow-up program at the VSB - Technical University of Ostrava at the Faculty of Economics. A questionnaire using the Google Forms application was used for the questionnaire survey. Microsoft Office Excel was used for basic data processing. The Statistical Package for the Social Sciences (SPSS) program was used for statistical analysis. More about SPSS, for example, in Verma (2003).

Pearson's chi-square test of independence ($\chi.2$) is most often used to test the independence of two nominal quantities. The aim of the test is to decide whether the occurrence of two quantities is related. Pearson's chi-square test is calculated on the basis of Formula (1) according to Friedrich, Hradecký, Michalcová & Pomp (2018) or Hendl (2009):

$$\chi.2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where n is the range of the set, O_i are the observed frequencies and E_i are the expected frequencies.

In the case of a four-field table, see Table 1, where the analyzed quantities have only two variants, the modified Pearson's chi-square test of independence ($\chi2$) is used, which is calculated on the basis of Formula (2) according to Friedrich, Hradecký, Michalcová & Pomp (2018) or Hendl, J. (2009):

$$\chi2 = n \cdot \frac{(a \cdot d - b \cdot c)^2}{(a+b) \cdot (c+d) \cdot (a+c) \cdot (b+d)}$$

where a, b, c, d are the frequencies from the four-field PivotTable.

The significance level is set at 5%. The condition for using the test is that at least 80 % of the expected frequencies are greater than 5.

If the $\chi2$ test of independence is not met, Fisher's exact test (p) is used (Formula 3), which represents the calculation of the probability with which a four-field table would be obtained equally or more distant from H_0, while maintaining the observed frequencies.

$$p = \frac{\binom{a+c}{a} \cdot \binom{b+d}{b}}{\binom{n}{a+b}}$$

The intensity of the dependence between the quantities is determined by means of the Cramer coefficient (V), see Formula (4) according to Friedrich, Hradecký, Michalcová & Pomp (2018) or Hendl, J. (2009):

$$V = \sqrt{\frac{\chi2}{n \cdot (m-1)}}$$

where m = min (r_1, r_2). The closer the value of the Cramer's coefficient is 1, the greater the dependence between the quantities. More in Anderson, Sweeney & Williams (2011), Mcclave, J. & Sincich, T. (2018) or Hendl, J. (2009).

3. Results

The questionnaire survey was attended by 81 students from the VSB - Technical University of Ostrava. The respondents were students of various bachelor's and follow-up programs. The questionnaire was entered between February and March 2021. 37 men and 44 women participated in the questionnaire survey, as shown in Table 1.

Table 1: What is your gender?

Gender	Frequency	Relative frequency (%)
Man	37	45,7
Woman	44	54,3

Source: own research

Table 2 shows students' answers to the question of whether they have already encountered and believed the Fake news report.

Table 2: Did you believe some report marked like Fake news?

	Frequency	Relative frequency (%)
Yes	46	56,8
No	35	43,2

Source: own research

Table 3 shows the students' answers to the question of whether they would welcome a seminar on Fake news.

Table 3: Would you like seminar about Fake News?

	Frequency	Relative frequency (%)
Yes	57	70,4
No	24	29,6

Source: own research

Table 4 shows students' answers to the question of whether they are aware of websites where Fake news can be verified.

Table 4: Do you know webpages for Fake News validation?

	Frequency	Relative frequency (%)
Yes	29	35,8
No	52	64,2

Source: own research

3.1. Testing the Relationship between Student´s Gender and Verifying Fake News

To determine the relationship between gender (Man and Woman) and the believed news called Fake news, the following hypotheses are established:

- H_0: Fake News verification does not depend on the gender of the students,

- H_A: Fake News verification depends on the gender of the students.

Table 5 shows the observed and expected count of the analysed quantities.

Table 5: Observed and Expected Count

Gender		Verifying Fake news		Total
		Yes	No	
Man	Observed count	25	12	37
	Expected count	21	16	
Woman	Observed count	21	23	44
	Expected count	25	19	
Total		46	35	81

Source: own research

All expected frequencies are greater than 5 (minimum value is 16), and therefore the assumptions of Pearson's chi-square test of independence are met. The test results can be seen in Table 6.

Table 6: Pearson Chi-Square and Fisher's Exact Test

Test	Value	P-value
Pearson Chi-Square	3,224	0,073
Fisher's Exact Test		0,114

Source: own research

The value of the test criterion for the χ^2 independence test is equal to 3.224 and the p-value is 0.773. Therefore, we do not reject the null hypothesis (significance level <p-value), which is confirmed by Fisher's exact test. Conclusion: Whether a student of a bachelor's or follow-up program at the VSB - Technical University of Ostrava believes the Fake News report does not matter the gender.

3.2. Testing the Relationship between Student´s Gender and Interest of Fake News Seminar

To determine the dependence between gender and interest in a lecture on Fake news, the following hypotheses are established:

- H0: interest in a lecture on Fake News does not depend on the gender of the students,
- HA: interest in a lecture on Fake News depends on the gender of the students.

Table 7 shows the observed and expected count of the analysed quantities.

Table 7: Observed and Expected Count

Gender		Interest of Fake News Seminar		Total
		Yes	No	
Man	Observed count	16	21	37
	Expected count	26	11	
Woman	Observed count	41	3	44
	Expected count	31	13	
Total		57	24	81

Source: own research

All expected frequencies are greater than 5 (minimum value is 11), and therefore the assumptions of the χ^2 independence test are met. The test results can be seen in Table 8.

Table 8: Pearson Chi-Square and Fisher's Exact Test

Test	Value	P-value

Test	Value	P-value
Pearson Chi-Square	24,040	0,001
Fisher's Exact Test		0,001

Source: own research

The value of the test criterion for Pearson's test of independence is 24.040 and the p-value is 0.001. For this reason, we reject the null hypothesis and accept the alternative hypothesis (significance level <p-value). This result is confirmed by Fisher's exact test. Conclusion of the test: The interest of Fake News seminar depends on the gender of the students at VSB - Technical University of Ostrava.

The Cramer's coefficient is 0.545, which means that the intensity of the detected dependence is medium.

3.3. Testing the Relationship between Student´s Gender and Awareness of Webpages for Fake News Validation

To determine the relationship between gender variables and awareness of websites to validate reports, the following hypotheses are established:

- H0: awareness of the Fake News website does not depend on the gender of the students,

- HA: awareness of the Fake News website depends on the gender of the students.

Table 9 shows the observed and expected count of the analysed quantities.

Table 9: Observed and Expected Count

Gender		Awareness of Fake News Websites		Total
		Yes	No	
Man	Observed count	23	14	37
	Expected count	13,2	23,8	
Woman	Observed count	6	38	44
	Expected count	15,8	28,2	
Total		29	52	81

Source: own research

All expected frequencies are greater than 5 (minimum value is 13.25), and therefore the assumptions of the $\chi2$ independence test are met. The test results can be seen in Table 10.

Table 10: Pearson Chi-Square and Fisher's Exact Test

Test	Value	P-value
Pearson Chi-Square	20,591	0
Fisher's Exact Test		0

Source: own research

The value of the test criterion for the $\chi2$ independence test is 20.591 and the p-value is 0. Therefore, we reject the null hypothesis and accept the alternative hypothesis (significance level <p-value). This result is confirmed by Fisher's exact test. Conclusion: Awareness of the Fake news website depends on the gender of students at VSB - Technical University of Ostrava.

The Cramer's coefficient is 0.504, which means that the intensity of the detected dependence is medium.

4. Conclusion and Discussion

The aim of the paper was to analyse Fake News among students of various disciplines and ages at VSB - Technical University of Ostrava, Faculty of Economics.

A total of 81 students took part in the questionnaire survey. The questionnaire was sent via the Google Forms application to students especially directly in teaching, which ensured a high return. The disadvantage of the questionnaire survey in the form of questionnaires was the impossibility to ask additional questions, or not all questions could be correctly understood by the respondents.

Testing of the dependence between the quantities was evaluated on the basis of Pearson's Chi-Square Test of Independence. The dependence between the gender of the students and whether the respondent ever believed a Fake News report turned out to be inconclusive. On the contrary, the dependence between the gender of the students and the interest on Fake News seminar and also on the awareness of the pages verifying the news, which could be misinformation, was proved. Using the Cramer's Coefficient, the found dependence of the mean intensity on both quantities was evaluated. So women are more interested in the Fake News seminar and Men are more interested in the pages verifying the news. Due to the fact, that the topic is very topical also with, regard to the current situation associated mainly with the Covid-19 epidemic, which is associated with a large number of Fake News and misinformation, the authors will address the topic in the future. Among other things, based on the results of a questionnaire survey, a Fake News seminar was arranged directly in the classroom.

5. Acknowledgement

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SOCIAL CONNECTEDNESS IN ONLINE ENVIRONMENT: LITERATURE REVIEW

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Social connectedness, social network, Facebook, Social Connectedness Index, literature review

Abstract

In the on-line environment, social connectedness is quite a new term. It is becoming very popular especially during last year as it is part of term used by social network Facebook, Social Connectedness Index. It is a measurement provided by the social network itself derived from data provided by it to public use. However, literature and research have been using these terms in different ways throughout the history. This study aims to create a systematic literature review of the usage of the term "social connectedness" and its relation to Facebook social network as it considers Social Connectedness Index to be one of the most important measures for predicting social behavior of people who use the social network. Most studies made on social connectedness do not use Social Connectedness Index and are oriented on health issues. There is a space for further research.

1. Introduction

Humans are social beings who require company of others. A huge meta-analysis by Pinquart and Sörensen (2000) also points to a very close relationship between an individual's self-assessment of life satisfaction and his or her overall social background. The number and quality of social relationships, evaluation within society and perceived belonging to a social group in their analysis prove to be frequent predicators of well-being. For their own good, people need other people.

The need and necessity of relationships is tied to people for life, and it is understandable that with the advent of technology and the Internet, people will use the technical achievements to connect with others. Social networks are places where this need is met. There are several differences between social media connections and reality connections. The most important differences are that they arise regardless of time and space. People can communicate with others in real time, even though they can be more than half a world away at the same time. This way they create big and small communities (Harris and McCabe, 2017). Big communities on-line are called social networks. The most famous social network is Facebook. It is place where people connect in several ways. They gather in interest groups, gather around liked pages, and "befriend" each other, creating friend circles around them. Data about these ties has been recently shared by Facebook company itself for research purposes on webpage dataforgood.fb.com. Anyone can download aggregated data consisting of information about social connections between people, for example in two regions of a country. Researchers started using Facebook's datasets to solve problems concerning Covid-19. (Kuchler & Stroebel, 2020)

In these datasets Facebook uses term "Social Connectedness Index" (SCI). Bailey, Cao., Kuchler, Stroebel, and Wong, A. (2018) created a procedure by which this metric is calculated. SCI expresses the rate of friendship links. This rate can then be calculated between geographical areas and used for various types of estimates of future development, whether it is the development of the economic situation or the spread of a dangerous virus. (Kuchler & Stroebel, 2020) (Bailey et al., 2021).

However, social connectedness is not a term used first time in this case. The term has been used in conjunction with the social network Facebook for some time, almost since the foundation of the social network (Schleyer et al., 2008). For a better understanding and the possibility of subsequent quality use of this term, it is necessary to create a literature review. This study aims to map current state of literature concerning social connectedness and determine fields of main aim of research of social connectedness on Facebook.

2. Methodology

This work uses the methodology of systematic literature review (SLR) and is inspired by the works of Kitchenham and Brereton (2008) as well as the SLR of Fintech by Suryono, Budi and Purwandari (2020). It is a commonly used methodology for analyzing and determining the state of the scientific field, especially in the field of information systems.

To search for articles and publications, it was first necessary to identify adequate citation databases and specialized full-text sources. The databases that best cover the issues of social networks and social connectedness were selected, as well as the traditional high-quality citation databases. The databases used are ACM Digital Library, EconLit, IEEE, SCOPUS, Web of Science, JSTOR and Science Direct. Subsequently, more specific queries were gradually used on these databases before reaching a sufficient scope and depth of research questions. At the same time, the current state of knowledge and research direction regarding the Social connectedness index was also considered and incorporated into queries.

Results obtained will be analyzed from thematic point of view and will be sorted by main focus of the articles and also sorted by geographical aspect of the article.

2.1. Research Questions

This study presents two following research question:

RQ1. How much research activity has there been concerning Social connectedness on social network Facebook?

RQ2. What are the fields of research using term social connectedness concerning Facebook?

3. Results

3.1. Search process

First, we tried to ascertain the total number of all articles concerning social connectedness as it is the fundamental term in our study. Simple "social connectedness" query was used as it would be adjusted in following search query. Second search query then consisted of the first keyword and second keyword used was "social network".

Table 1. Social connectedness queries and results

Database	Articles found in the first query	Articles found in the second query	Articles found in third query	Articles found in fourth query
Scopus	2058	269	49	10
ACM DL	69	5	5	0
Econlit	90	18	21	18
JSTOR	91	4	1	0
WoS	1835	111	70	17
Science Direct	406	79	17	4
IEEE	19	7	0	0

After we obtained these articles, we excluded some of them because they did not thematically fit into the field of studying social connectedness in conjunction with Facebook. At the same time, we used the third query, which contained the previous keywords together now in combination with the keywords Facebook, FB, Facebook.com. These keywords, along with the previous one, were searched in the main article information, Title, Abstract and Keywords. For our last shortening of list of references, we extracted just those which are actual. We have found out, that social network Facebook.com started to share aggregated data in August 2020. We have chosen this date as an important aspect and another criterion for selecting articles.

Social connectedness can be found in professional literature since 2008 in a total of 89 articles (Figure 2). However, the fields of these articles differ, so it was necessary to analyze the scientific fields where social connectedness is used. The most interesting milestones in the use of the term are years 2015 and 2020. 10 articles were created in 2015, which is significantly more than in the previous and the following year, and 19 articles were written in 2020, again significantly more than in the previous year. The reasons for both milestones will help us reveal the background of the research. aspects of the social network Facebook and how it affects its users.

3.2. Thematic analysis of the Articles Selected

In this chapter we make the analysis of 89 selected articles and their content. We will try to explain some facts we find out and present topics for discussion and the creation of new following articles.

3.2.1. Publication Per Year

Table 2. Social connectedness publications per years

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTAL
1	0	1	5	2	6	3	10	6	8	12	12	19	4	**89**

As it was mentioned before there are two significant years of article releases. In 2015, we record more articles than in other years, concretely 10 articles. Half of these articles have a thematic focus on health especially on the psychological analysis of well-being. We assume that this is a phenomenon of the time, as the book by Zimbardo and Coulombe (2015) also focuses on the same subject. Another milestone we find is 2020. 19 scientific articles were published that year and are mainly 2 areas of focus, Health and Sociology. Our original thesis was that the increased number of articles is based on the provision of data from Facebook last year. However, after a deeper analysis of these published articles, we came to the conclusion that it is not true as only 4 of these drew data from this dataset for their analysis (Kuchler & Stroebel, 2020) (Kuchler et al., 2020) (Bailey, Farrel, 2020) (Bailey, Johnston, 2020).

3.2.2. Classification by Methodology

We also analyzed methodology and research methods of selected articles. During analysis was found that most of the published articles dealt with archival data or data based on a questionnaire survey. Specifically, 90% of the articles used this type of methodology, 80 out of 89 articles. Of these 80 articles, 38 used archival data (from Facebook or similar data, eg from previous surveys) and 42 used data obtained from questionnaires and case studies. The remaining articles focused on methodology or creating new problem-solving procedures. Interesting are the articles on the Social Connectedness Index by Bailey et al. (2017) and Bailey et al. (2018), which establish methods of measurement and determinants of the index. An important finding is that none of the articles is a literature review.

3.2.3. Thematic unit analysis

Using Zotero software, all articles were enlisted into a database and analyzed. Subsequently classified according to this analysis into thematic units we chose. These units are Health, Sociology and Economy.

Table 3. Thematic unit analysis of fourth query

Thematic unit	Articles	Total
Health	Bova et al. (2021); Brown and Kuss (2020); Castillo de Mesa and Gómez Jacinto (2020); Cid et al. (2020); Clark and Moloney (2020); Dibb and Foster (2021). Hunsaker et al. (2020); Hwang et al. (2021); Kim and Zhu (2020); Kuchler et al. (2021); Sabik et al. (2020); Trevisan (2020); Yachin and Nimrod (2020);	13
Sociology	Bailey, Farrell (2020); Bailey, Johnston (2020); Bayer et al. (2020); Diemer and Regan (2020); Gavriilidis (2020); Ye and Zhang (2021)	6
Economy	Bailey et al. (2021); Ellison et al. (2020); Kuchler et al. (2020); Kuchler and Stroebel (2020).	4

3.2.4. Geographical unit analysis

We also did geographical analysis of articles as they focus on different parts of planet. We found out, that most of articles are oriented on USA as most of articles from thematic analysis are also oriented to USA (Mental and Well-being Health, Political in Sociology and Travel in Economy). Second most common was international study as Social Connectedness Index describes two geographical areas even internationally and it can be used for predictions made in this kind of scale.

Table 4 Geographical unit analysis

USA	International	England	Uruguay	Spain	Australia	China
12	4	3	1	1	1	1

4. Discussion

We answered both research questions, finding out how many articles and how much research there has been done in are of social connectedness and also we found out what are the thematic fields of study in this topic. Authors do not often use data provided by Facebook, to find connections between on-line relations and real life ones. Here we find a space for further research. This will be especially true in today's COVID-19 era and at a time when real life social connectedness has been relegated to the side for reasons of public safety. At the same time, we also find interesting that

most research focuses on health – trying to find a relationship between an individual's well-being and online social relationships, and the question is if such relationships can replace real ones.

5. Conclusion

The area of social connectedness, Social Connectedness Index is an area rich in the number of published articles. The proof can be 23 published articles in the last and current year (5 of them this year). The most active authors in this field are Michael Bailey and Theresa Kuchler, who have been producing articles in the last few years that focus directly on Facebook data. These authors are trend makers in this area and dominate in sociological and economical topics of research.

6. Acknowledgments

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FACEBOOK FRIENDSHIP IN REAL LIFE

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Keywords

Facebook, friends, friendship intensity

Abstract

The paper analyzes relationship between number of friends on Facebook and how deep are connections with these friends. In the autumn 2020 research with 471 respondents, focused on privacy issues was conducted in an environment of the Czech Republic. The answers were differentiated according to the age and gender of the respondents. The analysis further involved the comparison of the number of friends between men and women, among different age groups, and among a different type of connections gathering. The analysis has shown, that respondents have a different number of friends depending on the type of the connections gathering. However, it was not shown that the numbers of real friends differed. The analysis has shown that women have more real friends on Facebook than men. The main finding is that there are differences between the age groups, particularly in all the questions measuring the connection between respondent and friends. Young people would be expected to be in more contact with their friends via social networks and therefore will have the most Facebook friends, which is surprising is that the opposite is true - the older people are, the more Facebook friends they have.

1. Introduction

Social networks help to increase and support group interaction between users. Despite the expansion of new social networks such as Instagram and TikTok, the most popular network service in the world is Facebook (Pavlicek, 2015) (2.8 billion monthly active users in 12/2020 (Facebook, 2021)). For many people, the usage of Facebook has become part of daily routine. A significant positive association of active Facebook usage with subjective happiness and narcissism was researched and identified (Brailovskaia, 2019).

Not only for narcissistic individuals can be beneficial to have a large number of connections on social networks. Accessing Facebook via smartphones helped users to decrease loneliness and improve their levels of well-being (Ye, 2021). Positive social relations are known to have a beneficial impact on health. In the study (Carrapico, 2021) authors compare face-to-face and virtual friendship in their association with health. Two large-scale studies with more than 1 000 respondents showed that the number and quality of face-to-face friendships were directly associated with self-reported health status, however, the same did not occur with Facebook friendships (Lima, 2017).

The usage of social media in the last decades changed the way to make friends, exchange information, or find partners. People use networks not only for maintaining existing relationships but also for making new relationships or finding a job (Pavlicek, 2015).

Social networks and the number of links between users for example have a great influence on determining the results of elections on undecided voters – they tended to rank a fake news item shared by one of their Facebook friends as credible significantly more often than decided (Tal 2021). On the other hand, the study (Koller, 2018) examined whether users were more likely to accept the friendship of a "political colleague" than another party's supporter, and proved that the attractiveness of the profile was much more important than political affiliation.

A previous older study (Brandtzaeg, 2010) used in-depth interviews. They study, how younger and older users approach Facebook, what ties they have with their friends, and whether their behavior differs significantly. Among other things, it was found that all age groups display completely open public profiles without realizing it.

Until 2014, Facebook had the setting that all personal information, posts, photos, and other personal content were public by default. It was simple to change it for example to "Friends only", but the user had to think about it and set it up (Pavlicek, 2016).

It turns out that half of the users, for example, share their date of birth in the "Friends only" mode (Korcak, 2021). On the other hand, users confirm their friendship even to completely unknown people based on their "trusted" profile (Pavlicek, 2016). Special algorithms directly recommend suitable friends to users (Berkani, 2020). Personal data thus often begins to be shared with a number of unknown persons.

Balancing between the number of friends and the setting of privacy in the light of the possibilities or even the necessities that social networks give is becoming a fundamental question.

This research focuses on analyzing how users make friends on Facebook, how many they have, and how strong their ties with them are.

2. Methodology

We collected data during October and November 2020. It was a part of the big survey focused on social networks and privacy. Most respondents were from Prague University of Economics and Business (students were asked on their lectures), which we added with other respondents (application on Facebook, help students with finding respondents).

2.1. Survey questions

We analyzed the reasons, why users confirm friendship with other users on Facebook (Q_0). Is there anyone on your "friends list" on Facebook you don't know personally? If so, why? Possible answers were:

- A_1 – NO, I know all contacts from social networks and real life,
- A_2 – YES, sometimes I grant requests for friendship from people I only know from discussions,
- A_3 – YES, sometimes I actively ask for friendship from people I only know from discussions,
- A_4 – YES, sometimes I grant requests for friendship from completely unknown people (e.g. a common acquaintance),
- A_5 – YES, sometimes I even actively ask for the friendship of completely unknown people.

The other questions were, how many friends the users have:

- Q_1 – How many TOTAL contacts do you have in the "friends list" on Facebook?

- Q_2 – With how many contacts from the "friends list" on Facebook do you maintain CONTACT even in real life? (you see each other at least once a year)

- Q_3 – How many contacts from the "friends list" on Facebook do you consider to be TRUE FRIENDS (confide in a problem, ask for help, provide advice, etc.) – or they will contact you with a problem/request for non-trivial help on you?

- Q_4 – How many contacts from the "friends list" on Facebook would you LEND (or lend you) CZK 5,000?

All users are differentiated by gender and age. We had asked for the frequency of the usage of social networks such as Facebook, Instagram, and others.

2.2. Statistical analysis methodology

We have analyzed the number of friends on Facebook. In the Descriptive statistics section, there is basic information about the respondents and their answers in the survey.

In the results section, we compare the number of friends on Facebook among groups of users. We have tested these hypotheses:

- H_1: The man and woman have the same number of friends (against the alternative – the number of friends is different).

- H_2: The number of friends does not depend on the method in which the users make a connection with friends (against the alternative – at least one group has a different number of friends).

- H_3: The age groups have the same number of friends (against the alternative – the number of friends in at least one group is different).

All users are independent, we can use a t-test for H_1 and ANOVA for H_2 and H_3. All analyses are made in Excel using the Data Analysis tool.

Results are summarized in the form of tables and charts.

Facebook has a limit of up to 5,000 friends. Therefore, a record listing 6081 friends were excluded from the hypothesis testing, which was generally very special (in real life, it maintains contact with only 10 people from the friend's list). There were 10 users without an account and 3 of them have filled out a positive number of friends on Facebook, these records were excluded from the hypothesis testing too. We also considered 2 data to be untrustworthy since the data for Q_2 resp. Q_4 was higher than the value in Q_1.

3. Descriptive statistics

The survey was conducted among 471 respondents out of whom 227 were men and 244 were women. Most of them were from the Czech Republic (371 users). More than half of users (242) live in big cities (over 100 000 inhabitants), about one quarter are from middle cities (121) and the rst (app. one quarter) from small villages (108). Most respondents were students or college graduates (450 respondents). The largest number of respondents were young people (see Table 3). Most of the users are on Facebook at least once a day, 67% of them are non-stop online. About 40% of respondents have in the friends list only people, which they know from real-life (see Table 2). The preferred way to access social networks is a mobile device (see chart below):
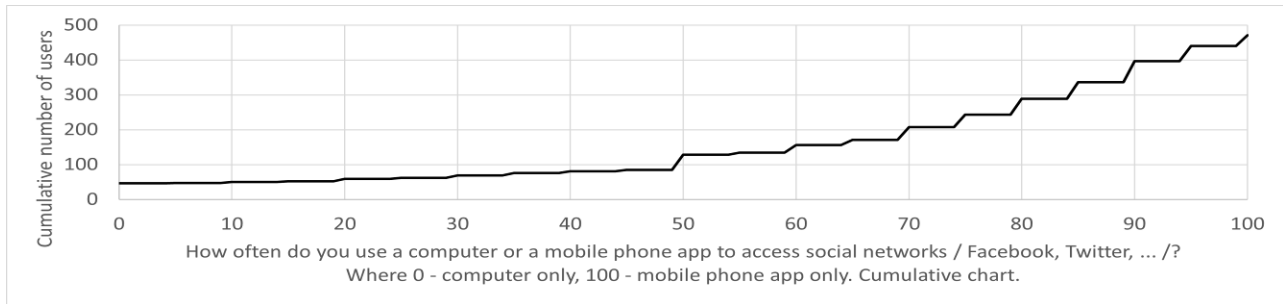
Figure 1 Preferred access to Facebook – desktop or mobile device

4. Results

4.1. Hypothesis H_1 testing (t-test)

The first tested hypothesis was: "The man and woman have the same number of friends (against the alternative – the number of friends is different)." Where the answers to question Q_1 to Q_4 were taken one after the other as the number of friends (4 independent tests). We have started with F-test for variances and then selected a two-sample t-test with or without equal variances depending on the result of the F-test.

Table 1 - t-test comparing number of friends between men and women

| | Mean | | F-test variances | | T (crit. val. 1.96) | p-value | Rejection |
	Men	women	p-value	equal var?			
Q_1	303	302	0.022	No	0.049	0.96	No
Q_2	91	91	0.47	Yes	0.035	0.97	No
Q_3	15	21	0	No	-2.75	0.003	Yes
Q_4	11	13	0	No	-1.41	0.16	No
N	224	241					

They have detected no significant differences between men and women in questions Q_1 and Q_2 at the significance level of 5 %. We cannot reject the hypothesis about the same number of friends to which we would lend money too, although there is already p=0.16. But what we can reject certainly is that women have the same number of real friends in their Facebook friends.

4.2. Hypothesis H_2 testing (ANOVA)

The next hypothesis was: "The number of friends does not depend on the method in which the users make a connection with friends (against the alternative – the number of friends in at least one group is different)." Answers were taken one after the other similar to H1. We have used the ANOVA test.

Table 2 - ANOVA comparing the number of friends depending of the method of making connections with

	Mean					F	p-value	Rejection
	A_1	A_2	A_3	A_4	A_5			
Q_1	250	335	378	324	274	3.07	0.016	Yes
Q_2	98	87	99	82	44	0.65	0.629	No
Q_3	19	17	22	17	7	0.72	0.581	No
Q_4	14	11	16	10	10	1.38	0.239	No
N	181	173	33	73	5			

No significant differences were detected between the mean values of the number of contacts involving different types of friendships (A_1-A_5) at the significance level of 5 % in most cases. An exception is TOTAL contacts on the friends' list which is significant. At least one mean is statistically distant therein; this is probably due to low values for A_1 and A_5.

4.3. **Hypothesis H_3 testing (ANOVA)**

The last hypothesis was: "The age groups have the same number of friends (against the alternative – the number of friends in at least one group is different)." Testing was similar to H_2.

Table 3 - ANOVA comparing the number of friends depending on the age group

	Mean			F	p-value	rejection
	less 20	20-29	30+			
Q_1	267	310	414	10.18	$4 \cdot 10^{-5}$	Yes
Q_2	83	77	130	7.58	0.0006	Yes
Q_3	16	15	26	6.16	0.0023	Yes
Q_4	9.5	9.6	23.5	23	$3 \cdot 10^{-10}$	Yes
N	292	84	89			

We can see that there are significant differences in at least one age group in all questions. As a result, we can say that number of Facebook friends depends on age (at the significance level of 5 %) at all issues examined.

5. Conclusion and discussion

The paper dealt with a survey of the approach of respondents, primarily students, who have written how many friends on Facebook they have and how exactly are they connected. Although a lot of people share their private data with friends on Facebook, some users have also unknown people in their friend lists.

Although the general opinion is that women use less communication technology than men, we have shown that women have among Facebook friends more real friends than men. It has been shown that there are differences between the number of Facebook friends depending on the style of friends gathering, but then there are no significant differences between the number of real friends between them.

We have found that there are big differences between the number of friends, the number of real friends, and the number of friends to whom the respondents are willing to lend money if we take age groups. What was very surprising was, that although those who "grow up with social networks" are young people, the highest number of friends on Facebook have older people. And that is in all types of friendships – only Facebook friendship and real friends in Facebook friends, the number of

friends they are willing to lend money to. So it turns out that if we talk about friendships on Facebook, it is necessary to take into account the older generation too. They may have encountered social networks only in adulthood, but builds networks of friends there no less.

6. Acknowledgments

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PROCESSING GOOGLE ANALYTICS DATA FOR A SMALL ACCOMMODATION ENTERPRISE

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Keywords

Google Analytics, small accommodation establishment, correspondence analysis, clustering

Abstract

In this study, different aspects and fundamental trends of web page promotion are methodologically analysed for a small accommodation and recreational facility in Podhájska (Slovakia). Using Google Analytics (GA) data, we have especially concentrated on different attributes of visitors (users) covering various parts of the web. The virtual reality 3D tour and classic elements of photo galleries form an example. Two techniques of multivariate analysis have been applied, i.e. multiple correspondence and cluster analyses. Such current data processing reveals the average behaviour of potential customers and can serve to continuously update websites for targeted groups of visitors. Although Slovaks are more inclined to use traditional technologies, the demand for more advanced web presentation is apparent. Moreover, a comparison of previous year provides a background for examining the genesis of individual characteristics during the time of pandemic.

1. General

Web analytics services capture a variety of data that allows website owners to gather statistics about their users. To track visitors, almost 50% of websites use GA, ranking it currently as the most

widely used tool in this branch worldwide (Brunec, 2017). Based on the JavaScript run, it is possible to track various activities such as current and historical number of visits (sessions), user behaviour and their properties, page per visit, bounce rate, conversions, and to use custom visitor segmentation (Weber, 2015; Semerádová and Weinlich, 2020; Novak and Pavlicek, 2021). According to Križanová et al. (2019), the geographical position, browser, operating system, screen resolution and device with individual models is just a selection of other options. In a vast majority of cases, GA data can be considered appropriate for analysing trends and average consumer behaviour. However, Alhlou, Asif and Fettman (2016) demonstrate bits and spiders make up a significant portion of the data, inflating pageview counts. Bots covering advertising (e.g. cost per thousand impressions) sometimes represent one-third of the website's activity. Filtering with updated IAB/ABC International Spiders & Bots list is the one instrument that can improve the apparent visits. When analysed correctly, the information represents an actual treasure trove for the website operator, which can be effectively used to increase their performance and profits. This study concentrated examination the different parts of a web page for a small accommodation establishment in relation to the structure and properties of individual visitors.

Web analytics and social media are examined using a wide range of mathematical, statistical, or econometric techniques (Ayanso and Lertwachara, 2014 Pavlicek and Syrovatkova, 2020, Pavlicek and Doucek 2015). Unsupervised techniques cover descriptive statistics, distribution approximations, dimension reduction and cluster analyses. Supervised learning techniques are directed, e.g. towards regression, approaches using conditional probabilities, and mathematical programming. Correspondence analysis (Botha and Mills, 2012; Križanová et al., 2019) and clustering approach (Iacobucci et al., 2019) are the methods of choice. The typical applications of GA tools in tourism and accommodation sector are demonstrated by Dinis, Costa and Pacheco (2016) or Croes et al. (2017). Despite the methods used in this study are generally applied in social media, their usage is rare covering accommodation facilities.

2. Data used and methods

This study focuses on a sample family accommodation and recreational facility in the village of Podhájska, Slovakia. The region is known for its thermal spring of strong mineral water drilled at a depth of 1900 meters. It is one of the most popular villages in Slovakia offering year-round recreation, but especially medical stays. Visitors there have a choice of more than 100 different establishments, including guesthouses, private homes, cottages, apartments, a campsite, and a hotel. Currently, 56 (68.3%) accommodation facilities in Podhájska have their own websites, but only five (6.1%) out of a total of 82 offer a virtual tour. A classic cottage reconstructed in the historic regional style, located about 600 m from the thermal spring, is the target here. Main website consists of the links to photo gallery, 3D tour and other fundamental information, clearly visible and simply accessible. Only the certain parts are analysed, i.e. categories 3D tour – 3D, exterior of the gallery – GALLERY_ext, gallery interior – GALLERY_int, general information – ABOUT, and price list – PRICE. Its proposed 3D tour offers of 11 spherical photographs. Here, viewing the price list can be perceived as interest in a stay. The next variable is the location, for the capital or city or non-specified – ns. With regards to the current literature (Brunec, 2017), this assignment is only an approximative. However, we consider ns category as mostly covering rural areas in the following. Origin variable covers Slovakia – SK, the Czech Republic – CZ, and the United States – US. The device variable distinguishes between desktop, tablet and mobile. But the desktop category of computers covers laptops in this study as well. Different types of browsers are also examined. They are analysed separately, and the most represented desktop is incorporated here in detail.

We use the selected GA outputs for further statistical processing after going through the requisite data editing steps. Note that Crawler Referral and Ghost spams are eliminated using various filters

as for the hostname. But additional filters are also used for screen resolution, the browser, operating system, etc. There are plenty of definitions for the multiple correspondence analysis (Husson and Pagès, 2010; Greenacre, 1993), but the one used here is based on the eigenvalue (or singular value) decomposition of the indicator matrix. We apply the charts of eigenvalues with the representation based on the correspondence maps. But due to issues with involvement of the dimensions, the interpretation must be based on an expert evaluation (Hervé and Valentin, 2007). Note generally, the conclusions are confirmed by the results of the k-dimensional tables. We encompass countries with more than 15 visits and browsers exceeding 10 usages. Contrary to the page views, individual visits, forming observations of our data matrix, cover the interaction on the page as multiple page views. Since the presentation of variables in a two-dimensional space is limited, we express the outputs of the clustering technique for all original data. Agglomerative hierarchical clustering is applied for a small cluster case using the method of K-means (Chavent et al., 2012).

We use R software (R Core Team, 2019) in this study with several packages such as FactoMineR, factoextra and ClustOfVar.

3. Results

A sharp decrease of eigenvalues is registered after the first dimension in 2020. However, an obvious elbow occurs in both cases covering charts of eigenvalues. In 2019, 16.2% and 15.0% are the corresponding proportions, while 28.3% and 13.8% are for 2020, respectively. The lower values are typical for correspondence analysis outputs due to gathering a more general class of relationships than linear (Husson and Pagès, 2010). The significant categories can be seen from interpretation of Figure 1. Due to only a small occurrence of the tablet category in 2020, this is excluded from the analysis. The main area of interest in 2019 is directed towards various gallery pages, i.e. GALLERY_int and GALLERY_ext, and the about page is also strongly represented (see Table 1). But the situation in 2020 is distant as frequencies are more equally distributed. The increase for 3D and price is visible, while interior of gallery is dropping. So, there has been a change in customer behaviour towards more advanced technologies of accommodation presentation, as well as real interest in a stay.
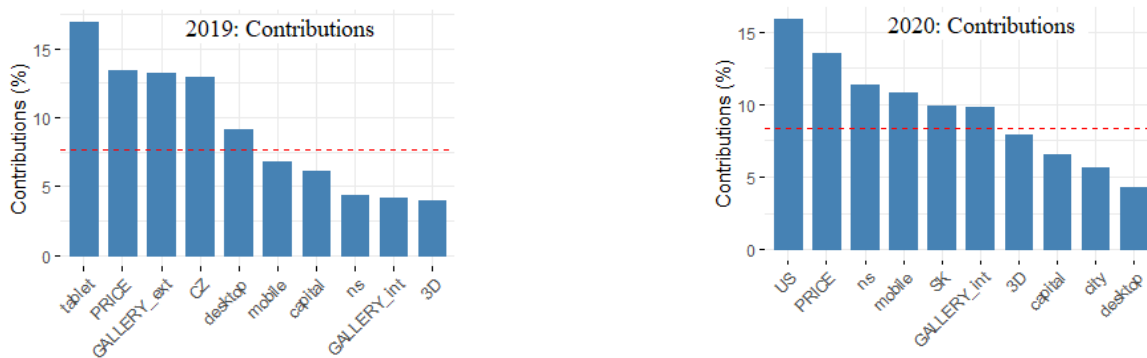
Figure 1. Representation of individual categories; Source: authors

Table 1. Expression of individual frequencies

2019: Summary table				2020: Summary table			
PAGE	Significance	Country	Device	PAGE	Significance	Country	Device
3D: 11	capital: 96	CZ: 32	desktop:	3D: 35	capital: 44	SK:	desktop:
ABOUT: 48	city: 69	SK:	mobile:	ABOUT: 39	city: 128	US: 75	mobile:
GALLERY_ext:	ns: 38		tablet: 19	GALLERY_ext:	ns: 24		
GALLERY_int:				GALLERY_int:			

| PRICE: 29 | | | | PRICE: 44 | | | |

Covering Figure 2, the page and device variables are the most related in 2019, which support the correspondence maps. For the first dimension, the price page is the most searched via tablet, especially for Czechs. Second dimension separates 3D from price and exterior of gallery. The 3D variable tends to be more searched via desktop computers, while exterior of gallery and price by mobile. We descriptively examine data in the link to different internet browsers for both years. Not supported graphically, the dendrogram for desktop computers in 2019 shows the page is the most connected to browser. Because Czech visitors are tied to tablet device, the situation here is different from the total behaviour. The 3D variable is significant, while strongly and positively related only to Czech visitors for the first dimension. The opposite connection of 3D and price again is evident. Distant to Firefox and Explorer, Chrome is used by Slovaks for exterior of gallery and about.
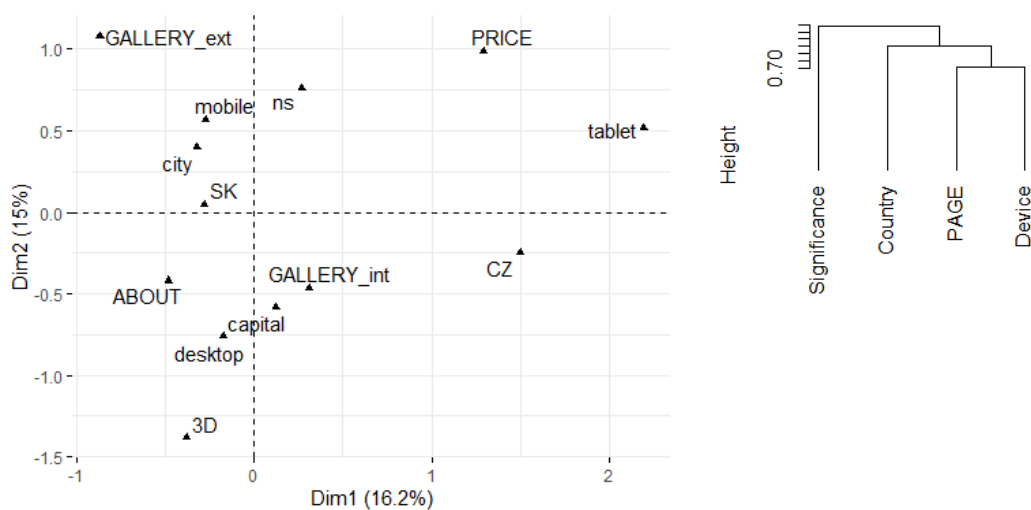
Figure 2. 2019: Correspondence map on the left and dendrogram right; Source: authors

For Figure 3, the page and country variables are the most related in 2020. There are strongly separated galleries from the rest of the pages, covering the first dimension of representation. Galleries are typically visited by Slovaks from the capital or rural areas using a mobile. On the other hand, the rest of the pages are visited by Americans with desktops. Second dimension separates price from interior of gallery and 3D. Due to visitor structure, Slovaks are concentrated on traditional internet services by providing photo previews. On the other hand, Americans prefer modern technologies and what is interesting, is their more positive connection to price. While 3D is distant from price in 2019, both are more related for 2020. Without graphical expression, the page is most connected to country covering desktop device, similarly to the whole data extent. Due to the prevalent occurrence of desktops in 2020, this in a certain sense imitates the results for all devices. Rural areas are ranged high in both dimensions, although strongly opposed to 3D pages. Slovaks are almost exclusively oriented on galleries using the Chrome browser, while Americans are oriented more on price, about and 3D pages using Firefox.
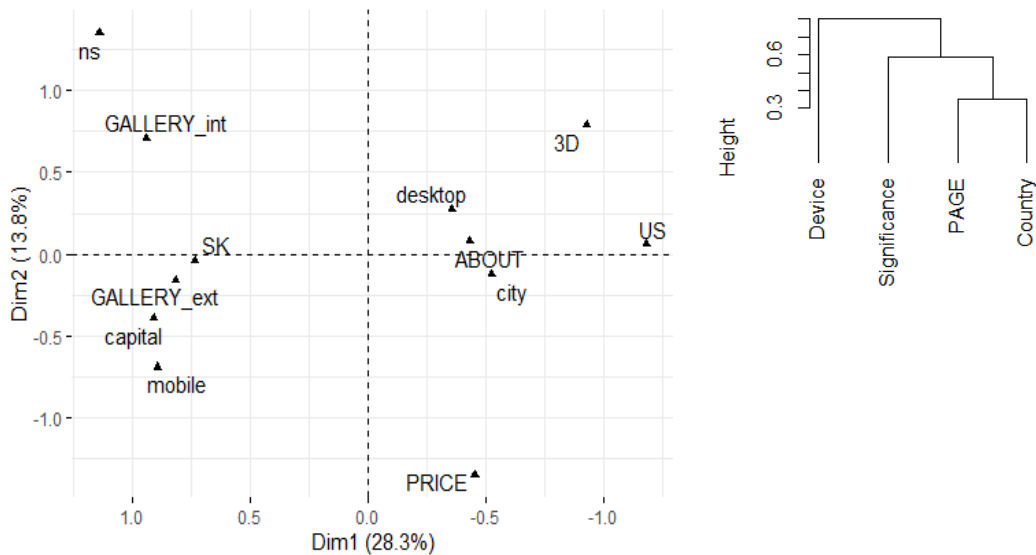
Figure 3. 2020: Correspondence map on the left and dendrogram right; Source: authors

4. Conclusion

Given that the results are tied to a specific establishment covering GA data, the study can be especially perceived in a methodological sense. Both multiple correspondence and cluster analyses prove their usefulness with many practical outputs, leading accommodation operators to potentially higher profits and better customer targeting. Compared to the previous year, 2020 recorded a step towards more advanced technologies of presentation. This can be partially due to a specific group of visitors in 2020 being from the US, as Slovaks prefer traditional technologies providing a photo preview accessed mainly by mobile device. Generally, foreigners prefer a 3D preview using desktops. Hits on price list can be roughly perceived as real interest in a stay, where its opposite relation to 3D in 2019 decreases in the following year. It is interesting to see, that Slovaks preferred using Chrome for both years, while the sample of Americans applied Firefox. Czech visitors were concerned to price pages using a tablet in 2019.

5. Acknowledgement

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ALTRUISM AND PERSONAL INFORMATION DISCLOSURE ON SOCIAL NETWORKS

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Abstract

The paper investigates the role of altruism in personal information disclosure on social networks and its motivations. In the literature two contradictory motivation of altruism can be found, the egoistic and the empathy – altruism hypothesis. The role of these two motives is researched and also the effect of altruistic values on personal information disclosure on social networks. The results support both types of altruistic motives and prove that altruism is a reason for information sharing.

Keywords

Altruism, personal information, egoism, empathy altruism hypothesis, information sharing

1. Social media and information sharing

The social media are very popular and a lot of content (text messages, photographs, audio and video sequences) has been shared on them. A lot of content contains personal sensitive information and is used for various purposes including the unethical (Novák & Pavlíček, 2021). The reason for its disclosure consists in both altruistic and selfish motives.

Carr & Hayes (2015) define social media as internet-based channels that allow users to interact with each other and enjoy the user-generated content. The user-generated content requires disclosure of the person and his personal information. Sharing information and details about the person, e.g. photos of one's birthday party or picture of everyday activities with a funny comment supports interpersonal relationships. During the pandemic the opportunities to meet and discuss things in the real environment were limited and that may have increased the online disclosures of sensitive information like the health status, preventing measures etc. to compensate for the lack of real meetings. Grover, Cheung and Thatcher (2020) think that the pandemic has changed the self-focus of sharing private information to other-focus, and in considering the costs and benefits of privacy disclosure for oneself the privacy calculus oriented to others must be considered, too.

2. Information disclosure and altruism

Self-disclosure means that some information about the self is communicated to another person. The prevalent explanation of the self-disclosure behaviour consists in the privacy calculus theory (Culnan & Armstrong, 1999). This explanation compares the costs and benefits related to self-

disclosure. The costs include privacy risks like private data collection, processing, storing, combining, loss of anonymity which may lead to manipulation, blackmailing, unwanted attention or simple disturbance and waste of time. Benefits include higher popularity, more influence, building a relationship or from the media where the information is disclosed more relevant advertising content or some discounts or additional services. Social media may support sharing and disclosing personal information because it leads to their higher attractivity for users and they have more information on their users that may be used for advertising purposes.

Especially in social media we may add another level of user's motivation of information sharing that follows from the necessity to consider or control the impression the audience has (Kramer & Haferkamp, 2011). To control it, users must manage how the audience perceives their information and requires them to empathize or to some extent identify with their audience. In our view that is just a sign of a more relevant ability to understand other beings and to behave altruistically. During the pandemic, this tendency has been increased by the restrictions and emergency. People were much more influenced by the content they perceived in the social media and other online resources and that induced those sharing the content to consider the reactions of the audience more. However, we mustn't forget that people are social beings not only during the pandemic and they are able to empathise with other all the times. That is why we increased the content of the privacy calculus and included the altruistic motives as well. In our current research we would like to find out to what extent people follow the altruistic motives when sharing their personal information on social networks and what its motives are.

3. Motivation of altruistic behaviour

People in general spend a lot of time helping others, be it our friends, children, partners or unknown people in need. That raises the question of motives. One position may say that we do these things for others from egoistic motives. We are egoists and do everything to benefit ourselves. For social psychologists this egoistic motive was incontestable till the 1960s. Egoism benefits others as a means to benefit ourselves. The ultimate goal is self benefit, the motivation is egoistic. The self benefits may include a) material, social benefits or self-rewards, b) avoidance of material, social or self-punishment and c) reduction of aversive arousal evoked by seeing other people in need. In this context the mood enhancement, empathic joy and escaping one's distress are worth mentioning, as they are part of the warm-glow effect.

Mood enhancement can be a reason for helping according to Cialdini (1973). He proposed in his negative-state relief model that we tend to help someone when we have a bad mood because it will improve our mood and feeling. He found out that people who had harmed someone or had seen somebody harmed were more likely to volunteer. In addition to that helping provides a rewarding feeling to people with who feel good, too. Empathic joy is the feeling of pleasure when one sees somebody in need experience relief.

There is also another option explaining the helping behaviour. It is possible that the welfare and wellbeing of another person is the ultimate goal of someone. To refuse on possible objection it is necessary to say that the argument that the person motivated by another's wellbeing will be pleased by achieving this desired goal does not support hedonism because hedonism states that man always strives for personal pleasure. In the altruistic case, pleasure is the consequence of altruistic behaviour; to benefit another still remains the ultimate goal. Hedonists claim that helping other is just an instrumental goal leading to the self-serving goal. Altruists reply that the fact that self-benefits follow from helping others does not show that self-benefits were the ultimate goal. The motivation may remain altruistic. Altruists care about others as an end in itself, not to avoid unpleasant feelings or distress.

The frequent source of altruistic motivation has been empathy, sympathy, compassion or tenderness (Batson, 1987). Altruists perceive and understand the welfare of others. Batson proposed the empathy-altruism hypothesis according to which empathy is the source of motivation for benefiting others, i.e. for altruism. The empathy-altruism hypothesis does not rule out the self-benefits as unintended consequences of the helping behaviour, but the ultimate goal still remains the reduction of other's misery (Batson, 2003).

4. Research

That is why we decided to verify the validity of the extended privacy calculus and the motives of altruism on the students from the University of Economics and Business in Prague. As there are different views on the motivation for altruism, we hope that the empathy altruism hypothesis reflects reality. The second investigated option was the warm glow motivation for altruism.

The second aim of our paper consisted in researching altruistic motives of personal information disclosure and the type of information influenced by the altruistic behaviour.

Isen (1970) found out that helper's positive state or elimination of the negative state determines helpfulness and introduced the warm glow to describe the emotional experience. So warm glow may increase the prosocial behaviour. Warm glow can be operationalized as an emotional state that is related to helping. Hartmann et al. (2017) defined warm glow as a presence of reward (feeling happy, pleased, content). We added the elimination of negative state to include all aspects of feelings. The aspect of intrinsic emotional reward remains and covers wider spectrum of emotional response. Some authors question pure altruism and propose warm glow as an alternative egoistic motive for altruistic behaviour (Andreoni, 1989), (Kahneman and Knetsch, 1992).

We measured warm glow as an emotional construct of pleasure feeling and avoidance of negative feeling in accordance with Hartmann (2017). We had to be more specific than the general emotional scales and related the positive emotions to providing personal information on the social networks.

The other hypothesis we were investigating concerned the role of empathy as a motive and explanation of prosocial altruistic behaviour. Development psychologists stress the role of empathy for moral development of children (Esenberg, 2002), (Hoffman, 2000). All the research shows empathy is important in the development of prosocial and altruistic behaviour. Similarly to warm glow, we specified the altruistic motives to include providing of personal information on social networks.

The limitations of our research consist in the fact that the difference between real life and self reporting is great. The feeling of empathy may occur before the helping takes place. Other factors than empathy may have a great influence, too. Internal and external norms of obligation determine altruistic and helping behaviour in general. (Einolf, 2007).

We prepared a questionnaire online and asked students in the period 12.-30.4. 2021 to fill it in. We used the 5-point Likert scale in the answers with 1 meaning definitely yes and 5 definitely no. We collected 87 respondents, 33% females, 67% males aged 19-27 years.

4.1. Empathy

Table 1: Empathy aspects

Question	M	SD
I empathise with people who are less fortunate than me. (EM1)	1,78	0,74
I mind if people around me are having problems (EM2)	2,14	1,09
Things that happen around me affect me a lot. (EM3)	2,03	0,9

The results show that students are quite empathic; the mean answer is in all three types of questions around the point two of the Likert scale.

4.2. Warm glow

Table 2: Warm glow aspects

Question	M	SD
I feel happy when I make somebody's work easier. (WG1)	1,49	0,73
When I help others to solve a problem I have a pleasant feeling (WG2)	1,21	0,55
I feel contented when I make somebody happy. (WG3)	1,2	0,4
I get rid of an unpleasant feeling when I help somebody in need. (WG4)	2,04	1,09

The warm glow is also very frequently connected with helping behaviour. All values except getting rid of unpleasant feeling are below the point 1,5. Only the motivation by getting rid of an unpleasant feeling is lower. Students are more motivated by the positive feelings related to altruism.

4.3. Altruistic values

Table 3: Altruistic values – Bringing benefit

Question How important is for you:	M	SD
Help your friends on social network by disclosing your personal information (AV1)	2,79	1,08
Make your friends on social network happy by disclosing your personal information (AV2)	3,67	1,1
Make your friends on social network some work easier by disclosing your personal information (AV3)	3,34	1,14

As for the altruistic values, in this case bringing some benefits to other people, the average values show that students to some extent disclose their personal information to benefit their friends on the social networks, but the importance is in middle between importance and unimportance. Surprisingly the least average value has making friends happy and the highest value has helping friends.

Table 4: Altruistic values –Avoiding harm

Question How important is for you:	M	SD
Not sharing personal information on the social networks that would confuse your friends (AV4)	2,18	1,08
Not sharing personal information on the social networks that would make life of your friends more complicated (AV5)	1,93	1,09
Not sharing personal information on the social networks that would worsen mood of your friends (AV6)	2,15	1,13

The importance of not disclosing personal information not to harm friends on the social networks is more important to students. Thus, not harming their friends is more important for them than benefiting.

Table 5: Information shared on social networks

Question Do you share on the social networks true	M	SD
Sensitive information (photographs, ideas, feelings, emotions, experiences, fears) (IS1)	3,11	1,19
Factual information (surname, date of birth, address, occupation) (IS2)	3,13	1,19
Basic information (name, email) (IS3)	2,65	1,31

These results are not surprising, students share their basic information the most, followed by sensitive and factual information that are shared less, we may say this information is not shared so often.

The Cronbach's alpha of both types of the altruistic values together is 0,861 which shows high internal consistency of the values.

Table 6: Correlations between empathy, warm glow and altruism

	EM1	EM2	EM3	WG1	WG2	WG3	WG4
AV1 r_s; P	0,11; 0,31	**0,26; 0,02**	**0,39; 0**	**0,33; 0,002**	0,11; 0,31	-0,02; 0,88	**0,32; 0**
AV2 r_s; P	-0,04; 0,7	0,08; 0,49	**0,22; 0,04**	**0,21; 0,05**	**0,32; 0**	-0,09; 0,42	**0,48; 0**
AV3 r_s; P	0,05; 0,66	0,112; 0,3	**0,22 0,04**	**0,25; 0,02**	**0,35; 0**	-0,11; 0,33	**0,35; 0**
AV4 r_s; P	0,04; 0,97	0,18; 0,11	0,1; 0,38	-0,26; 0,81	**-0,22; 0,04**	0,12; 0,27	**0,31; 0**
AV5 r_s; P	0,06; 0,57	0,09; 0,42	0,16; 0,13	0,1; 0,35	**0,22; 0,04**	-0,02; 0,87	**0,25; 0,02**
AV6 r_s; P	0,09; 0,4	0,08; 0,49	0,14; 0,2	-0,01; 0,93	0,02; 0,88	0,03; 0,78	**0,4; 0**

From this table we may conclude that warm glow is more related altruism than empathy, but empathy can't be excluded as a motive of altruistic behaviour. Especially students that are affected by things that happen around them evaluate altruism positively. As for the motivation by warm glow, we may stress the role of negative feeling avoidance. That is correlated with all altruistic values. We can support both the egoistic motivation and the empathy-altruism hypothesis. More detailed and more specific research would be necessary to come to conclusions that are more precise.

5. Conclusion

The results of our survey were not unanimous, but that is not surprising in the case of social research. People differ a lot. We found out that both warm glow and empathy play a role in students' altruism and disclosure of personal information, the warm glow is a stronger motivation, but we can't exclude altruism. Altruistic motives affect disclosure and sharing of sensitive personal information the most, other types of personal information are not so relevant in the altruistic context.

6. Acknowledgement

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ATTITUDE OF CZECH INFLUENCERS TOWARDS DISINFORMATION

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Keywords

Fake news, Ethics, Motivation, YouTubers

Abstract

Covid-19 pandemic has shown an incredibly high amount of disinformation content. This study focuses on finding out what attitude towards that several of the Czech youtube influencers have and on their reasoning. Seven in-depth interviews with Youtube influencers were conducted and analyzed in MAXQDA PRO software. The results show mainly the interest in possible opportunities to monetize the content. For some, it meant spreading the disinformation without checking sources (intentionally); for others checking the sources and debunking it, however, for consubstantial reasons. The problem of motivation for creating the content emerges in the discussion. The rationalization that "everybody does it this way" and that "we need to cover the cost" is not reassuring either as they are role models and trendsetters to the Millennials. The number of videos that are consumed by millennials is prodigious. Using the reasoning of the monetization behind the decision for fact-checking is basically unethical.

1. Introduction

The purpose of this research is to find out how content makers work with disinformation when creating YouTube videos on scientific topics. The pilot presented on IDIMT conference in 2019 (Procházka, 2019) showed that there are severe laps in checking the sources when creating the youtube content, and the "Full story" enlarged the sample and on IDIMT 2020 presented the extended view on the subject (Procházka, 2020). This platform counts over 2.3 billion of users in January 2021 (Global social media ranking 2021 Statista). And it only counts those users who log into the site at least once per month, i.e. the number of For several years it has been in the Top 3 of the most visited websites in the world. Additionally, YouTube is considered nowadays as a learning and educational tool for the engagement of the Web 2.0 generation (Burke and Snyder, 2008) and it influences the behavior of the viewers, especially children and young adults. However, the platform has no regulations regarding the validity, reliability, generally quality of content. According to YouTube "*Terms of Service,*" as a YouTube account holder, you should "*understand and agree that you are solely responsible for your Content and the consequences of posting or publishing it*" ("*Terms of Service - YouTube*"). Therefore, the responsibility for incorrect and misleading information is held solely by content makers. The need for the project is quite important these days as YouTube strives to become even more popular as a new platform of knowledge (Glavas, Mathews, & Russell-Bennett, 2019) and during the pandemic the disinformation has triggered the surge of fake news and disbelieve.

Knowledge from this research could be used, for example, by marketing departments working with influencers, if they need to work with a creator with a high degree of integrity and expertise. Taking

into account the results of this research, for example, secondary and primary schools could decide whether it is appropriate to include videos of scientific YouTubers as a supplement to teaching. The findings can also serve as a basis for further research into this phenomenon. Pilot of the study was presented and published in IDIMT 2019 proceedings and the "full story" was published in IDIMT 2020 proceedings. Using the snowball method, the sample was enlarged and focused on the disinformation and how the content is checked for it and why during the COVID – 19 pandemic.

2. Theoretical Background

Youtube platform counted over 2.3 billion of users in January 2021, it is the second most popular social media platform, second most popular search engine after Google, and over 1 billion hours of videos is watched by users every day (Global social media ranking 2021, Statista). Social media trends in the selection of research design, data collection techniques, and analytic approaches are not well known (Snelson, 2016). Starnawska, M., Procházka, D. A., & Dvouletý, O. (2019) mention the disparities in the strategies and results of different earning group. This could be affected strongly using Youtube. About 62% of all companies in the US use Youtube platform to create the video that is connected to their business (Global social media ranking 2021, Statista). All observed articles are showing the 3rd party point of view, either a viewer's opinion or an expert's assessment. Some of them focus on security point of view (Pavlíček, Doucek et al., 2015) The point of Czech and Slovak YouTubers is covered as well. Instead of watching television, the trend of watching online videos is growing (Pereira, Fillol, and Moura, 2019). Youtube videos are discussed in several papers (Noruzi, 2017; Xiao, Wang, and Chan-Olmsted, 2018) in terms of their suitability for citation in academic papers as they are becoming increasingly popular as a source of information (Kim, Yoo-Lee & Sin, 2011). Recently, citation standards for this type of resource have even been introduced (Noruzi, 2017). Studies show that young people, in particular, consider social media as a relevant source of information (Pereira et al., 2019; Xiao et al., 2018). School-age viewers are the largest group on Youtube (Blattberg, 2015). According to several questionnaire surveys, this target group considers YouTubers as their role models (Aran-Ramspott et al., 2018), but also sees them as trustworthy, but they are still primarily seen as a source of entertainment. Despite the characteristics of the new media, YouTubers use similar credentials to traditional media (Barden, 2018; Xiao et al., 2018). The word influencer is very often mentioned in scholarly texts - a person who can influence his viewer in some way, whether it be his views on social or political topics or his buying behavior (Aran-Ramspot et al., 2018). So if we perceive scientific YouTubers as influencers, they act as a certain authority that their audience follows and trusts. Therefore, it is important to find out if the information provided by YouTubers is true, and with what sensitivity and how the sources of information are used by scientific YouTubers. Although professional videos on Youtube are more numerous, amateur non-fiction channels enjoy higher popularity (Welbourne and Grant, 2015). The most popular researchers are life-style artists or entertainers (Aran-Ramspott et al., 2018). Therefore, the scientific side of Youtube is relatively neglected. Mostly, the research studies on downright scientific YouTubers quantitatively analyze the final output of scientific YouTubers - what formats they use to persuade, what is the link between followers and YouTuber (Welbourne and Grant, 2015; Martins-Flores and Muniz de Medeiros, 2018) or what narrative techniques are most commonly found in videos (Morcillo, Czurda, and Robertson-von Troth, 2016). These studies found that although the creators of these videos are amateurs, their output is characterized by a high degree of sophistication, which is contrary to the general notion that Youtube content is unprofessional (Friedrich, 2017). Qualitative research is relatively neglected in this topic. Ellis-Hervey and Alston (2015), while qualitatively dealing with non-formal education videos on Youtube, are more about focusing on education about "*practical skills*" and not strictly scientific disciplines such as biology or physics. In the context of the Czech Republic and Slovakia.

According to Sudzina and Pavlicek (2020) YouTubers are mostly engaged in popular media focused on youth. However, domestic scientific YouTubers are still a relatively unexplored phenomenon. Consequently, the research aims to answer the following research question: How do scientific YouTubers check for disinformation? The emphasis is put on the side of content makers (YouTubers) to fill in the research gap.

3. Research Methods

The research methods part stays mostly very similar to the both previously mentioned qualitative studies that have been done during the previous two years. Due to this fact, part of literature review and the methodology of this research paper remain the quite similar to the previous two papers as, logically, there research activities are connected and share the similar basic knowledge and approach to coordinate in the more robust research paper to be published. I took into the consideration that the conference paper is to be discussed and afterwards the outcomes of these three conference papers, corrected for the many of the valuable comments received, will be published. The most suitable method was qualitative research, in particular, in-depth, semi-structured interviews with individual YouTubers, which lasted between 45 – 70 minutes. The collection of information would ideally continue until the theoretical saturation is reached; however, this goal was not achieved. In-depth interviews are an ideal method for providing a large amount of complex data, which were probed to see if there are any patterns of behavior among scientific YouTubers. Semi-structured interviews provide more space for more detailed and individual information from each respondent than structured interviews (Bell, Bryman, and Harley, 2019). The aim of using this method is to obtain the most detailed and comprehensive information from the respondents. A screenplay was created with questions that focus on topics such as checking on the information for validity and reliability, knowledge of the fake news, in particular with connection to COVID-19 pandemic and the reasons for checking/not checking the data for possible disinformation. The disinformation and fake news are treated as similar for the scope of this study and as youtubers consider them to be synonyms.

In order to fill the research gap, the interview method has been selected as a tool for gathering the required information in depth. Overall, the interviewing procedure has a clear purpose; it assumes preliminary planning of information gathering actions and the processing of the results obtained. The interviewing method was chosen as it has a number of advantages. First of all, it enables us to get missing information directly from the knowledge and experience of content makers. For instance, McNamara (1999) stated that interviews are particularly useful for getting the story behind a participant's experiences and that it can pursue in-depth information around the topic. Secondly, the interviewing situation, which is close to the usual form of conversation, contributes to the emergence of a comfortable atmosphere of communication and increases the sincerity of the answers. Silverman (2004) claimed that interviews are most appropriate for exploring sensitive topics. It is expected that influencers will need this setting to talk about omitting to look for reliable sources of information. And finally, the verbal communication eliminates the problem of misperception of the questions, because it is always possible to repeat and explain the question more in-depth to the person to get a clear answer. As noted by Navarro Sada & Maldonado (2007), interviewing is "*a valuable method for exploring the construction and negotiation of meanings in a natural setting.*" Furthermore, Berg (2007) argued that the value of interviewing is not only because it builds a holistic snapshot, analyses words, reports detailed views of informants, but also because it enables interviewees to "*speak in their own voice and express their own thoughts and feelings.*"

Semi-structured interviews were conducted as the purpose of it is to use discussion, conversation, as well as questions to get an insight into the research topic. According to Bernard (1988), a semi-structured interview is the best tool when there will not be any other chance to interview someone

again. The choice of respondents was based on the following criteria: type of content, knowledge of Slovak or Czech, number of followers (more than 10 000).

To respect the criteria "*type of content,*" the content of YouTube videos should have been qualified as "*educational*" or "*instructional*" meaning, proving an instruction on how to do in a particular situation. Interviews were conducted personally. All interviews were recorded.

To analyze the outcome of interviews, the software MaxQDA PRO was used. The interviews were transcribed, coded, and categorized.

The sample reached was seven Youtube influencers, interviewed via the ZOOM platform using the high – speed internet connection on both sides, HD cameras and good quality microphones to reach the state as similar to the real meeting as possible. The recordings were coded not only for the verbal codes and categories, but also for the non-verbal codes and categories and the codes were interlinked.

4. Research Sample

The basic set of respondents for the research were "*scientific and educational YouTubers,*" which are people who publish on Youtube content to educate or inform about the areas of physics, mathematics, biology, or even social sciences. The primary parameter is the assumption that these YouTube users use external sources of information to process the content of their videos.

Potential respondents were found by entering keywords and phrases such as "*science,*" "*how it works,*" "*scientific YouTuber,*" "*scientific videos*" in the Youtube search function, and the content of their video creation was then examined.

Youtubers be contacted via email and social networks. The final respondents were YouTubers who, after addressing, agreed to give an interview and to use the snowball method or referral to other suitable candidates for the interview. The final number of interviews was five.

In English, 15 respondents were interviewed for the research via Skype. They were recruited through random sampling via the search on YouTube and the table with 46 YouTubers from different countries around the world. The following keywords were used to select channels: "*scientific YouTuber,*" "*scientific channel,*" "*educational channel.*" 5 Respondents were Czech or Slovak, and they were met in person.

All respondents are English/Czech speaking YouTubers from different parts of the world. The content of their channels has an educational purpose.

5. Data Analysis and Results

MAXQDA PRO was used for coding the results. 7 interviews were coded and categorized. Exploration of the topic of working with resources - specifically the process of finding and assessing the quality, then what and if any activities are being developed to work credibly was tried during this period as well. During the data processing, of course, new codes appeared, which were subsequently found in other interviews as well. Finally, 21 codes were found, which were divided into five main categories – disinformation, misinformation, intent, monetization, ethics.

Youtubers generally showed the aptitude to distinguish the disinformation. Albeit they work with the results differently. The knowledge and aptitude for checking for disinformation does not mean they do not use it. The issue for the general public might pose that the youtubers did not show the ethical approach to the knowledge. Often the calculation of attracting the attention of the viewers

by showing them the "shocking" heading (better case) and not aligning with the heading afterwards is viewed as the moral middle way. In two cases, the use of disinformation in the content was the conscious choice.

"We need to live from something, you know." (A., 256 odb.)

"Well, people want to hear it. They will hear it from me or from someone else. If I do not do it, it will not save them from the information. I just need to be quicker than the other youtubers. And, of course, I correct it if I see it caused some major trouble." (N., 117 odb.)

6. Conclusion

In all cases, the quality of the data gathered by scientific Youtube influencers are checked for disinformation. The good news for the wider community is that the interviewed influencers are quite skilled in checking their data for disinformation (and in several cases even for misinformation). This does not adhere to the fact, that in previous research interviews (Procházka 2019, 2020), the same influencers did not know or wished to check for the validity and reliability of the sources. Nevertheless, the knowledge and aptitude for checking for disinformation does not mean they do not use it. The issue for the general public might pose that the youtubers did not show the ethical approach to the knowledge. Often the calcul of attracting the attention of the viewers by showing them the "shocking" heading (better case) and not aligning with the heading afterwards is viewed as the moral middle way. In two cases, the use of disinformation in the content was the conscious choice. The reason for both approaches was number of views and possibly even higher number of followers. The wider study that would confirm these preliminary findings should follow.

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EU POLITICIANS ON TWITTER – ACTIVITY ANALYSIS – RESEARCH DESIGN

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Keywords

Twitter, politicians, EU, activity

Abstract

The article introduces extensive ongoing research study, focused on detailed analysis of activity of 200 European politicians on Twitter. From all EU countries, the head of state, prime minister, chief ministers and opposition politicians were analysed. We have conducted frequency, type and content analysis. European countries were divided into several groups, based on GDP and location, which showed similar behaviour. Results of the research will be published in following article.

1. Introduction

According to Rebenstorf (2004) "political interest is the main component of political motivation, a variable indicating ability in ideological conceptualization, which is essential for participation in the democratic process." And if the political interest considered to be important it is each politician's purpose to make everything possible to engage in politics as many citizens of his country as possible.

Furthermore, the well-informed choice of a representatives of the power is key character of democracy. In the series of interviews held in Sweden, politicians also see new media platforms and Twitter in particular as a better way to democracy. Because all new media tools are strengthening the freedom of speech, they improve transparency.

According to the study taken place in 2009 "The data showed significant positive relationships between attention to traditional Internet sources and political self-efficacy and situational political involvement. Attention to social media was not significantly related to political self-efficacy or involvement. "The study was held between college students - younger generation. But since the year 2009 a lot of things changed. More and more people prefer to find all information they need through social networks, such as Twitter.

If we are comparing the usage of Twitter by famous actor and high-ranking politician, for example, there weren't be very different in their foundation. It is all about building a reputation by expressing their opinion in a more "free way "(rather than prepared interviews in traditional media). Twitter is an American online news and social networking service on which users post and interact with messages known as "tweets". Those are usually short messages, that are expressing opinion very sufficiently. This way of interacting helps politicians to be so to say "on the same level" with voters

and society. Which is implemented be Swedish politicians in the series of interviews mentioned above.

Moreover, according to Hunt and Getzkow's study of social media usage in politics "the fixed costs of entering the market and producing content are vanishingly small. "Which allows almost any politicians start their own account not dependent on the rank he has.

On the other hand, according to Lee and Oh's study personalized tweets do not lead to a success. More personalized messages created greater bond only with more affiliative individuals, while lowering the willingness to give them their vote among those less affiliative. Also their study proved, that personalized tweets only improved evaluations with those, who do not have strong group identification.

Nevertheless, in our study we analyze Twitter activity only of high-ranked politicians nowadays in European Union.

1.1. **Academic Literature**

In the era of new media politicians tend to engage in social networks and use those as a platform of communicating with the society. It is important to analyze and understand where people tend to follow and get updates on politics, whether via social networks (primarily Twitter) or more traditionally (TV, newspapers). Politics and Twitter revolution exposes how this particular social network platform gained popularity among politicians. The authors prove that the political engagement changed significantly since the Twitter arrive. People got more involved in politics and it's more persuasive than peer influence. (Parmelee & Bichard, 2011) But more important is to see if politicians in different countries are willing to get towards those more modern ways of engaging in dialogue with their voters. Parties need to actively manage media buzz on social networking sites (twitter) to stimulate its capability in managing more seats. (Safiullah, Pramod Pathak, Saumya Singh, Ankita Anshul, 2017)

The paper about Swiss national elections held in 2011 proved, that politicians used Twitter as a complimentary channel for distribution of their campaign. Also the Twitter presence did not much affect the voter's opinion and decisions.

Marcel Broersma and Todd Graham in their study compared elections in Netherlands and UK in 2010 and compared the use of tweets posted from candidates in tabloids and newspapers. They proven, that more argumentative posts were popular in UK, while in Netherlands it was about facts. It also interesting from the point of view, that information can be retrieved in new media platforms and be used by the representatives of old media.

Another study about general elections in UK 2010 even suggested, that some parties used such digital platform as Twitter was used to get in contact with journalists. As journalists were also frequently using Twitter to get information about campaigns and interactions between different politicians.

Comparing two representatives of social networks - Twitter and Facebook, the study in Norway suggested, that Twitter has more hostile environment, than its competitor - Twitter.

Effing R., van Hillegersberg J., Huibers T. believe that "Use of Social Media does not always result in a more effective political campaign. It heavily depends on how its use is designed, which emphasizes the need for further research. "

Some studies, on the other hand, suggest that Twitter opinion leadership makes a significant contribution to individuals' involvement in political processes, while social media platforms like Twitter do not really support individuals' political engagement. This provided insight shows that it is possible that political leaders can influence their prospective voters.

Furthermore Nils Gustafsson has proven that network sites alone does not necessarily drive previously inactive respondents to political participation. It explains that there is a scale between people who actively share and participate in political discussions and people who remain rather passive.

According to Suk Kyoung Kim, Min Jae Park and Jae Jeung Rho trust in government depends on good communication through social network channels.

The analyses shows that the extent of Twitter 'promotional' use also depends on the size of the 'Twitter market', which is also related to the general internet culture of the country. (Redek and Godnov, 2018) Moreover we are willing to compare the difference of the "Twitter market" in different countries with the GDP in each EU country.

Though other paper concluded that involvement into twitter politics arena also depends on particular political system in the country. (Merkulov and Balashov, 2015)

2. Methodology

Based on World Bank, we designed a ranking of countries in the European Union from the country with the highest GDP per capita to the one with the lowest.

Table 1 – Groups by GDP

GDP per capita (USD)	Countries
> 51,000	Luxembourg, Ireland, Netherlands, Sweden
51,000-45,000	Germany, Denmark, Austria, Belgium
45,000-36,000	Finland, UK, France, Malta, Spain, Italy
36,000 $30,000	Czechia, Slovenia, Slovakia, Lithuania, Estonia, Portugal
< 30,000	Hungary, Poland, Greece, Latvia, Croatia, Romania, Bulgaria

Also, we decided to improve our analysis by dividing same sample of countries by with other criteria. We made a list of groups of countries with a geographical division. To generate balanced groups per zone, we did not follow completely the standardized categorization of countries.

Table 2 – Geographical groups

Zone	Countries
West	UK, France, Spain, Portugal, Belgium, Ireland Luxembourg
North	Sweden, Finland, Denmark, Estonia, Latvia
East	Lithuania, Romania, Poland, Hungary
South	Greece, Bulgaria, Croatia, Slovenia, Italia, Malta
Central	Germany, Austria, Czechia, Slovakia

2.1. Scope of analysis

Afterwards, we choose a representative sample of politicians of each country in European Union. We decided to gather all the data on the official head of the country (e.g. the president, the King, the Queen…), the Prime Minister, the Minister for Finance, the Minister for Culture, the Minister for Foreign Affairs, the Minister of Education, the Head of Parliament, the Head of Constitutional Court and two politicians of the opposition.

In addition, we decided to select several ministries to complete our analysis. First, we have chosen to integrate the Ministry of Culture. Indeed, this ministry is important because it is supposed to represent the culture of each of the countries we are studying. As a result, it is supposed to be communicated through different media in order to show the world the different aspects of the culture of its country.

Then we selected the Ministry of Foreign Affairs. In the case of our study we study European countries, so the relationships between them go through this ministry.

Moreover, integrating the Ministry of Education into our panel also seemed obvious to us. Indeed, the population is very concerned about the future. As a result, we hope to see interesting activity via social networks and consistent interaction.

Finally, we also chose the Ministry of Finance. It is part of one of the pillars of a constitution since it makes it possible to regulate expenditure and all other matters related to the state. Moreover, it is present, like all the others in most European countries, which makes it an interesting choice.

Later, in order to see a more numerous and representative panel, we decided to add the Head of Parliament, the Head of Constitutional Court and two politicians of the opposition. These two politicians will be selected by identifying the political leaders of the competitive parties considering the last elections in every country.

Later on we decided to add Minister of Justice instead of the Head of the Constitutional Court because in none of the chosen countries there is a head of the Constitutional Court that has Twitter.

2.2. **Platform**

The social media platform which we will use for our analysis is Twitter. We chose this platform because a lot of data is available, which makes our study all the easier. In addition, politicians are very active on this network, allowing us to have a more interesting basis for analysis for our study.

2.3. **What data will we observe? How will we collect this data?**

2.3.1. Quantitative analysis

We collect the key figures and exact numbers of each of their Twitter accounts (e.g. number of followers, likes etc.) in an automated way.

First of all we decided to collect the number of followers. Indeed this allows us to make a first observation on the popularity of the person but also on the number of people potentially interested in the tweets and statements of this person.

In addition, the analysis of the number of Tweet also proves to be interesting to observe. Indeed, by using this quantitative data we can analyze if this person is more or less active on social networks and more particularly on Twitter. Additionally, we will collect the number of retweets for each politician in their last 100 tweets.

2.3.2. Qualitative analysis

We also analyze the most popular Topics for each politician. We take 5 most important topic for each Twitter account we have in our analysis. Those important topic in our paper means, that those particular topic were used more frequently than others.

For the second part of a qualitative analysis we retrived from foller.me tool all popular hashtags for each politician.

2.4. **How we analyzed this data?**

In each group we going to do all the same steps as in all others in both Geographical part and GDP comparison part.

First step is to determine how many politicians from our sample group actually have their personal Twitter account.

In order to make the information easier to comprehension we made several graphs. Those graphs each concern one specific position (head of the country, minister of justice). In those graphs we compare the ratio (number of followers/all Twitter users) of each politician with ratios of other politicians of the same role in countries of each specific group.

The third step is to get simple information about activity on Twitter of each country (all politicians from the country). In order to do so we counted all the tweets from all politicians in each country. Then we take the percentage of tweets that are only retweeted we'll find an average number of retweeted tweets in 100 tweets (since the basis is 100 it's also the percentage of retweeted tweets per 100 tweets). After we got those numbers from each country we count how many tweets were actually written by politicians and how many were retweeted.

The fourth step is a qualitative analysis. Here we make table for each country with all the politicians from our sample who has Twitter account and 5 of their most important topics. For each country we create a list of key topic, in order to understand, what topic are vital in each country and also in each group. (in GDP comparison and Geographical)

Then we finally take popular hashtags from each politician. They are still divided by country, but we are looking for similar topic of those hashtag throughout the whole group of countries. This part also concerns important topic for specific group. Also we can see if politicians are joining some popular in the world hashtags or simply use hashtags that are only relevant to the citizens of their countries.

2.5. Proposed hypothesis

We believe, that there is a strong correlation between the country's GDP level and the frequency in usage of Twitter among politicians. We want to prove, that in the countries with a higher GDP level more high ranked politicians have their own Twitter account and they tend to post tweets more often, then politicians from countries with a lower GDP level.

We also want to prove that politicians from European Union while trying to highlight international events, they tend to focus on events in European Union. We believe that the usage of positive hashtags will prevail.

3. Conclusion

The research, as described in the article, was conducted between 2020 and 2021. We are currently compiling the results, which will be published in the near future. However, preliminary results indicate that there is indeed a big difference in the use of Twitter as a political communication tool. The main differences that emerge are based on wealth /countries with higher GDP show much higher usage rates/, geolocation factories do not play such a role. Content and frequency analysis reveal that local specificities play a significant role in Twitter use.

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DIGITAL HEALTH – EMERGENCY SUPPORT FOR VICTIMS AND FIRST RESPONDERS

REAL-TIME STRESS MONITORING BASED ON WEARABLE SENSORS AND PHYSIOLOGICAL MODELS

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Keywords

Abstract

In recent decades, the development of autonomous systems in the field of cyber defence have been a priority for military organizations. An increasingly important area is the field of "Human Factors" and within the framework of this research orientation, extensive development projects have also been launched for the physiological monitoring of soldiers, with important new possibilities arising from innovative developments in the field of biosensor technology. The aim here is to optimize human performance in the field with highly developed mission equipment and the interaction between man and machine. This article describes the main objectives of the VitalMonitor project, which is carried out in the frame of the Austrian Defence Research Program FORTE. The project focuses on the development of a real-time monitoring system for situation-dependent physiological load assessment on soldiers based on innovative body-worn biosensors integrated into clothing or equipment. Intelligent sensor fusion and data analysis methods enable an overview of the actual physical stress situation in military training, exercises or missions and a near real-time management of the individual stress situation as well as an optimized deployment strategy.

1. Introduction

Soldiers are at the center of deployed sociotechnical systems despite major innovations in the field of autonomous systems and artificial intelligence (Swiss, 2020). Optimized capability and

performance development for soldiers is therefore a key focus for military organizations. Physiological monitoring based on near real-time information on the stress status of individual soldiers is able to support time-critical decision processes during military operations. In recent decades, extensive research and development projects have been launched focusing on the physiological monitoring of soldiers, with new opportunities arising from innovative developments in the field of biosensors. The analysis of scenario-based physiological requirements will be the basis for the optimization of physical resilience as well as operational readiness and will eventually reduce the risk of dangerous situations caused by physical exhaustion.

Results from research activities from current deployment scenarios of large armies and real-world problem areas that make it increasingly clear that the physical performance of soldiers can have a decisive influence on operational readiness and subsequently can influence the outcome of the military success. It should also be noted that analyses of current military scenarios indicate an overall increase rather than a decrease in occurrence of physical stress. Although advances in defence technology are reducing the weight of individual equipment and weapons, and in some cases even improve their ergonomics, it can also be recognized that the total amount of military equipment to be carried and operated by individual soldiers is gradually increasing (Friedl et al., 2016). Depending on specific military activities, there are completely different requirements and psychophysiological stress patterns which impact the soldiers. As a result of the high level of technology in military work tasks, psychophysiological performance is of central importance for successful mission accomplishment. The main objective of the VitalMonitor project therefore is to conduct exact stress analyses in realistic scenarios using mobile spirometry solutions and wearable sensors, and to develop a real-time physiological status monitoring (RT-PSM) system for soldiers based on decision support system, which includes scenario-oriented stress models and innovative analyses methods. This enables an individual stress situation picture and to optimize the deployment strategy.

2. Background and Requirements for Load Modelling

The challenging military work tasks often require a high level of responsibility, and in case of a decline in mental performance, this can have critical consequences. Reduced concentration and reaction cause delayed or possibly even wrong decisions, which can have fatal consequences (Witzki et al., 2011). Statistical evaluations from the U. S. Army Combat Readiness Center (Thomas et al., 2006) show that approximately 80-85% of all military accidents are directly related to cognitive performance degradation. Precise knowledge of the stress situation in relation to real deployment scenarios as well as the individual burden in such situations enables monitoring of the individual stress and individual stress control in order to avoid critical individual capability changes (e.g. action and decision errors) through appropriate measures. High physical performance also increases cognitive performance in stressful situations. A RT-PSM system, which is able to measure changes in physiological parameters such as heart rate, heart rate variability, skin conductance, core body temperature, etc. and which analyses the measured values intelligently, enables both mission commanders and soldiers to control their individual stress situation in a targeted manner and thus avoiding poor performance. In many operational scenarios, soldiers and special forces are expected to have a high level of training paired with peak physical and mental performance. This project will focus on two specific response forces, CBRN defence and explosive ordnance disposal forces, resulting in the following requirements:

- Real-Time Assessment of Physiological Status

- Decision Support for Military Commanders

- Determination of Optimized Work-Rest-Cycles

- Prevention of Physical Overstraining in Training & Missions

- Personalization of Physical Fitness Training

Due to the military-specific working conditions and multifactorial stress situations, the transferability of ergonomic principles and experience from the civilian research sector is only possible to a limited extent (Witzki et al., 2011). For example, load models that can be used for analyses in competitive sports can only be used to a limited extent for modeling physiological stress. Accordingly, own research methods must be implemented with which the workloads in the military can be recorded and evaluated according to scientific criteria, taking into account weapon- and function-specific characteristics (Eßfeld, 2008). Recent advances in the field of wearable bio-sensors including higher performance, better measurement accuracy and battery life by simultaneously reducing size and cost allow for new applications of real-time wireless body-worn sensor systems. A real-time system for physiological status monitoring (RT-PSM) offers new opportunities for military purpose with individual assessment of soldiers' performance limits. However, most commercially available systems do not meet the relevant military requirements. They are usually lacking validated methods and algorithms to derive essential information in real time and are not designed to be integrated with the soldier technological ecology (Friedl, 2018). Based on the requirements and the experience gained by the Austrian Army in the past, the following objectives are defined within the framework of the project development:

- Evaluation of new sensor types for stress measurement in military scenarios and their use in military training, exercise and deployment

- Integration of innovative sensors (including prototypes) into the VitalMonitor „Smart Clothes" solution for laboratory and simulated field measurements

- Development of a concept for an individualised performance baseline for CBRN and EOD personnel employment standards

- Derivation of the body core temperature based on the measurement of the skin temperature

- Development of analysis models to conduct performance diagnostics based on powerful low-cost sensor technology (machine- / deep learning approaches)

- Derivation of time-optimized (simplified) analysis models to allow valid, near-real-time analysis of sensor data for time-critical real deployment scenarios

- Innovative data management at different levels of abstraction, which enables end-to-end transparency from raw sensor data to analysis results to interpretations and evaluations

- Expert management tool that provides experts with a transparent view of the entire analysis process - from raw data to the models used and evaluation results

In order to enable a successful realization of the targeted innovation concepts and technical developments, a consistent project workflow was developed and the necessary working steps were defined in detail (see Figure 1).
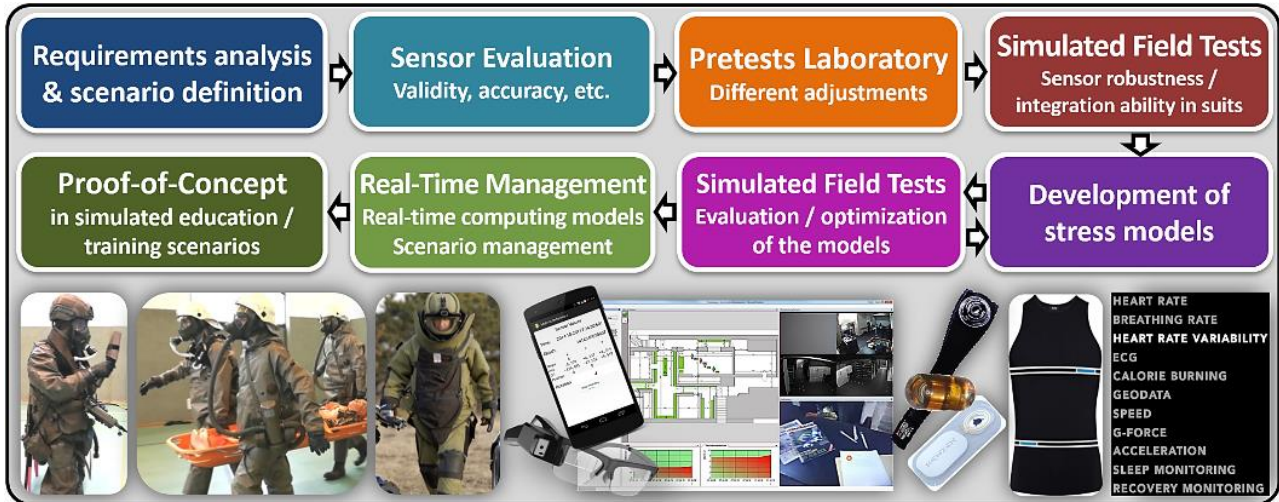
Figure 1: Graphical overview of the project workflow.

A large number of portable commercial sensor systems (COTS sensor solutions) are available on the market. Unfortunately, it is difficult to assess the performance of these COTS solutions, since there is usually insufficient information regarding the validity of the measurement data or the algorithms used (Friedl et al., 2016). An extensive evaluation of potentially usable sensor technology was conducted as part of the project and is currently ongoing. This will be followed by an extensive pre-test to configure the data acquisition in sports science laboratories, initially in reduced military adjustment with sports students, to test the existing "QUS-Smart Clothes" solution in combination with selected additional sensors, according to the necessary operational robustness and to obtain baseline data. Subsequently, stress tests within the Military Medical Center lab of the Austrian Army in military functional clothing (CBRN or bomb protection suit) will be carried out under controlled simulated stress conditions. The sensor system will be evaluated with regard to its operational capability in the functional clothing. Based on these results, the sensor setup will be defined and tests with a concrete, realistic application scenario will be carried out under controlled, simulated application conditions with a small number of test persons. These tests will be used for a first development of "expert load models". In a further step, extensive investigations will be carried out within the framework of a study concept involving a larger number of test subjects in simulated, practice-oriented and standardized process scenarios. Here, statistically relevant measurement data will be collected which on the one hand will serve to validate the developed expert stress models and on the other hand will form the basis for machine-learned models.

3. Wearable Sensors

The main sensor-equipment within this project will be the QUS smart shirt solution. Based on this smart shirt product (see Figure 2) which is already used extensively in competitive sports, empirical values from many sports are at disposal. Approaches that have a direct reference to the military load scenarios as well as a near-real-time analysis of the measurement data of the different sensors are development goals in this project. Based on the requirements from the application scenarios and the results of the sensor evaluation, additional sensor systems are selected as necessary extensions to the smart shirt sensor technology. Sensor extensions for the smart shirt solution will be developed as part of the project development (see Table 1). This integration of additional sensor technology and the necessary communication modules will enable better applicability in military deployment scenarios, especially in combination with protective equipment and combat suits.
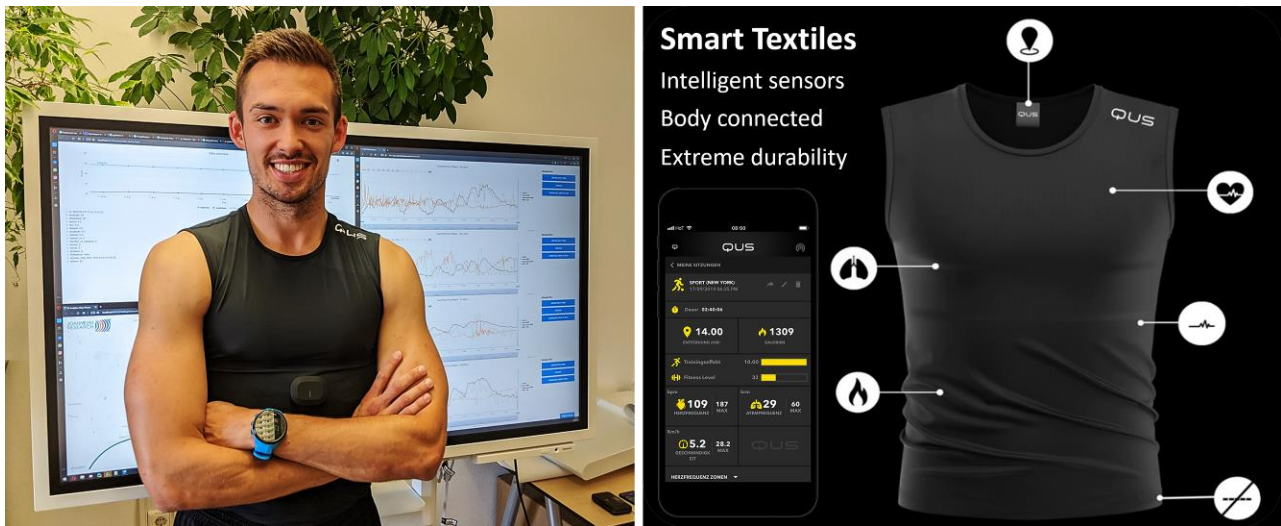
Figure 2: QUS smart shirt solution with bio-signal visualization in the background.

A key innovative objective of this project is the integration of a sensor setup that enables individual heat stress analyses and that recognizes critical developments in the water and electrolyte balance. As a consequence, severe stress situations will be detected at an early stage. Additionally, this will allow decision support in determining working hours and breaks. The following table provides an overview of the relevant sensor technology that is available in the smart shirt as well as sensor technology that is available for laboratory tests.

To achieve high acceptance levels for body worn sensors, good wearing comfort is essential. Results from (Beeler, et al., 2018), suggest that devices placed on or around the upper arm, the hip, or the shoe will be preferred over devices worn around the wrist or on or around the chest in a military context. Investigations into wearing comfort are therefore an important aspect of this project and different positions of additional sensor solutions will be tested.

Table 1: Overview of wearable sensors

Parameters	Physiological parameters	QUS Smart Textiles	Lab Sensors
Cardiovascular strain	HR, HRmax, ECG, breathing rate	QUS Smart Textiles	
Metabolic strain	lactate, glucose		LOC-sensor
	aerobic /anaerobic threshold	QUS Smart Textiles	
Heat strain	core body temperature, body surface temperature, WBGT	prototype under development	temperature pill, temperature patch,
Muscular strain	muscle activity, oxygen saturation		EMG sensor, PPG sensor
	movement dynamics	QUS Smart Textiles	
Cognitive and affective strain	HRV	QUS Smart Textiles	
	EDA, eye-tracking		eye-tracking glasses
Fluid balance	quantitative sweat measurement	prototype under development	Sweat patch

Essential parameters for a RT-PSM system for military special forces performing their activities in an CBRN or bomb suit are the core body temperature and the associated heat stress as well as the resulting critical developments in the water and electrolyte balance (Glitz, et al., 2018). Therefore, it is also an essential aspect of the project to select existing sensor solutions for the determination of

the core body temperature and the quantitative sweat measurement and to evaluate them in a further step in order to develop an integrated prototype solution with the QUS smart shirt.

4. Sensor Evaluation

The evaluation of the innovative sensor technology was a central objective of the VitalMonitor project. The sensors were tested for their validity and usability in military operations under different framework conditions (e.g. heat). The validation was divided into four phases (Figure 3). From phase to phase, the framework conditions for the sensors were designed increasingly unfavourable (e.g. climatic conditions) and came closer to real military use. In the first two phases the sensors were examined on recreationally trained students, in phases three and four on soldiers (see Figure 3).

The data generated by the innovative sensor systems were compared with data from the respective gold standard. Descriptive statistical analyses and inferential statistics were used to analyze the data. The results of this analysis gave useful information of further sensor development by the manufacturers.
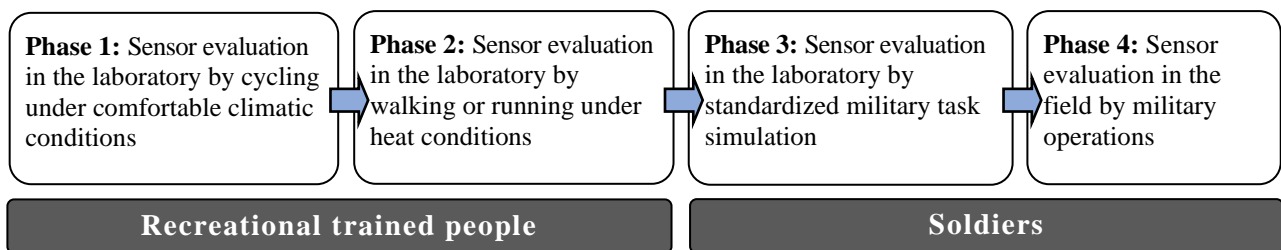
Figure 3: The different phases of sensor evaluation.

Sensor evaluation in the laboratory

The sensor evaluation in the laboratory consists of three phases (Figure 3). In the first phase, the new sensor technology was compared with the gold standard under comfortable climatic conditions (room temperature from 19 to 21 degrees Celsius and humidity between 30 and 50 per cent). Young recreationally trained people (ages 18-25) were tested. They completed an incremental exercise test on the bicycle ergometer during data collection.

In the second phase, the incremental exercise test was conducted on the treadmill under heat conditions (room temperature from 34 to 36 degrees Celsius and humidity between 60 and 80 per cent). An acclimatization phase of 60 minutes was carried out before the test. Since walking and running are characterized by a more extensive upper body movement than cycling these movements could lead to artefacts in the collected data. Furthermore, increased sweating due to heat and humidity could have also affected the data quality. Further investigations were carried out if significant deviations between data from the sensors and data from the gold standard were given.

Based on Chemical-Biological-Radiological-Nuclear (CBRN) standard operation procedures, critical and frequently performed tasks were identified. Based on that, standardized task simulations were developed to simulate operational conditions for the sensor evaluation in phase three. Each task simulation had a duration of one hour and included 6-8 specific CBRN tasks. Sensors were evaluated on soldiers by conducting this standardized military task simulation. The focus of the senor evaluation was no longer primarily on the comparison of data generated by the new sensor systems with the gold standard but also on technical and usability tests in the context of military operations.

Sensor evaluation in the field

In phase four, the sensors were tested in the field by soldiers during a military operation. As in phase three, the focus of the evaluation was on technical and usability tasks. This final analysis was also given to the various manufacturers to develop the final product.

5. Project Modules

Figure 4 shows an overview of the main modules which will be carried out within the project.
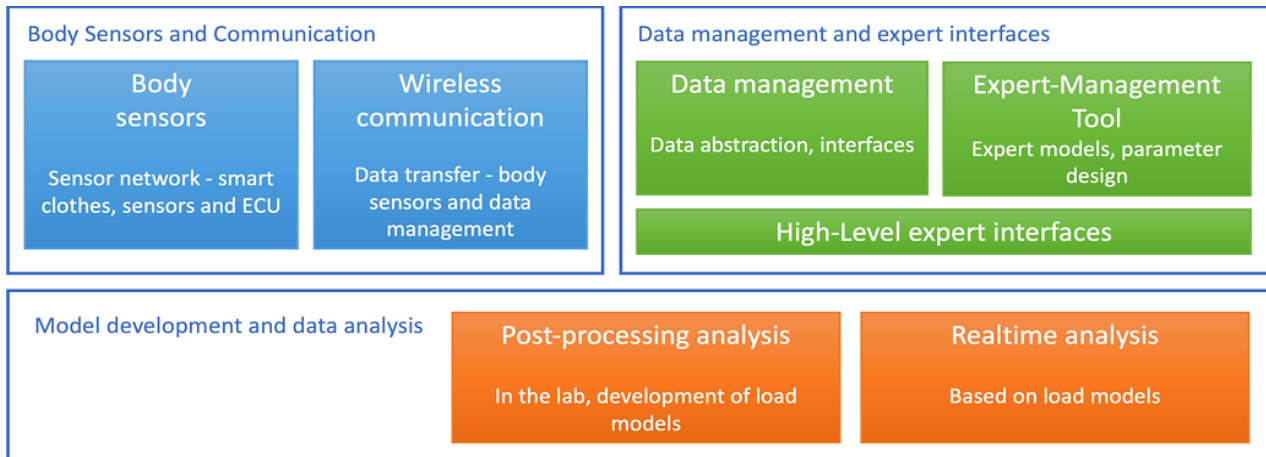
Figure 4: Graphical overview of the VitalMonitor project modules.

Secure data access, efficient data management and clear visualization are crucial for the system (see Figure 5). Therefore a „central data ware house" (CDW) supporting real-time communication and synchronization, data reprocessing as well as providing input / output interfaces has been implemented. The data warehouse which includes a non-relational database with a flexible storage schema can be set up directly on location for example on a field laptop. Its primary use is to record timestamped (bio-)signals, store post-processed results and to hold field trial relevant meta data. In order to guarantee a common time base for all sensors, it can interface with a network time protocol server. Depending on the use case, datagrams are exchanged either through UDP or TCP sockets, with the former cutting latency by omitting transmission control. To secure the communication channels, payload encryption and transport layer security can be activated. The CDW supports real time transmission channels with a rate of up to 20 KHz. Processing modules can connect directly with the database, making statistical analyses possible in real time as well. External communication interfaces are encapsulated in a separate layer and are available through modern web services and remote procedure call protocols (REST, GRPC). Eventually, these interfaces are utilized by additional software components (e.g.: logging, processing, viewing).
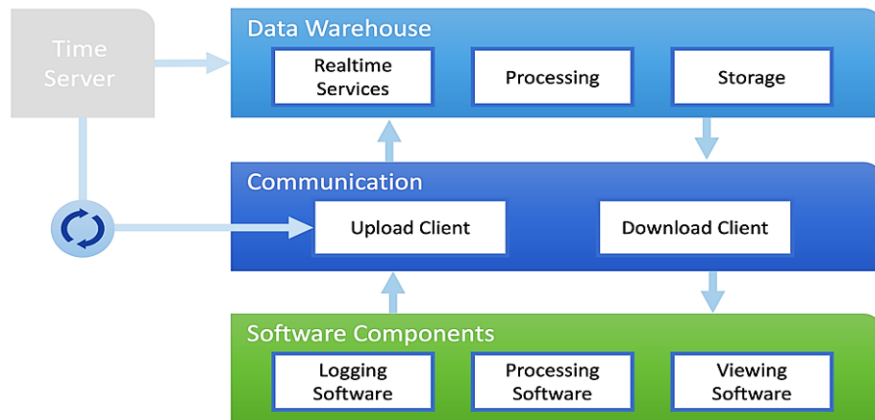
Figure 5: Components of the real-time data management.

On top of the underlying data warehouse and communication modules a two-fold interactive visualization and management interface will be implemented: (i) an expert interface for data assessment and iterative development of physiological models and (ii) a high-level interface showing use-case specific information only. The expert interface will show sensor data streams (low-level data) together with model-based analysis results (high-level data) in a graphical interface as a basis for model development, verification and optimization. For leveraging the know-how of experts, means for data labelling and model parameterization will be implemented. The entire data-flow from raw data acquisition to inference will be made accessible via this "Expert-Management-Tool". Additionally, a high-level interface will be provided, which will assists during specific exercise or deployment use-cases and which will illustrate analysis results as well as high-level data for continuous assessment of the soldiers. Individual physiological parameters, indicators and alerts, are made visible in a graphic interface for the instructor/trainer/medical staff as a basis for continuous assessment and potential intervention. The interface will be adaptable in terms of expert-level/roles, sensor-setup, physiological parameter and can therefore be adapted to fit the special requirements and priorities in various military scenarios. Figure 6 shows an expert interface for the model parameterization.
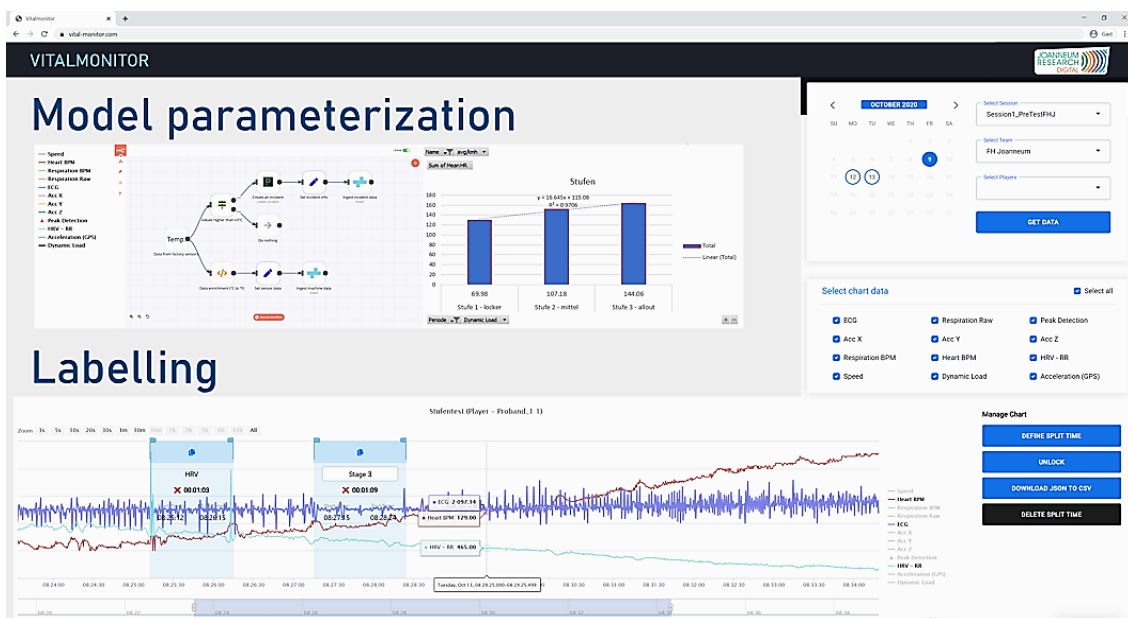
Figure 6: Expert interface for model parameterization.

6. Conclusion and Outlook

Soldiers are at the center of deployed sociotechnical systems (Swiss, 2020), while requirements in the physiological and also cognitive field have increased significantly. Therefore, optimized capability and performance development for soldiers is a key focus for military organizations. Innovative biosensor technology, which is currently available on the commercial market, enables the monitoring of physiological parameters during physical strain and thus basically also during different military deployment scenarios. A targeted use for military tasks, which provides soldiers, executives and medical personnel with meaningful, real-time situation-relevant information, requires an intelligent analysis of the sensor data. These analysis methods take into account, on the one hand, the load characteristics of the operational scenarios and, on the other hand, the individual fitness and stress situation of the persons. As part of the VitalMonitor project, physiology based methods and algorithms are developed on the basis of extensive tests as well as laboratory and field trials using powerful biosensors, which enable the derivation of reliable, supporting information for military training, exercise and deployment scenarios. Considered over a longer period of time, the data from this monitoring system also allows an analysis of the health status of the individual soldier as well as his fitness status, which brings an important individual added value. In order to achieve a high level of acceptance among soldiers, usability tests conducted on the body worn sensor system are a very important part of the project.

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HOW TO COLLECT USER REQUIREMENTS DURING A PANDEMIC CRISIS: THE ISSUE OF NOT HAVING FACE-TO-FACE MEETINGS

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User requirements, pandemic crisis, disaster management, crisis management, disaster scenarios, collection and analysis, use case, online tools, social network analysis

Abstract

The COVID-19 pandemic heavily distracted our life in a manifold way. It not only affected our social contacts, private and business, but also changed our way of living and working. Due to the response measures scientists were not allowed to conduct face-to-face events, like workshops or interviews, anymore. This influenced many of the ongoing projects that were planned to use such events to collect information from stakeholder groups. This paper presents a customizable approach to conduct end-user requirements collection and analysis based on available online methods and shows how this can be applied in national and international projects to overcome the issue of not having face-to-face meetings.

1. Background and Introduction

1.1. User requirements in crisis and disaster management projects

Development of innovations in the field of crisis and disaster management is strongly needed, as we can see disasters strike humankind all over the world. Currently we also face a worldwide disaster, namely the COVID-19 pandemic, which influences us in a manifold way. To allow the first responders, crisis and disaster management practitioners and other people working in this context to increase their effectiveness and reduce their danger, technology innovations for this group are one of the current and future solutions. But before the innovative solution can be developed, the project has to collect the relevant user needs and translate them into user requirements. After this step, the user requirements can be transformed to system specifications in close collaboration with the system developers. But how to best collect user requirements, especially in the field of crisis and disaster management is not an easy question to be answered. Many influencing factors should be taken into account when planning the user requirements collection process.

If user requirements are incorrect, misinterpreted or change during the project, this can lead to the failure of the whole innovative solution or explode the costs of the development until it is not feasible anymore (Davey & Saunders, 2019). Therefore success or failure of the whole project heavily depends on the user requirements collection (Davis et al., 2006; Kumar & Sharma, 2015; Lane et al., 2016; Nuseibeh & Easterbrook, 2000). The collection not only depends on choosing the right method, it is also influenced by how the method is carried out or how the mood of the end-

users is (Lane et al., 2016). Thus, the main aim is to best reflect the needs and expectations of the stakeholders. The success measure is then the degree to which a requirement meets the purpose for which it was intended (Nuseibeh & Easterbrook, 2000).

End-users are the relevant data sources to collect the user needs and requirements, but in the field of crisis and disaster management they are not just normal office workers of a company, they are first responders, members of the operational rooms or decision makers. They all have in common that their time is precious and they are not willing to offer lot of them freely (Davey & Saunders, 2019). The outcome of the project, the solution, must be at least so interesting to them, that they take some of their time to take part in the requirements collection process. Selecting the right format for the collection is therefore very important, later on there is no chance to re-due the work or only in combination with an increased time budget, if the requirements are not satisfactory. Various methods exist for this process, ranging from interviews (Veiga and Ward, 2016) and surveys (Protopapadakis et al) to field studies, also including online tools (Dwitam et al. 2020, Stade et al xx), but the most appropriate approach depends on the context of the project (Lane et al., 2016) and as it turns out now, also on unexpected restrictions due to a pandemic.

1.2. **The issue of not having face to face meetings**

The coronavirus SARS-COV-2 was declared as a Public Health Emergency of International Concern on 30th of January 2020 and a pandemic on March 11th (World Health Organisation, 2020). As it is mainly spread through close contact, small droplets emitted by talking, sneezing and coughing, one of the most relevant measures against its spread was the reduction of contacts going even as far as total lockdowns, where the population is only allowed to leave their homes for some strict reasons (Alfano & Ercolano, 2020). This strongly affected our society worldwide, thus also posing significant challenges to the scientific communities. Social science research, specifically stakeholder engagement research, was one area that was potentially impacted given its need for person-to-person interaction (Tobin et al., 2020). The measures against the spread of the disease made it necessary to stop nearly all on-site research activities including workshops, seminars, conferences or other dissemination events. For all these activities new formats had to be found, as it turned out that postponing events will not be the solution. It is still not clear how long we will have to be socially distant.

The end-users in the field of crisis and disaster management could often be won by offering them a half day end-user requirements workshop that included some attractions afterwards, like site visits of interesting other facilities to compensate for the occupied time and give them the opportunity to see how their work is done by similar organizations. Now with the pandemic striking our everyday life, the various methods for user requirements collection are strongly reduced to formats which do not need the personal interaction of people and thus making compensating side events impossible. There are several advantages of the "home office life" including the reduction of everyday travel time, the possibility to attend events that are otherwise too time and cost intensive or the ability to disconnect if something is not interesting (Meyer et al., 2021). But it also has a lot of drawbacks, as there is now an increasing offer for interesting online events, the already increased workload due to the crisis, or the missing networking and discussions with colleagues during the work or at face-to-face events (Albéniz et al., 2020; Becerra et al., 2021; Tobin et al., 2020). Therefore, an approach is needed that at least reduces the participant's time within the workshop and gives them other advantages like the possibility to attend from home.

Many different approaches are already in use or under evaluation on how to best organize conferences, seminars, workshops or exhibitions, but as it is often the case, the selection of the format depends on the goals of the event and the stakeholders that should attend. In the field of crisis and disaster management the relevant stakeholders are practitioners already overwhelmed by

the current work during the pandemic and thus the format of the event has to take this into account, otherwise, the outcome will not be sufficient for the project. Therefore, we developed a framework for the collection and analysis of end-user requirements that is using a mixed-approach of online methods, which is described in chapter 2. The application of this framework and first results are then presented in chapter 3, concluding with a summary and discussion in chapter 4.

2. A Framework for online user requirements collection and analysis

2.1. Concept and Approach

If end-user requirements should be collected, the commonly used method for this is to invite a group of stakeholders (or several groups) to an end-user workshop for e.g. half a day to present the intended project aims and innovations to be developed and to discuss in one or more sessions the requirements issued by the participants. If such an approach is not possible due to the pandemic restrictions or other circumstances and the collection cannot wait until the situation is coming back to normal, another format has to be used. We developed a framework to collect end-user requirements in the field of crisis and disaster management that does not need too much time from the participants, as this was issued as one of the major concerns from them, and that fits the needs of Corona dominated time.

The collection of user requirements should be done in an iterative way so that requirements appearing later on can still be implemented or the already identified ones can be evaluated or ranked. Therefore, we propose a mixed-methods approach consisting of online surveys, online workshops and a feedback loop. This is split into several events accounting for different stakeholder groups (Figure 1).
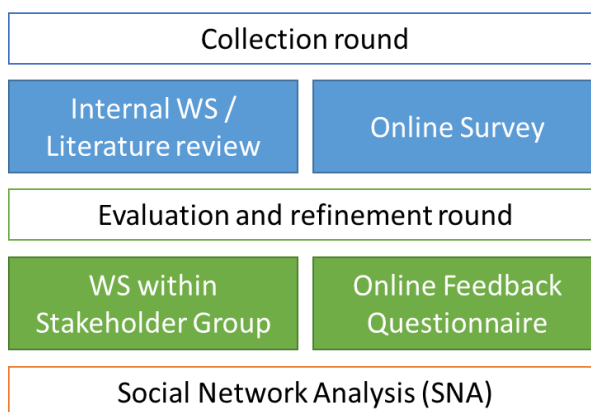
Figure 1: Overview of the user requirements collection and analysis approach

To collect the extensive list of user requirements we propose to start first with an internal workshop and/or a literature review to collect information about the state-of-the-art in the respective field and to see how current technologies are getting more and more sophisticated and to see where the potential for the own development lies. Then, based on the results, an online survey can be developed that reflects the relevant application scenarios of the planned innovation and concretely asks for the stakeholders for each scenario and suggested user needs. The outcome of this first collection round is a draft list of user requirements extracted from the literature, the internal workshop and the online survey feedback. The analysis of the requirements can include the assignment of the requirements to different scenarios, the timing (if needed before, during or after the event) and to which components of the envisaged technology it is issued. Then comes the

evaluation and refinement round. It again consists of two methods, the workshops within one or more stakeholder groups and the online evaluation questionnaire for the workshop participants and potential other stakeholders. This is then followed by the second analysis to include additional requirements that appeared and to refine the previous analysis results. If more stakeholder groups are consulted, each requirement can get an importance ranking per stakeholder group to analyze its relevance for each group of users. The whole process should then be finished with a social network analysis (SNA) to analyze the interrelations between the requirements and other influencing factors or categories.

2.2. Collection methods

In the concept, several methods were suggested to collect the user requirements. They should now be presented in more detail.

Internal workshop/ Literature review

This first part of the concept should collect the already existing end-user requirements within the own organization and the end user requirements identified by the scientific community. A literature review on the innovation topic also allows to get an overview on possible application scenarios and end-users. This information can then be used for the consultation of the relevant end-users within the online workshop. The internal workshop should be organized as a virtual event with not more than five participants lasting for about one hour.

Online Survey

To get a broad range of user requirements, a short online survey should be generated and disseminated to the relevant identified stakeholders. The more stakeholders identified and the more contacts to them are available, the better is the first round of user requirements. The survey should include a separation of the requirements per scenario and should take the analysis questions into account. To get feedback also from users that are not familiar with the project, it is necessary to briefly explain the planned innovation and the implications for their work. Short example answers for each question can help them to understand what is asked of them.

Workshop within stakeholder group

After the first list of requirements is generated, a dedicated workshop for each stakeholder group can be arranged. To reduce the effort and time needed from them, we suggest to integrate this workshop into recurrent meetings of the respective stakeholders, like staff meetings. It is then necessary to reduce the workshop time as far as possible, not exceeding 30 to 45 minutes. The workshop should start with a short presentation of the project and then continue with a discussion on the available user requirements per category to evaluate them and add further requirements.

Online Feedback Questionnaire

If the workshop provided enough input for the final list of user requirements, this step can be skipped. We suggest to add it, if the stakeholder group consists of very different experts with different aims within their work or different expertise, to get a more detailed feedback on each category. The list of user requirements can be sent to them after the workshop, and also to additional stakeholders not able to participate in the workshop to collect their feedback and evaluation about the relevance of each requirement.

2.3. Analysis and results preparation

After each round, the outcome of the step should be a list of user requirements that can be easily analyzed. We suggest using a standard Excel-sheet or similar where each user requirement

extracted, gets a continuous number. Then the requirements can be analyzed based on the event where it was collected, the relevant scenarios, the timing within the scenario or the technology part/ group within the project. Additionally, it can be relevant to also include the type of stakeholder group for which the requirement is relevant. This list can then be used to evaluate the user requirements again by the stakeholders to get a prioritization of them. Later on the user requirements should be also discussed with the technology developers to allow them a feedback about the possibilities to implement it during the project and on which costs. This then shows which end-user requirements can be fulfilled within the project for which costs and what is out of scope of the project or can be discussed in a follow-up project.

The final analysis can then be done using a Social Network Analysis (SNA). The method has its origin in the social sciences, where social networks where analyzed to understand the people's actions and decisions (Knoke & Yang, 2019). Social Network Analysis (SNA) techniques can be used for handling the problem of prioritization of the requirements, since requirements management resembles in various aspects a social network, e.g. requirements form a network of interdependencies which are changing over time, or for selecting the requirements a group of stakeholders is interacting to take a group decision (Fitsilis et al., 2010). We use the SNA to analyze the connections between the user requirements, the scenarios and the technology components. It can show how many connections each requirement, scenario or technology has and how close they are to each other. This can offer valuable insights on the relevance of user requirements and the further development of the innovative solution.

3. Application in the national and international context

3.1. The projects behind

Within the national funded project AIFER (Artificial intelligence for the analysis and fusion of earth observation and internet data for decision support in disaster control) research will be done to develop an AI-based algorithm for the fusion of information based on the analysis of earth observation and internet data to enrich the common operational picture with additional information. Here we applied our concept for the end user requirements collection.

Another project, where the concept is currently applied, is the EU-funded project METICOS. The project aims to introduce Big Data Analysis of border control information systems, in order to provide a step change towards more modern and efficient smart border management and towards gaining societal and political acceptance of modern control technologies of EU borders such as "no gate solutions".

3.2. Online questionnaires and end-user workshops

In the first project, AIFER, we started with an explorative literature review on the relevant scenarios and stakeholders in the field of earth observation data analysis and social media analysis and identified six relevant scenarios for such a tool. These scenarios were then used as a basis for the first internal workshop. During the workshop first requirements were discussed, based on the literature review. In a next step, an online questionnaire was designed to collect information on the already available data from earth observation and social media analysis, to identify the relevant stakeholders and general user needs from the end-users. Based on this result a first excel-sheet was generated to summarize and structure the requirements. They were assigned to the relevant scenario and during which phase of the scenario this would be needed. The process then continued with the organization of two separate stakeholder workshops, one with stakeholders of the strategic level and one with stakeholders on the tactical level. This was done within one of their monthly staff

meetings to reduce the additional time invested by them. Within the workshop the available list of user requirements was discussed and evaluated as well as expanded with additional ones. Afterwards they received the complete list of user requirements and were asked to evaluate the importance of the requirements according to their role within an operation.

In the second project, METICOS, we also started with the literature review to collect background information on the different smart boarder technologies and the types of users. Then a short questionnaire was sent to the end-users within the project to collect information about their relevant scenarios, which included general information, information on the problems faced within it and the needed and available resources. In parallel the already mentioned user requirements of the project proposal were identified and discussed within the consortium. In a next step we organized four end-user workshops to explain the methodology and to allow them to understand how our next questionnaire should be filled. In this case we were more interested in the use cases then the user requirements, so they were given the excel-sheet to define use cases which are of relevance to them. This information will then be part of the overall analysis. All relevant additional information which may be relevant for the use case is also asked for in the excel-sheet. Therefore it is possible to develop with the BPM ADONIS Tool several layers (processes, roles, equipment, documents, etc.) and connect this together to receive an overall picture of the defined use case (see Figure 2). Especially using a tool like BPM ADONIS allows the transparent and structured visualization of the connection and interference of several aspects and topics like roles, equipment, etc.
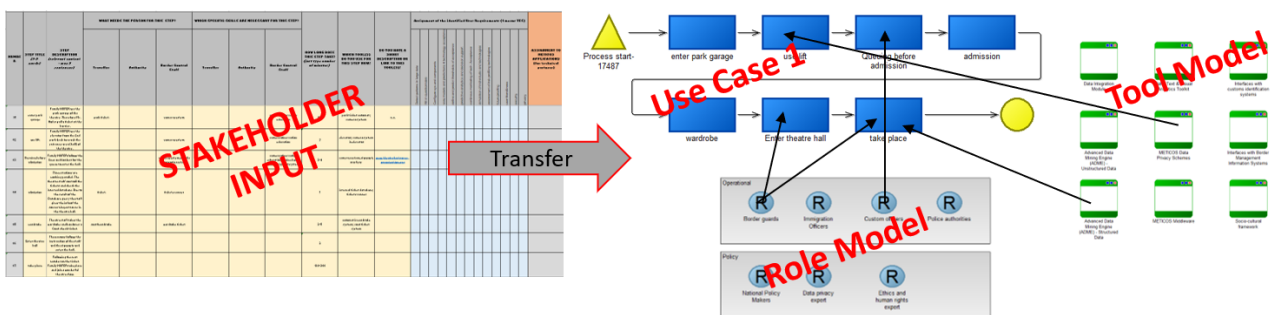
Figure 2: From Excel-Sheet to BPM ADONIS Tool – Example METICOS project

3.3. Conduction of the analysis

Putting the user requirements in a structured format is the first step to be able to conduct an analysis of them and allow technology developers to work with them. Discussing the user requirements with the technology developers is also an essential point within the whole process. This allows to evaluate the user requirements based on the technological context. Additionally, to this, the user requirements and their relevance for the project, the scenarios and other relevant parameters are analyzed using the social network analysis method. We use the measures of betweeness centrality and closeness centrality to show which nodes have the most connections and which nodes have the shortest distances to other nodes. It offers valuable insights on the importance of user requirements, relevance of the scenarios and the connection to the technology components.

4. Summary and Discussion

Due to the impacts of the COVID-19 pandemic on our everyday life as well as the academic research, new concepts and approaches are needed to continue the scientific research (Meyer et al.,

2021). This is especially true in the field of crisis and disaster management as the pandemic itself is one of the major disaster topics. The effects of the measures against the pandemic are heavily affecting our research projects and it is not feasible to postpone everything until the pandemic ends. This was partly done at the beginning, but it turned out that after one year, we are still not back to normal and when this will happen is still unknown to us. A lot of research is done with the involvement of stakeholders by applying methods like workshops, interviews or focus group discussions (Albéniz et al., 2020; Becerra et al., 2021; Hameed, 2021; Lazar et al., 2000; Margolis et al., 2020; Meyer et al., 2021; Tobin et al., 2020; Zarvic et al., 2009). The main aim is to provide innovative solutions that are addressing the needs of the end-users to assure the later uptake by them (Lindgaard et al., 2006). Also our research projects were planned with face-to-face elements in the proposal, but as it turned out, this was not allowed due to the restrictive governmental and organizational measures. Therefore we developed a concept to collect end-user requirements that only relies on online methods. To restrict the necessary time of online meetings, we used a mixed-methods approach and combined workshops with online surveys and questionnaires. This was highly relevant, as our stakeholders are first responders that are working hard to reduce the negative consequences of the pandemic and thus their available time for scientific meetings was very short. We were able to apply our approach in one national and one international project and showed some first results including the analysis of the collected user requirements via Social Network Analysis (SNA). The developed concept was quite well accepted by the end-users as it allowed them to provide valuable inputs without being occupied for too long. This was reflected by the high participation rate during the workshops. It was observed that from the invited participants nearly all were applying the workshops and most of them were very responsive. A more detailed evaluation on the acceptance of the method was not done yet. One major constrain was the dissemination of the online survey to relevant stakeholders to collect preliminary user requirements. This is also dependent on the cooperation of the internal project end-user partners. The SNA was applied as an analysis tool and offered with minor effort a great overview of the interrelations between the requirements, the scenarios and the development components. Overall we see the concept as a very good alternative for the face-to-face workshops if the external circumstances does not allow them. If no restrictions are made, we still propose to do a mixture of online formats and face-to-face events as both of them show different advantages and disadvantages (Margolis et al., 2020).

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IMPROVING THE INTERNAL COMMUNICATION OF AN EMERGENCY RESCUE SERVICE BY USING PROGRESSIVE WEB APPLICATIONS

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Rescue Service, Progressive Web Application, Emergency Communication

Abstract

The Austrian mountains are a wonderful place for hiking. Unfortunately, accidents can happen everywhere at any time. If people in the Austrian mountains are in distress, they can call the members of the Austrian Mountain Rescue Service for help.

Especially the early phase of a rescue operation is crucial for the remaining process of the whole operation. The head of operation must collect, validate and distribute a vast amount of information. All individual rescuers must come together as fast and efficient as possible and need to get information from the head of operation and need to report their own participation to others who have joined the operation.

The whole information flow must not slow down the approaching of the group to the lost or injured person needing their help. To improve information distribution, we designed a progressive web application with an easy to use, intuitive and adaptive user interface with the purpose to support a rescue team, especially during the early phase of rescue operations.

1. Introduction

Whenever people hiking the Austrian mountains are in distress, they can call the Austrian Mountain Rescue Service[16] for help. This life-saving service is formed by specially trained volunteers operating in a well-defined area they are living in.

When an emergency takes place, victims call an emergency control room which forwards the information to the local group of mountain rescuers responsible for that area. This is done in two steps because at first, a member qualified to lead the operation has to accept the mission and acquire additional information from the victim. If this head of operation decides their help is indeed indicated, the remaining local group is informed.

At this stage, all available members of the local mountain rescue service group stop whatever they are doing at that time, grab their gear and head to their staging areas. These are special well-known

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[16] https://www.bergrettung.at/

places suited for the rescuers to meet at because they are on the way to the emergency location, the equipment is stored or the vehicle is parked there or out of similar reasons. Because all members are scattered around and want to reach the victim as quickly as possible, efficient communication among the rescuers is crucial.

Because off-the-shelf solutions were not applicable for various reasons, we developed a solution following the design science methodology to improve information distribution among rescuers in the situation described in section 2. It was especially important that the result is acceptable for members. Because of the nature of voluntary work, we had to consider that the mountain rescue service is a heterogeneous set of people from different professions and varying affinity to modern technology.

2. Requirements for Rescue Operations and the Alarming Process

The Austrian Mountain Rescue Service consists of volunteers and is divided into well-defined spatial groups operating in terrain which does not allow the usage of heavy equipment. Additionally, the number of emergency missions varies greatly. While there can be weeks without any incident, there might be several emergencies on one day when the weather is good. During an emergency, due to the terrain, a lot of personnel is required to carry all the equipment and maybe also the victim. Therefore, it is not feasible to serve rescue missions with personnel on standby.

Every rescue mission needs a head of operation being qualified by attending further training beside the training to become a mountain rescuer. The duties of this person are coordinating all rescuers and communicating with external parties like other emergency services. This person also has to take final decisions and is liable for them. Consequently, such a qualified person must be available all the time for the local group to be operational.
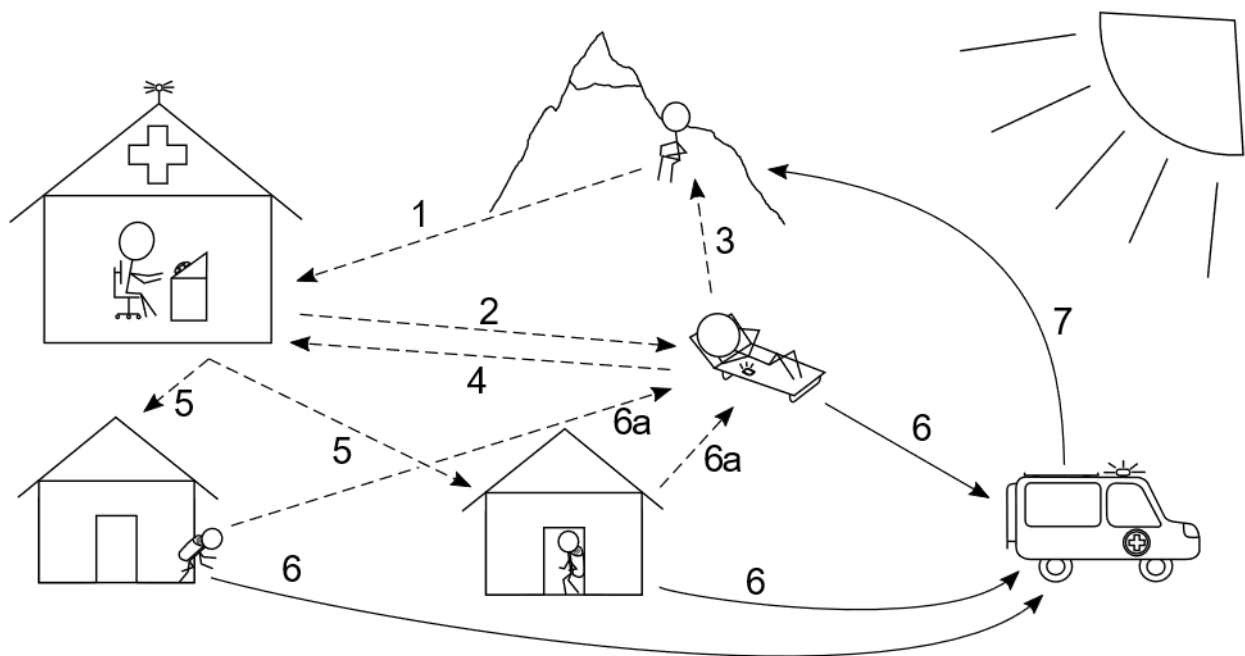
Figure 1: Steps during the alarming procedure and approach to the victim. Communication is denoted by dashed arrows, change of location by solid arrows.

2.1. Early Phase of an Actual Emergency

In the case of an emergency, several parties are involved. Some steps for saving a person in distress can only be done consecutively, some can happen at the same time. All the time the parties involved need to share information. Figure 1 gives a rough outline of the information flow (dashed arrows) and the necessary steps (numbers).

2.1.1. The victim

After an accident or during a medical problem, either the victims themselves or bystanders inform the emergency control room (step 1) about the situation using an emergency number. Sometimes, the information they can provide is very sparse, for example the exact location is very important, but not always correct and must be cross checked.

2.1.2. The Control Room Operator

The person in the control room answers the emergency call and tries to acquire as much information as possible. If the location appears to be in alpine compound, the operator looks up the responsible local group of the Austrian Mountain Rescue Service and contacts the potential heads of operation using short message service (step 2). Eventually, one of them accepts the distress call and receives additional information from the operator.

2.1.3. The head of operations

When potential heads of operation receive the message, they only get the rough type of accident and need to call back for further information like location and contact information. With the description from the operator, the head of operation tries to acquire further information from the victim about their problem and location (step 3). This is important, because the local head of operation knows much more about the area than the operator in the control room. Eventually, the head can decide to call in the remaining members of the local group, also by short message service sent out by the operator in the control room (steps 4 and 5).

From that moment, the head is very busy, since she or he needs to communicate with the victim, inform the now incoming rescuers about special equipment required and where the staging areas are. Furthermore, all rescuers also try to acquire information and want to inform the head about them joining in. At the same time, the head also must grab the gear and head to a staging area.

2.1.4. The rescuers

On receiving the alarming message (step 5), they also only get sparse information like the name of the head of operation, a rough location and the type of mission. They then try to reach their next staging area as fast as possible (step 6, exemplary denoted by the car). They also must inform the head that they are joining the rescue operation (step 6a). When reaching an emergency vehicle, the rescuers there need to know, whether more are about to arrive or whether they can already leave for the victim's location (step 7).

2.2. Problems During this Early Phase

As not every rescuer has a radio at home, the early communication must be done using mobile phones. So, either one person can call another, or a text base messaging service broadcasting to all participants must be used. However, reading a stream of text messages is hardly possible in such a situation.

Consequently, the head of operation gets constantly called by different parties like the victim asking for status updates, the rescuers informing they are joining or asking for information about special gear to fetch from the base station. Depending on the type of emergency, the alpine division of the police might also call. The head themselves needs to know about the number of rescuers and call for reinforcement if necessary.

Another problem arises at the emergency vehicles. If the driver does not know whether more members are coming, they might leave the area too early and the rescuers not making it in time need to use their private cars without the privileges of the emergency vehicle.

3. Related Work and Existing Solutions

There are existing availability systems, naming Divera 24/7[17] as one example, allowing each member to report their availability state. However, problems with such solutions were missing flexibility, licenses and fees.

We also tested WhatsApp. While this form of communication was successfully used in a later stage of the rescue operation, comparable to Debnath, Haque, et al. (Debnath, Haque, Bandyopadhyay, & Roy, 2016) and Gulacti, Lok, et al. (Gulacti, Lok, Hatipoglu, & Polat, 2016), WhatsApp was not applicable during the initial phase. Here, also user acceptance showed to be a big issue because of the members' need for data protection. Furthermore, the groups would also be used for different conversations and especially during stressful situations, it was not possible to filter out the availability state of the members.

There exists a lot of scientific research about the communication, data management and analysis during disaster and large emergency situations like Reynolds and Seeger (Reynolds & Seeger, 2005) or Dilmaghani and Rao (Dilmaghani & Rao, 2009). Also, our institute was partner in one of these projects, INDYCO - Integrated Dynamic Decision Support System Component for Disaster Management Systems (Liehr & Czech, 2014; Stumptner, Lettner, & Freudenthaler, 2015). But they mostly focus on a higher degree of disaster and discuss the communication between different services. Progressive web applications (details in section 4.2) have also been examined for victim's self-assessments by Wahlström (Wahlström, 2017).

4. Our Internal Communications Mobile App

Our attempt on improving the communication was to build a custom mobile application. The core functionality must be easily usable by all members, must not raise security or privacy concerns and it must be supported by all member's cellphones. And most importantly, it must solve the problems described in section 2.2 and inform the administrative head of the local group about currently available rescuers at any time.

4.1. Description of the User Interface

All the core functionalities can be found on the main page, providing easy and fast access. The first two screenshots Figure 2 and Figure 3 show the main page of the app in its idle state, while the third, Figure 4, shows the differences during a rescue operation.

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[17] https://www.divera247.com/
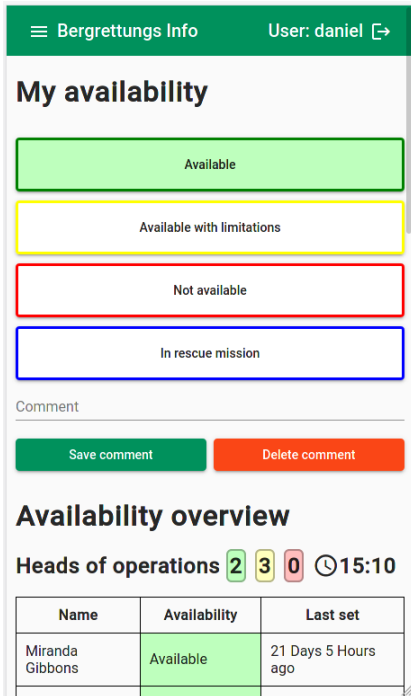
Figure 2: Upper part of the main page in idle state showing control panels for the users' availability state.

Figure 3: Lower part of the main page in idle state showing the availability states of the other members separated by potential heads and rescuers.
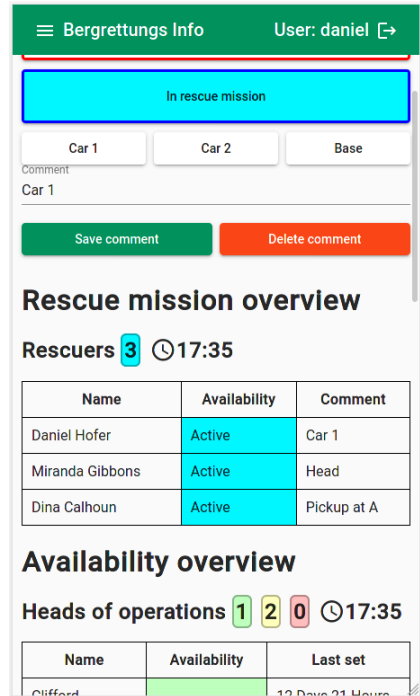
Figure 4: The display of the main page during a rescue mission.

4.1.1. User Interface Outside a Mission

Members can set their availability state by simply tapping their desired state. As soon as it is highlighted, they can be sure their state is saved as the display change is only triggered by the response from the server. For auxiliary information, there is an input field called *Comment* below the state buttons. Its purpose is to provide the possibility leaving a message, further describing their availability state. For example, to tell they are hurt and cannot carry heavy stuff, however they can still drive the emergency car.

The second part of the main page showing the *Availability overview* divides the members into three groups:

- **Heads of operation**: In this section, all potential heads of operations are displayed. They are separated for one important reason: The administrative head of a local group always wants to make sure that at least one head of operation is available. If this is not the case, a neighboring group needs to help out.

- **Rescuers**: Here, all ordinary rescuers are displayed.

Next to the headline of each section, the amount of people for each state is displayed for quick reference. The times displayed are also provided by the server. It allows to compare the displayed time with the current one, in case of an unreliable connection the user knows whether the information displayed is up to date.

In each section, the table shows details of the people involved containing their names, availability states including a color coding and, if present, also the comments. The last column contains the

currentness of the set data so the user can determine whether the state was refreshed just 5 minutes ago, maybe triggered by an alarm message, or whether the displayed state is already a week old.

4.1.2. User Interface during a rescue mission

The changings of the user interface during a rescue mission are displayed in Figure 4.

The upper section called *My availability* changes by adding three buttons for common rescuers and four buttons for heads of operation. By pressing one of those buttons, the user can quickly set a comment, for example to set their desired staging area. Heads of operation get an additional button with the content *Head,* so they do not lose time by typing this comment.

Bigger changes happen at the *Availability Overview*. An additional section is inserted called *Rescuers*, containing all members with state *In rescue mission*. In contrast to the other tables, there is no differentiating between rescuers and heads anymore. This is because the actual head of operations is already determined and displaying this information is useless. Furthermore, the *Last set* column is replaced by *Comment*, since this information is much more important, and the *Last set* information would show the start of the rescue mission. The last change is because any person already taking part in the rescue mission cannot be called for reinforcement, those already active are removed from their idle sections.

4.2. Overview of the Implementation and Used Technologies

Our application is structured in three tiers. A persistent storage, currently a relational database, a stateless backend providing a RESTful API and the frontend which is a progressive web application. The backend is written using the framework Spring and mostly provides the API for data access and enforces the authentication and very basic authorization. Apart from that, it does not contain components in the scope of this paper.

However, the uniqueness of our app is achieved in the frontend. As already stated, it is a progressive web application (Sheppard, 2017) and as such, tries to mimic the look and feel of a native mobile app while providing some advantages of websites. The most important of these advantages in our case is that the application only needs to be developed once and we can use common web technologies like TypeScript, HTML, CSS and the functionality of Angular, the framework we used. Furthermore, the distribution of the application is as easy as publishing a website. All the necessary additional files are generated by Angular and most mobile web browsers recognize the website as progressive web app and offer to install it. Another advantage is that rolling out updates is done by publishing a new version of the website, the facilities of the browser then take care of updating the local copy.

5. Practical Usage

We have been using this app now for a year and it turned out to work well based on personal feedback provided by other members. In the meantime, it has been adopted by all members of our local group. Even those not using WhatsApp out of privacy concerns like it for its closed-circuit nature.

When the rescuers are approaching the staging areas, e. g. a rescue vehicle, we now get an estimate about who else is going to come and based on this information, we can already anticipate their chosen staging area out of experience, even if they did not set an appropriate comment. Consequently, the vehicle drivers know whom to wait for and the approaching rescuers now have the information whom to call in case of a delay.

Occasional checks of the *Last set* column showed that our members update their state also without external triggers like an alarm message. However, in the case of an actual alarm, a majority updates their states almost immediately and a plausible estimation of available rescuers is possible. The comment functionality is also well used in such a situation, for example by denoting the possibility to join the rescue mission later because of not being at home or similar reasons.

For some rescue operations, only a limited number of rescuers is necessary. In this case, the application also proved to be useful. In such a case, the rescuers being on closer proximity to the victim's location would change their state earlier than those further away as they typically know they will arrive earlier than their colleagues, as we approximately know where we are residing. Therefore, the latter group would see whether they are still required.

6. Problems and Planned Research

Although the basic functionality already works well, there is still room for improvement. For example, the authorization model is rather flat as once logged in, everybody can read every information. Only for the user management, there are additional security measures in place. Therefore, this app can only be used by one single local group at the moment. However, this is also an excellent subject for future validation of the authors planned research about automating the access control enforcement in the communication between backend and persistent.

Furthermore, this app has potential for many more features and research topics. One would be the applicability of algorithms used to encrypt the content of messaging services in the environment of the app, especially regarding key exchange and decryption of sensitive information. This would also improve data protection in case of a data leak. Currently, no sensitive information is stored and only names and telephone numbers the members have access to anyway.

A better authentication model could also be useful, because at the moment, each session has a fixed lifetime. However, if the login is to be refreshed during a rescue operation, users might simply skip using the app for time reasons. Therefore, the *break the glass* model (Brucker & Petritsch, 2009) could be applicable here. The basic idea of *breaking the glass* is to have some form of access control in place and during special events, these measures can be bypassed in a controlled manner. In our case, this could mean that during a rescue operation, the validity time of a user session is prolonged.

Another partly solved problem is no or bad internet reception. While the app is mainly used in the early phase in which members are still in areas with good coverage, this problem still requires attention. Currently, the app, when opened, tries every minute to update the availability states and keeps the previous values until new information is present. Some parts of the app also cache data from the backend and show them if the backend cannot be reached.

7. Conclusion

During rescue operations in the mountains, time is a crucial factor. Therefore, every minute saved from the initial rescue call until the victim is found is precious. Communication is the key during the approach of the rescuers to their staging areas and from there further to the victim. A task which is hard, because at the same time, we must prepare our equipment, drive our cars. The head of operation additionally must communicate with parties like the alpine division of the police, the control room operator and most importantly, the victim themselves.

Therefore, we developed a web application, working on all major and current mobile phones with one code base by programming a progressive web application with the purpose of automating the communication between the members of a rescue mission in the early phase. More important however is the fact that we designed the user interface as easy to use as possible while at the same time providing all the information in a useful and easily retrievable way so that the main rescue operation is not disturbed.The most important functionalities of the app are all located on the main page. Key elements shown there are the availability state of the rescuers and the currentness of this information, the number of arriving rescuers, their desired staging area and small text messages considered as useful by the users. During the different phases, the interface changes only as little as necessary to display the new information while at the same time irrelevant data are hidden, so the user is not distracted by them.

8. Acknowledgments

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SMART SUPPLY CHAIN

BIG DATA IN B2B PURCHASING DECISION MAKING

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Keywords

Big data, procurement, supply chain, decision making, behavior

Abstract

Big data and data driven decision making belongs confidently to the most popular nowadays topics. One benefit is focused on higher transparency of market information and second on more efficient decision making with automation elements. There are different approaches to analyzing data driven decision making and process transformation. Many theoretical studies are focused too scientifically with low practical value. On the other hand, some AI application in scientific papers are based on data with problematic data structure or precision of model applicable directly in decision making. The reason is inconsistence and quality of data structure in different business environment and never ending fight between traditional econometrists and data miners in scientific world. In the paper, we would like to focus on different aspects of using data services for B2B procurement decision making.

1. Introduction

Data are dominating in current process of innovation across all sectors and are dominating in Industry 4.0 shifts (Zgodavova et al, 2019). Big data development, new data service provision or data science is accelerating in different companies to improve, make more efficient with human cost reduction. Processes supported by data through dashboards or expert systems are efficient way to increase efficiency of enterprise processes. Together, data have a potential to change decision making processes and provide semi-automated or automated decision making with high level of precision close or better than human based decision making. Of course, many of creative approaches realized by human is still far away from machine learning results, although in several situations it is more about mistakes reduction and cost effectiveness. Strategic sourcing is difficult to change but operational purchases are suitable candidate to full automation resulting into more efficient labor efforts redistribution, e.g. to more innovation driven procurement or other decisions critical for business success.

Although data science, data technologies and methods are developing into more robust and complex approaches and techniques, the reality of decision making automation driven data service adoption in world of practice is still on the edge of practicability. Data derived from real processes are often far away from clean data and methodologies used in experimental researches esp. within a

research community in the field of economics or social sciences. Character of new data from real processes determined by complex human behavior are challenging for data scientists with vision to provide innovative data services with high precision adoptable in world of practice. Taleb's thesis from the book Skin in the game (Taleb, 2018) can be the message also for researcher to data scientists in current world to change mindset and bring fairness and real risk management and understanding the world in econometric and data science related researches. From the similar aspect we can support this also by Herbert Simon's statement: "For every problem, one has a theory, a way of addressing the problem. Unfortunately, for many of the important problems in life, ther's a bad theory." (Ross, 2008)

In this paper, we are opening the world of raw data from real processes to show complexity and problems of data science and open debate on new scientific approaches to understand and use big and complex data and to develop methodologies and methods useful for causality and prediction applicable in real world of practice.

2. Added value of digitisation and data driven decision making process

2.1. Trends in data driven procurement decision making

According to Gartner study Top 10 Trends in Data and Analytics for 2020 (Gartner, 2020) there is growing trend for using smarter, faster, more responsible AI, decision intelligence and the shift from static dashboards to dynamic data stories with more automated and personalized experiences and to in-context data stories to each user based on their context, role or use. These dynamic insights deliver the right knowledge based on data modelling from extensive amount of data sources and types using different technologies such as augmented analytics, NLP, streaming anomaly detection to the right user in right processes for increasing efficiency of his decision making and validation the results.

Decision intelligence will bring complex adaptive systems that bring together multiple traditional and advanced disciplines and provides a framework to help data and analytics leaders design, compose, model, align, execute, monitor and tune decision models and processes in the context of business outcomes and behavior.

The crucial emphasize is focused on automation of decisions processes and documentation or auditing.

The rising amount of data sources providing added value in aggregated way stimulate development of data marketplaces and exchanges with single platforms to consolidate third-party data offerings and seamless data integration in interoperable form.

Dealing with decision making in B2B procurement area or supply management and according to several workshops realized by authors within procurers in Central Europe, the shift can be described as changing static information to real-in-time or automated data driven decision making.

Aggregation of several data sources will increase data quality and representative samples. In the field of market and supplier analysis, data from one business ecosystem can be enriched by data from business registries or other business ecosystem to reveal company's behavior in more accurate mean. For example, bid rigging behavior can be more visible in public procurement space or in special category of product or market segment what is risk factor also in supply chains with currently no visible behavioral signals.

On the other hand, purchasing managers has to set up efficient negotiation or procurement strategy for purchasing specific product. Within information asymmetry currently existing on the market,

there is only few possibilities how to learn from other purchasers, e.g. professional conferences and workshops, where through presented use cases they are enhancing their knowledge how to deal with specific situations in procurement and here, the data can play a significant role (Moretto, 2017).
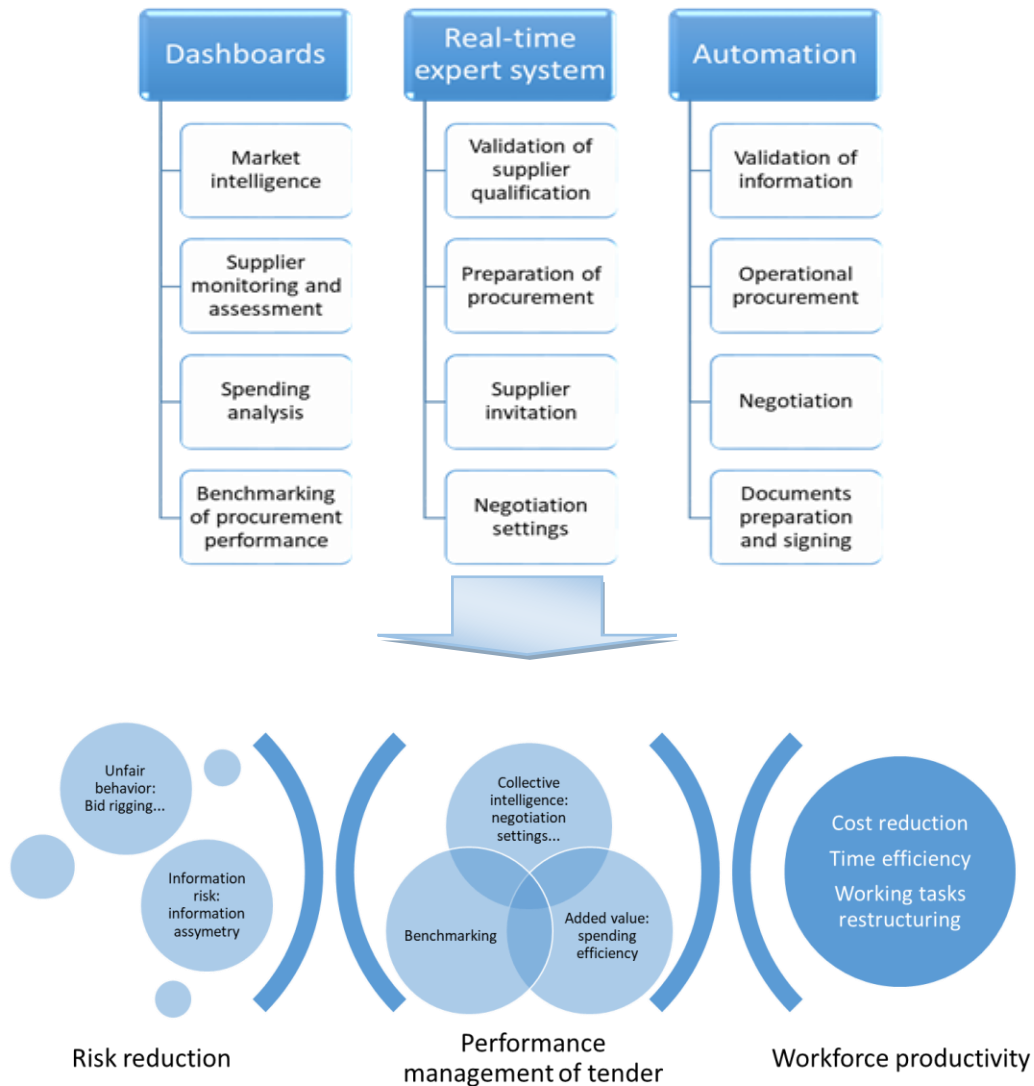
Fig. 1 Data exploitation for procurement decision making

Data aggregation provides opportunities to benefit from collective intelligence in the case, that users of such an ecosystem will be willing to share their experiences directly from their processes. The motivation to share can be beneficial from the collective intelligence point of view for everyone. The added value is not only in providing knowledge from experienced managers to "early adopters" but also to share experiences with supplier behavior in opposite direction.

The most complex solution is to fully automate decision making process where some decision making can be shifted to SW agent with predefined rules for his behavior. Although, there is still some open issues esp. in legal responsibility, generally the approach is applicable and according to discussions with member of Board28 (board of most experienced purchasing managers in Slovak and Czech republic) organized by NAR Marketing company as one of the leader in e-procurement SW in Central Europe, fully automated procurement can be effective with low risk in the field of operational procurement, where the negotiated savings are not so important as efficiency of workforce and errors reduction. The automation of such a process may lead to better utilization of

this workforce shifting purchasers to more sophisticated areas as procurement of innovation or bottleneck categories.

2.2. **Opportunities, benefits and limitations of big data in purchasing management on examples**

When we are dealing with big data in the field of market intelligence and B2B procurement decision making, there are several areas, where data driven solutions may be applied. In this section we will present several areas of data driven decision making application in commercial and public procurement.

2.2.1. Normality and linearity of business data

According to years of research, we can confirm, that data related to most frequent decision making problems are hardly normal or linear. Most common distribution of related continuous data are exponential, logarithmic, chi squared or F, negative binomial and similar. Together, dependencies are non-consistent in linearity and often have thresholds or cyclic patterns.
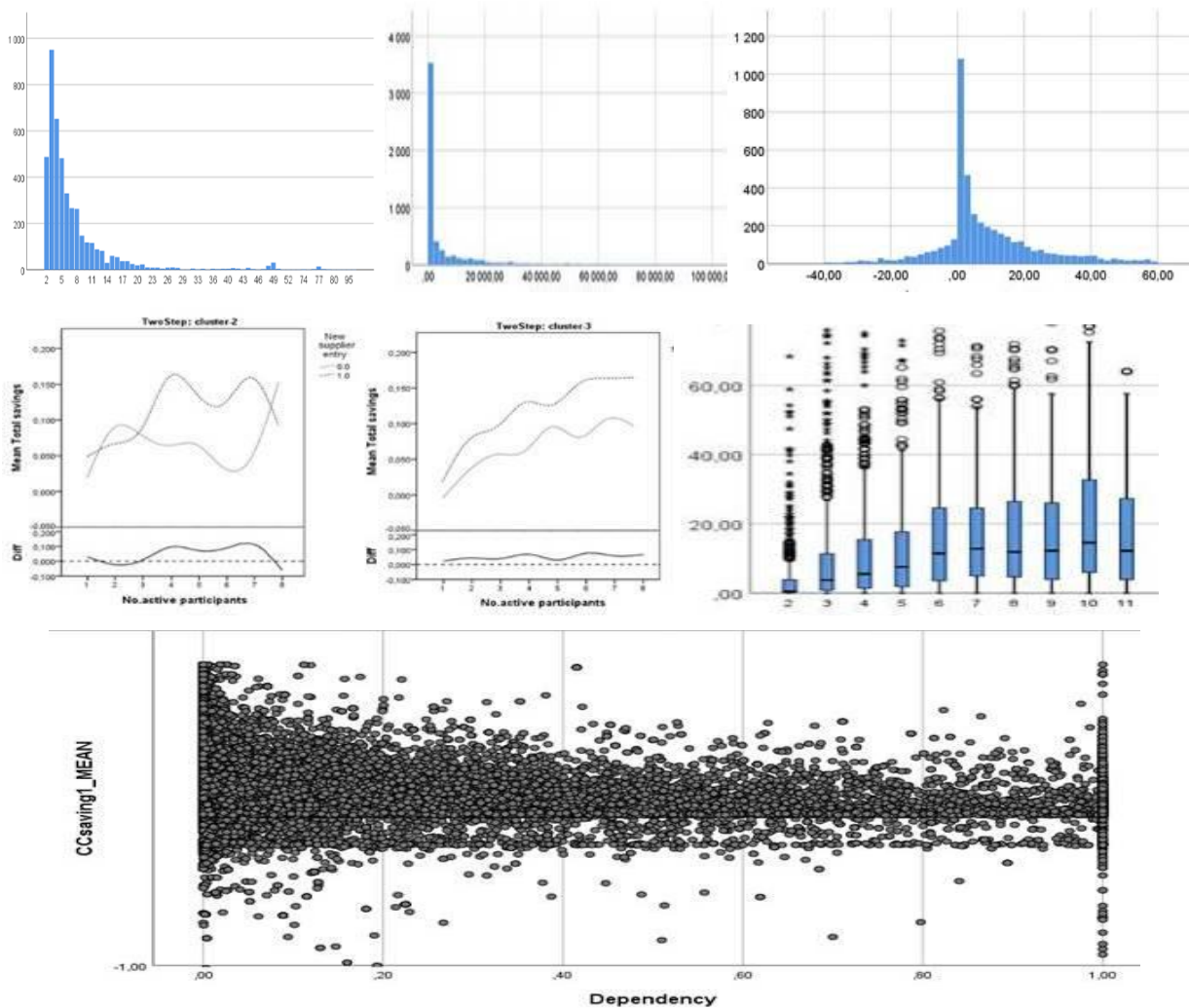

Fig. 2 Different visualisation of histograms and 2-3dimensional dependencies.

Interesting are also some situations, where dependency between two variable is heteroskedastic with one flat end. Such a data are problematic for transformation to normal distribution and for

parametric statistical methods. Together, non-parametric approaches are often providing low level of R^2 within standard econometric approaches.

Together, when enriching data from different business data sources, the character of data is not going to change. That's why the approach to data analysis or modelling have to be performed carefully esp. when causal econometric models are applied.

One of interesting approaches can be complex multidimensional panel regression supported by AI or deep learning, where traditional economists have still problems to accept this for causal approaches. Although, new techniques for causal datamining methods are currently developed which is promising way for both data miners/information management scientists and rigid causal oriented econometrists. The example is visible in decision trees where causal modifications are developed by some statisticians (Li et all, 2016)

2.2.2. Potential for benchmarking

One of the best and most simple solution is using big data to provide an opportunity to compare performance, strategies, behavior of one user to the market or group of similar users. Observatory potential is one of the most valuable benefit in the world of practice. It is easily understandable and that's why it is more trusted by end users as too complex and sophisticated methods like neural networks or random forest predictions. Although, observatory analysis may also be visually difficult, esp. when deviations from mean comparing two samples are too different. Visibility of extrems may have verhigh importance, although the visualisation can be problematic from the user friendliness aspect. Together, comparison of two trends in attributes with missing values within specific timeframe is sometimes confusing.

Fig. 3 Example of problems in data visualization for dashboards

One of the good example is benchmark analysis comparing volumes of suppliers contracts within one category of products or services. The figure present visualization of comparing suppliers in public procurement in Slovakia from data service transparex.sk. We are using original version of screenshots in Slovak language. It presents comparison for contract volume (pie graph), average number of competitors in tenders (vertical bar) and savings achieved in those contracts (horizontal bar) for three CPV categories. Here we see the potential of comparison, where the information about market position of suppliers invited or analyzed for B2B negotiation, where in small space in dashboard we are able to provide relevant information. Although, the problem begins, when extreme value of contract exists in the system. Figure 3 present the problem, when one supplier

won the sole contract with extreme value in building and construction sector. Non-consistency in data, where several extremes are normal may lead to visually unsuitable approaches and removing these extremes is also not useful as the observational benefits will be lost.

2.2.3. Bid rigging patterns

One of interesting information is signal of non-standard or unfair behavior in form of bid rigging or cartel. Such a alert is very efficient information which is based on aggregation of several data sources. In this case, data can identify and analyse different indications of unfair practices (Mihaly Fazekas...). Although, when analysing and visualising results we have to types of difficulties. The decision problem which is affected by information on bid rigging or collusions has to be algorithmised or modelled through different scientific methods. The easy way is to use some network analysis approaches or association rules as APRIORI algorithm, which can be easily visualised. On Fig. 4, apriori (left graph) is visualised using R language and "arules", "arulesViz" packages. Although, this approach doesn't looks so easy when we are dealing with multidimensional benchmarking problem. We have identified two dimensions:

- Full or partial diagnostics - It means, it is important if the decision problem is to identify only partial occurrence or to monitor full sample of occurrence. For example, apriori is looking for rules from specific threshold of frequencies. But the frequence of association (cluster of specific portfolio of suppliers frequently biding together) is very relative and it is specific cross different market situation, e.g. in one market segment is frequence of incidency high when reached more then 20 occurencies and in other segment also 5 occurences may mean high frequency. Together, when we would like to monitor trends and changes we need to calculate also clasters of suppliers with low frequency (from one as first occurrence in time). This problem is based on complex combinatorial calculations, when sample of all combinations also with frequency = 1 may be too high for standard computational performance and can spend amount of memory (terrabytes). The complexity is increasing when idenified combinations of suppliers inside all contracts have to be compared and tested in multidimensional space.

- Dashboard analytic approach vs simple alert – this problem relates with visualisation for end user within specific decision making process. Standard approaches are dashboards providing possibilities to analyse and play with information, to search for different relations between suppliers etc. This approach has difficulties in achieving user friendly solution to visulise those relations. Fig. 4 provides and example when on the right network graph, the relations are presented through Noe4J db tool. The problem is most crucial when analysing very complex market segments or contracts, where one supplier may be winner in hundreds of contracts with thousands of competitors. Enriching this information on information about interconnections between different companies, shares and persons makes this visualisation much more difficult. The easier way is to calculate based on specific algorithm relevant signal reflecting risk factor for manager and to visualise only simple alert in relevant phase of decision process to deliver information with suggestion to reduce the risk by suitable measure (e.g. recommendation to invitate specific sample of additional suppliers).
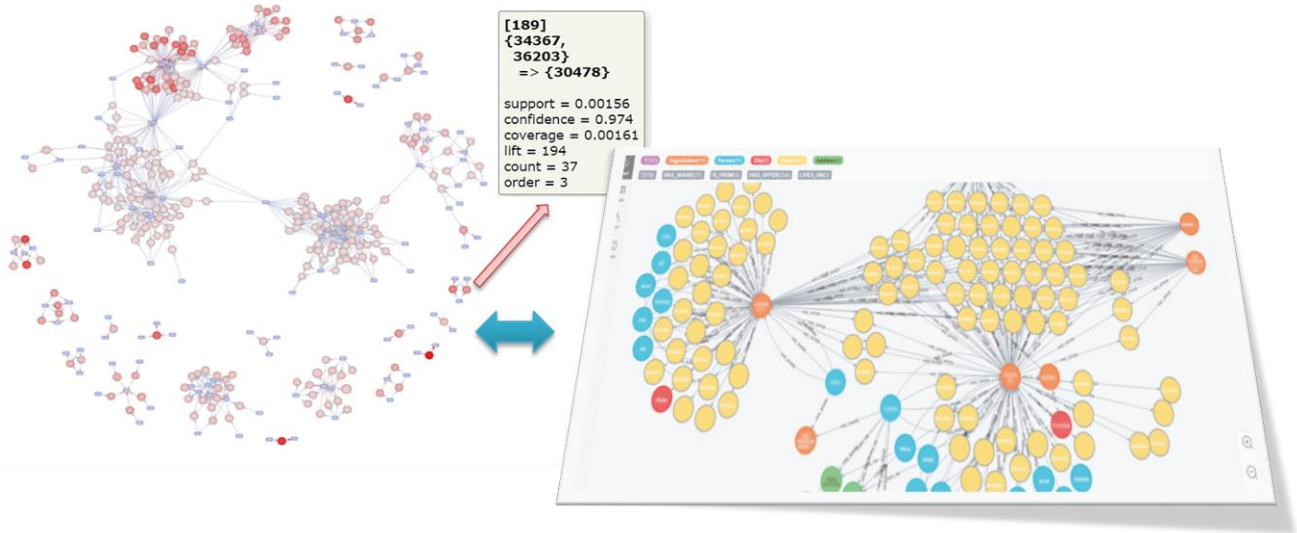
Fig. 4 Apriori and graph database visualization approaches

2.2.4. Identification of risk thresholds

In several decision making problem in spend management, purchasing managers are dealing with risk analysis to classify if some spending situation or supplier indicator represent higher level of risk. One of interesting risk management problems is risk related to dependency. It means, for purchasing organization is important to monitor the level of dependency on supplier as several theories or policy documents set up some risk thresholds (generally 40%), when this contractual relationship means higher risk for purchasing organization leading to worse contractual conditions. Big data provides an opportunity for continual testing these thresholds and update risk levels with validation of financial or non-financial impact predicted through data modelling.
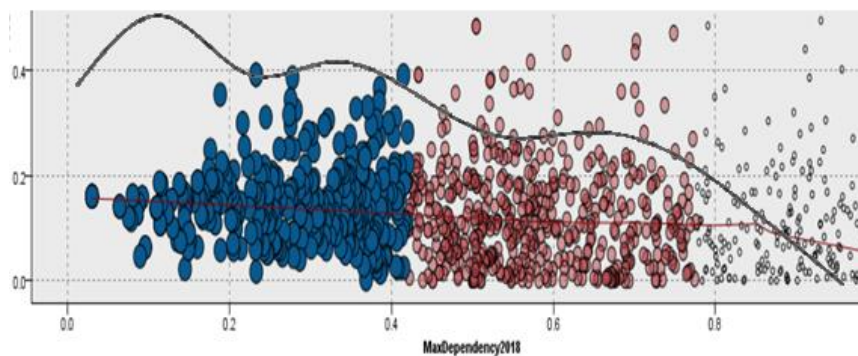
Fig. 5 Clustering approaches for threshold identification

On the Fig. 4, we see simplified visualization of multidimensional clustering problem to identify thresholds of dependencies with certain impact on prices (in the Fig. 5 the y-axis variable is Saving achieved from negotiation as derivative variable of price). The graph may simply visualize different trend signals for important change in the negative impact of dependency level on prices/savings. Such a visualization may lead to modifications in spending related risk management strategies for companies based on continual testing big data space.

2.2.5. Multidimensionality

Another interesting problem is the multidimensionality of decision problem. In this context several modelling approaches by scientists are applied. Although, as mentioned above, in world of practice complex scientific methods may harm the trust as crucial factor for the motivation to use results of such a modelling in decision practice. Also here, several approaches are possible. Multidimensionality of decision problem may rise from complexity of market situations, where behavioral patterns are depending on aspects like type of product or services purchased, competition size, price trends, innovation level of product category, type of procurement category (strategic vs operational…), differentiation between incumbent and new supplier within specific supply chain or on the global market and many other.
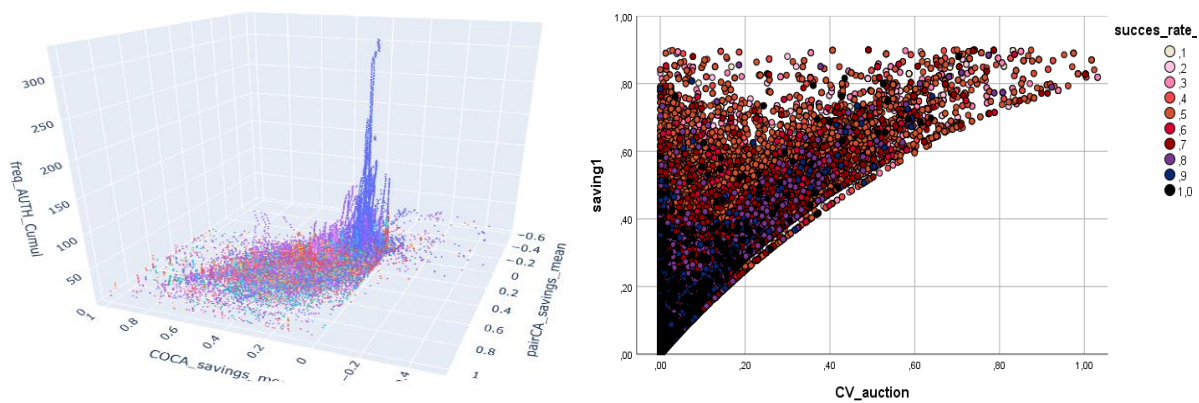
Fig. 6 Multidimensionality in procurement data

Multidimensionality within max. three or four dimensions can be visualized sometimes also through standard scatter plots or 3D graphs, where third or fourth dimension can be presented through different colors or shapes. According to our experiences with commercial and public procurers, this type of visualization is very attractive and probably should be applied first, before more sophisticated techniques like machine/deep learning will be applied. Although, the understandability is often low. On the left graph we see four basic dimensions where fourth dimension is visualized by different color (CPV – product classification in public procurement). This visualization was tried to explain different dependences between average savings of buyer-supplier relationship, the frequency of their contracts and average savings provided by the same portfolio of supplier entering the negotiation. The problem is to integrate other important dimensions as number of companies negotiated within negotiation, value of contract or type of negotiation which are often significant predictors in most of modelling approaches. The right graph present dependency between CV – coefficient of variation based on auction offers and Savings achieved with third dimension success rate of supplier. This dependency is visible in V shape, which is problematic to model by standard econometric models. After first observatory analysis and visualisation to end users, after trust in data and data presentation will be achieved, more sophisticated techniques may be used but according to our experiences, knowledge for decision making achieved from e.g. ML techniques should be then implemented not in dashboard approach but directly in the decision making process as alert, specific recommendation or automated feature.

2.2.6. Decision rules for data-driven decision making

One of the main problem of data modelling for decision making in the world of practice is how to understand data modelling results and how to use it in concrete situation. After our discussion with purchasing managers, there was interesting shift in usage of decision rules in different visualized

forms. This method was absolutely new to all managers but they appreciate understandability of modelling results in graphic and text form.

The main benefit of using decision rules techniques was understanding non-linearity and specificity of using concrete decision rule in concrete situation. The approach IF THEN is applicable directly in decision making process as tree visualization or similarly like ML approaches mentioned above in the form of alert or recommendation directly in the process. The most important issue in the case of tree visualization is to consider partial visualization of specific branches or rules as in complex data ecosystem the tree can be too large and difficult to visualize on the screen. On the other hand, this kind of visualization meets requirements of end users – managers to simply understand modelling results and learn what to do in concrete situation.
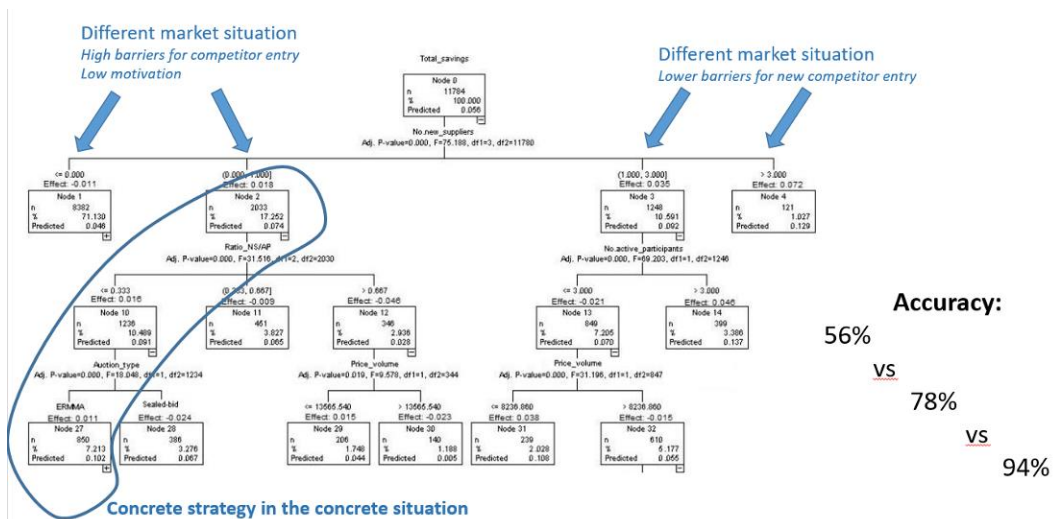
Fig. 7 Chaid algorithm explaining the role of new supplier in negotiation on procurement savings

3. Conclusion

Data from real procurement processes are often complex and cause headaches for rigid econometrists regarding assumptions to use standard approaches or transformations. On the other hand, the data are now big enough to provide valuable source of information and decision making support or its full automation. The most crucial issue is how precise the data service should be or how exact the knowledge provided from modelling is sufficient for decision making in particular procurement phase. As for automation of operational procurement decision making is not so sensitive on precise prediction or achieving highest savings (because of the nature of operational purchases, where we are dealing with low contractual value but higher potential of mistakes or human efforts), the data service doesn't need to be based on complex modelling with high savings achievements/prediction but it is enough to apply benchmarking approaches to provide standard behavior within decision making, e.g. within middle quantile.

On the other hand, for managers, the visualization of complexity based on aggregated data from the company's processes or aggregated data from market (e.g. from e-marketplace) is very useful but not so simple when dealing with extreme values and non-consistent behavior.

Nowadays, the challenge for data scientists is to bring methods for modelling and multidimensional visualization or creative ways how to visualize multidimensionality and complex dependences to understand the behavior in procurement processes and to provide precise expert or predictive analytics not only by using buzzwords like AI, ML or DL but also provide the knowledge which is

really validated by real world of practice not influencing the behavior by inappropriate prediction. The right way of data science in B2B procurement area may lead in fully automated decision making of procurement and negotiation with interesting results and potential to shift human efforts to more creative and knowledge intensive area as procurement of innovation to bring new added value for the company. This direction should be applied in current education to provide data skilled students for real world of practice (Zgodavova et al, 2008, Zgodavova et al, 2011).

4. APVV acknowledgement

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ANALYSIS OF SELECTED CHARACTERISTICS OF E-CONSUMER BEHAVIOR OF SLOVAKS DURING THE FIRST WAVE OF THE COVID-19 PANDEMIC

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Keywords

Abstract

The issue of the impact of the pandemic on the economy is still relevant, especially in time after the peak of its second wave. Entities on both the supply and demand sides of the market had to adapt to highly non-standard market conditions in a relatively short time. Closing the economy, combined with social distancing, was supposed to slow the spread of the pandemic. The question of how successful this effort has been can only be answered over time. In any case, the consequences of a lockdown in the form of changes in common patterns of behavior can be monitored almost immediately. The aim of the presented study is to examine selected characteristics of consumer behavior of Slovaks during a pandemic compared to the reference pre-pandemic period. During the first lockdown in 2020, the B2C interactions of the five largest Slovak e-shops and their customers in the environment of the social network Facebook were monitored on a daily basis. The results suggest that customer interactions have shifted over time during the current day, while the interactions of content producers have remained unchanged. In order to remain effective in spending resources on promotion, companies will need to better reflect changes in customer behavior patterns in the future. At the same time, it is necessary to monitor how the identified trends will create new standards.

1. Introduction

Efficiency is a basic prerequisite for market success, it is no different in the process of managing supplier-customer relationships. Literature (Balaniuk et al. 2021, Proskurina & Pushkar 2021) brings us several perspectives on the key determinants of efficiency, both from the point of view of producers and from the point of view of the consumer. Technologies in many areas of business contribute to shortening supply chains (Maryška, Doucek, Kunstova, 2012, Zgodavová et al. 2019,

Zgodavová et al. 2020, Chandak 2021). It may result in better cost optimization, transparency and more flexible pricing (Delina 2014). However, price is slowly ceasing to be a determining factor in market success, and more and more customers are beginning to take into account factors such as social responsibility and sustainability in their consumer behavior. Barska and Wojciechowska-Solis (2020) state in their study that as part of the constant shift in consumer awareness of sustainable development, this trend has spread, inter alia, to grocery. For consumers, food consumption decisions are increasingly becoming an opportunity to showcase their specific value system. Local foods, which consumers perceive as healthier, unprocessed and contain less preservatives, are gaining in popularity. The production of such goods requires the use of fewer natural resources, leading to a lower ecological footprint. At a time of massive growth in the share of e-commerce, it is necessary to take into account other important success factors, such as trust and reputation (Delina, Tkáč, 2010, Dorčák, Markovič, Pollák 2017, Soviar, et al. 2019). Shao et al. (2019) state that security is an important determinant of customer confidence. This is followed by a reputation and adaptation of the platform. Customer confidence is negatively associated with perceived risk and positively with the intention to continue using the platform. While successful market players fully benefit from a good reputation, Lv et al. (2020) in their study point out that the main motivation to buy on low-reputation platforms is a discount on the price. It could be said that the amount of the discount is often times a kind of compensation for the perceived reputational risk. A specific category of online platforms that support e-commerce are certainly social media (Brown et al. 2003, Dorčák, Štrach, Pollák, 2015, Hossain & Sakib 2016). And it is far from just the domain of small and medium-sized enterprises. Social media has become a means of modern communication even for multinational corporations or state governments. Aladwani and Dwivedi (2018) note that there has been a growing interest of stakeholders in the governance of public affairs in social media over the last decade. In the context of this growing interest, there is a real need to understand the process and outcome of government-citizen interactions. Aladwani and Dwivedi (2018) further explore this important issue by proposing and validating the SocioCitizenry theory, depicting the interaction between government and the citizen through social media. SocioCitizenry theory takes into account three main constructs, namely:

- quality prediction,
- trust configuration,
- approved adaptation.

Karampela et al. (2020) conducted research in the B2B environment, where they examined, through company profiles, which factors have a significant impact on the accepted presence of companies on social media. They also tried to identify the challenges, or directly the benefits, associated with the subject's presence on social media. The strength of the customer's relationship with the brand was determined in this research by four indicators, namely:

- commitment,
- intimacy,
- repletion,
- perceived quality.

Using modeling of structural equations, data from an online survey of 200 customers of British B2B companies were analyzed. The researchers found that the supplier's presence on Facebook, LinkedIn and Twitter has a positive impact on all four indicators of the strength of the customer's brand relationship. The interactivity of the brand has a positive effect, which increases its perceived quality as a partner. Commitment to the brand positively affects the brand's ability to react. Social networks are beneficial for building the relationship between the subjects of market exchange. At

this point, we come to the fundamental problem of the presented study, specifically to the situation where social media no longer play only a complementary role in the distribution of information, but become one, it could even be said that the only possibility of interaction for almost all market participants. The COVID-19 pandemic at the beginning of 2020 paralyzed almost the entire global market ecosystem. The local and global downturn in the economy was aimed at slowing the spread of the pandemic. Wang et al. (2020) state that the beginnings of the pandemic were marked by significant changes in consumer behavior, in particular the accumulation of basic foodstuffs and everyday consumer products. The state of food accumulation by consumers at the time of the COVID-19 pandemic in China was similar to the state of food accumulation by consumers in the rest of the world. If we take into account the fact that the traditional infrastructure was largely replaced by electronic sales, and most of the goods were delivered directly to the customer, it can be stated that the crisis situation put disproportionate pressure on the entire distribution chain. This brings us to the basic research problem of the presented study, but until we proceed to its formulation, we consider it necessary to specify the basic factors that define the research problem, namely:

- closure of a large part of the traditional infrastructure,
- crisis behavior of the demand side of the market manifested by the accumulation of goods,
- the absence of the possibility of traditional interactions related to social distancing,
- overload of the distribution chain.

The interactions of market actors under the pressure of the pandemic did not disappear, just as the market exchange did not disappear at the time of the lockdown, only the way changed. Interactions as well as a significant part of the market exchange have moved to the online environment. Due to the nature of the environment and the nervousness of the market, this non-standard situation has created a combination of highly unpredictable factors in the nature of both challenges and threats to all stakeholders. The research problem was formulated in the form of the need to examine changes in consumer behavior that occurred in response to a non-standard COVID-19 pandemic outbreak.

2. Objectives and methods

During the first COVID-19 lockdown in spring 2020, specific market conditions were created almost on every market across the north hemisphere. These conditions created a model environment for research in almost every spectrum of science. The first part of the paper presented the theoretical basis of the analyzed issue.

The aim of the second part of the paper in the presented study will be to describe and evaluate selected activity indicators of more than half of million customers of the five largest e-commerce entities operating in the Slovak virtual market, ranked based on traffic to their websites in the journal E-Commerce Bridge for 2019 (E-Commerce Bridge, 2020). The duration of the research represented the period of the first lockdown announced in the Slovak Republic during the state of emergency in the months of March to June 2020.

The research set consists of customers shopping in Slovak e-shops. The research sample is made up of fans of the official profiles of the research subjects within the environment of the social network Facebook. It consists of approximately 5000,000 users.

From the point of view of recording data for subsequent analysis, in the period from 15th March to 13th June 2020, the activities of monitored business entities in the form of posts and parallel interactions of monitored customer groups on these posts were systematically recorded on a daily basis.

For the purposes of the analysis, it will further examine the nature and timing of interactions of individuals in the marketing communication of business entities in the form of Facebook posts. By post for this case, we will therefore understand the contribution of the dominant character of marketing communication, which will be published in the monitored period by the subject, resp. subject profile manager on the official profile of the monitored company.

Forms of customer interactions / reactions will be expressed in the form of Likes, Comments and Shares on that Posts.

As for the data collected, they will first be classified, then evaluated through descriptive statistics and finally interpreted graphically to illustrate key findings. Subsequently, the analysis procedure will be evaluated, as well as its achieved partial results relevant to the defined goal of the paper.

Within the study itself, space is created for the identification of possible patterns of customer behavior, which was identified on the basis of a sample of almost half of million customers of the five largest e-commerce entities in the Slovak Republic. With this contribution, the authors want to contribute to the shift of knowledge within the managerial and economic sciences, with the aim of creating a qualitative knowledge base within the needs of future in-depth research into the impact of the COVID-19 pandemic on the economy.

Taking into account all the facts and variables, the research question can be formulated as follows: "Is there a change in the pattern of behavior in our chosen research group in the form of a change in the relative number of interactions compared to previously performed reference measurements?"

3. Results and discussion

Social networks during repeated lockdowns in 2020 were a safe alternative to traditional ways of meeting the majority of the population in terms of anti-pandemic measures. Despite the fact that for a part of the population we take into account technological barriers associated with the active use of Internet services by default, in our study we look at the population as a homogeneous and fully digital literate research set in this case. The process of adaptation of the population to technological changes in the market we are monitoring is continuous, with a clear progress towards stagnation. Over more than two decades, the ratio of potential and real users has been gradually leveling off, gradually saturating the market. In professional texts, we repeatedly encounter claims that the pandemic hit the market in sufficient digital condition, so it was possible to digitize the necessary part of the transactions in a way that did not significantly disrupt the intensity of market exchange. At this point, it should be mentioned that it is not only the transfer of the product as such that takes place within the supply chain. Service and support processes also ensure the exchange of information in its various forms. The flow of information in a virtual environment significantly shortens the reaction time, which adds dynamism to the whole process of market exchange. Consumers are targeted by the promotional message of producers, to whom they provide active and often assertive feedback in almost real time. The mix of variables under the pressure of uncertainty multiplies the uncertainty on both sides of the market exchange. For the purposes of our analysis, we chose the largest social network Facebook, then we focused our attention on the social media activity of the five largest players on the Slovak Internet market. Specifically, we analyzed the following business entities:

- Alza.sk,
- Mall.sk,
- Nay.sk,
- Martinus.sk,

- Bonprix.sk (in this case, it was the geographical location of the global profile).

From the point of view of overall indicators of social media activity of our chosen subjects within the monitored period, it can be stated that it is a relatively active market both from the point of view of the activity of subjects and from the point of view of the activity of the user group. The following Table 1 presents the basic indicators of activity:

Table 1: Social Media Activity Indicators

	Number of posts (n)	Number of likes (n)	Number of comments (n)	Number of shares (n)	Number of days (n)
SUM	679	171,138	59,684	8,795	91
Daily Max	14	6,497	5,854	1,152	91
Daily Min	3	52	0	3	91
Daily Average	7	1,881	656	97	91
Daily Modus	7	910	488	6	91
Daily Median	7	1,016	358	29	91
Total fans approx. 500,000					

In the monitored period of ninety-one days of a state of emergency, we recorded almost 240,000 interactions on almost 700 contributions on the profiles of subjects we monitored. We then classified them into predefined five timeframes, which represented the model day during the lockdown. In order to identify changes in consumer behavior, we used research conducted in the past as a pre–pandemic framework (Pollák, Dorčák 2016). The reference values are as follows:

	00:00-08:00	8:00-12:00	12:00-16:00	16:00-20:00	20:00-00:00
Like	103%	103%	89%	105%	127%
Comment	88%	101%	100%	100%	94%
Share	81%	92%	112%	99%	105%
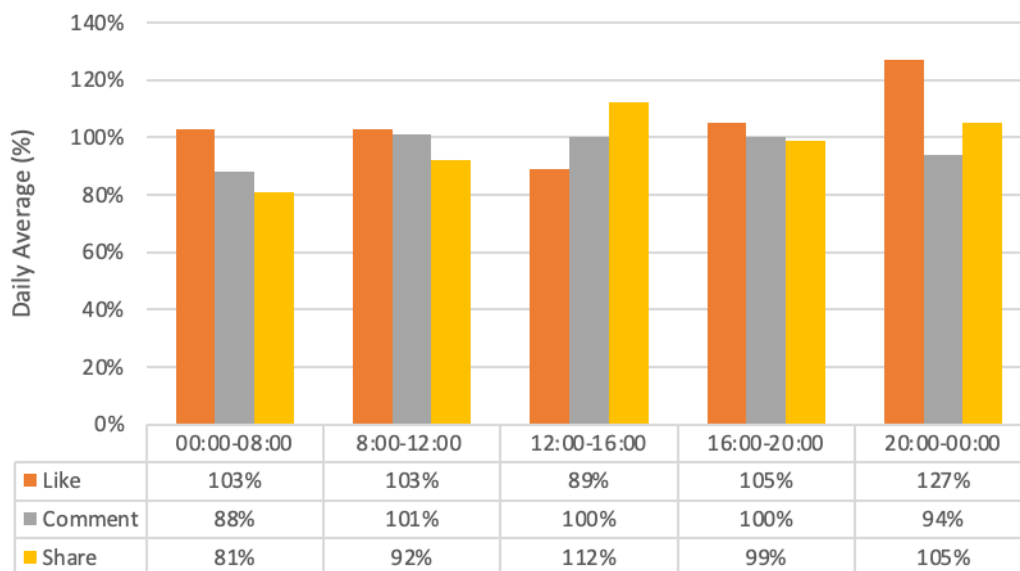
Figure 1: Interactions – Reference research / Model Day (before COVID-19 pandemic), Source: own processing based on Pollák, Dorčák (2016)

As can be seen from the figure, user interactions are distributed relatively evenly across the model day. A gradual increase in interactions can be observed in the afternoon. Regarding the model day within the pandemic lockdown, we record significant shifts within all evaluated parameters. The following figure presents the measured data:

	00:00-08:00 (Mo-Sun)	08:00-12:00 (Mo-Sun)	12:00-16:00 (Mo-Sun)	16:00-20:00 (Mo-Sun)	20:00-00:00 (Mo-Sun)
ø Number of likes (%)	1%	386%	68%	40%	5%
ø Number of comments (%)	0%	283%	156%	61%	1%
ø Number of shares (%)	1%	167%	207%	120%	5%
ø Number of posts (%)	20%	183%	102%	166%	29%
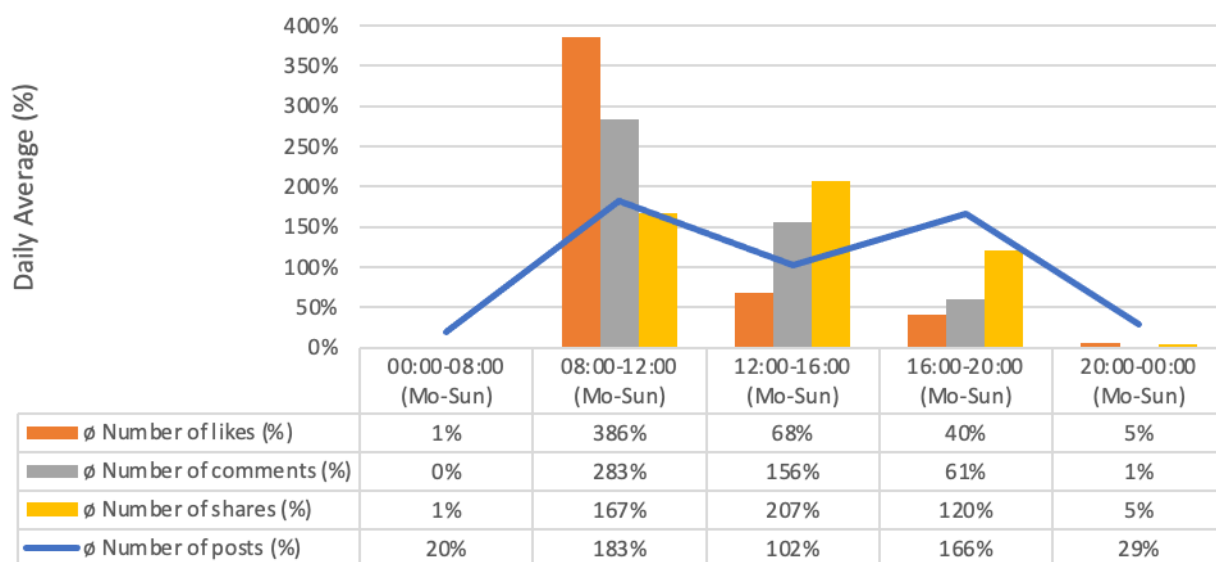
Figure 2: Interactions –Model Day (during COVID-19 pandemic), Source: own processing

As part of the comparison of the reference research with the data measured during the first of the lockdowns in 2020, we can state (and thus answer the research question) that there is a significant change in the patterns of behavior of our chosen research group in all monitored areas. From the point of view of the achieved maxima of individual types of interactions, we can observe significant differences in each of the time frames. While in the reference research the average values of individual indicators oscillate around the value of 100%, during the lockdown period monitored by us, the dominant part of interactions shifts to the morning, while in the early morning and late evening we record only trace values regardless of the type of interaction. Although it is possible to observe a certain trend of increasing the relative number of shares in the time frame 12:00-16:00 (Noon to 4PM), the maximum of the relative number reached during the pandemic is almost doubled. The likes, comments and shares are many times higher than the overall average during the morning. Then they subside in the afternoon. In terms of the number of contributions that interactions elicit, we record symmetric values only during the morning time frame. The increase in the activity of the subjects in the afternoon does not cause a symmetrical reaction of the users.

4. Conclusion

The consumer is a relatively complicated and indeterminate variable in supplier-customer relationships. Under normal circumstances, its behavior can be predicted in part on the basis of common patterns. The process of distributing information and, of course, the process of distributing goods and services must take full account of these patterns of behavior. Only in this way is it possible to increase the efficiency of spending corporate resources towards achieving competitiveness. In the case of crisis situations, the number of variables approaches the limit when it is almost impossible to choose the optimal strategy. It is therefore essential from a scientific point of view that any crisis situation is perceived from the perspective of a potential opportunity to produce new knowledge. This knowledge should help prevent uncertainty in decision-making. The ambition of the presented study, which is part of a comprehensive and ongoing research, was to identify changes in consumer behavior that were caused by the COVID-19 pandemic in the selected market. From the point of view of consumer behavior, interactions within the customer tribes of the five largest Slovak e-shops during the 91-day state of emergency in the first half of 2020 were analyzed. The results suggest that customer interactions have shifted over time during the current

day, while the interactions of content producers have remained unchanged. In order to remain effective in spending resources on promotion, companies will need to better reflect changes in customer behavior patterns in the future. At the same time, it is necessary to monitor how the identified trends will create new standards.

From the point of view of research limitation, it is necessary to mention that the presented data have a predominantly regional nature. From the point of view of data processing, this is the primary qualitative form of the output. The identified patterns of behavior will be further tested to eliminate the effects of seasonality, and also, to confirm identified trends over time. Last but not least, it should be mentioned that the data are recorded in terms of interactions (with respect to available resources) at predefined time intervals based on the time of publication of the posts. We assume that the dominant rate of interactions occurs at the time the content is published. This limitation can be removed using additional computational capacity, for the allocation of which it is necessary to produce just data of a dominant qualitative nature.

From the point of view of possible future directions of research, we consider it essential to examine aspects such as seasonality and stability of characteristics over time. Also, the extension of the study to more territories within the European market. The statistical processing of the characteristics identified during the Christmas holidays is currently underway. At the same time, data are being collected in the time period one year after the first COVID-19 closure of the economy. After a thorough statistical analysis and evaluation of the findings, the authors plan to publish their findings in order to obtain feedback from the academic community. It is also planned to use the data as input qualitative variables in a large-scale research project on the effects of the COVID-19 pandemic on changes in consumer behavior in selected European countries.

5. Acknowledgment

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FACTORS INFLUENCING IMPLEMENTATION OF ELECTRONIC PROCUREMENT IN ECONOMIC SUBJECTS - EMPIRICAL EVIDENCE FROM SLOVAK COMPANIES

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Keywords

Electronic procurement, digitization, economics subject's factors, Slovak Republic

Abstract

Based on literature review there are factors influencing company's necessity to implement electronic procurement system. Dividing factors into three conceptual categories – organizational, technological, and environmental offer better view on factors that might influence company's decision to embrace EP. Factors that might be influencing manager's decision were collected through questionnaires sent to 400 randomly selected companies with controlled distribution to companies of all sizes and regions in Slovakia. Testing hypotheses by non-parametric test Mann-Whitney showed that distribution of EP implementors is not equal to non-implementors when focusing on company size, return on sales, innovation attitude, using of IT and IS, having specialized IT department and perceiving company's environment regarding competitors and supplier-customer chain. Evidence based on received data also states that companies using EP in business processes reach higher rentability on sales as the companies that do not.

1. Literature review

As stated by Robinson, Wale and Dickinson (2010) and Rolstadas, Hetland, Jergeas, and Westney (2011) E-procurement (EP) is the use of technology by company to establish contracts and purchase products or services. Another definition by Rai et al. (2006) states procurement is in charge of determining consumer needs, translating them into requirements, coordinating the distribution of goods and services, and evaluating customer satisfaction. Knowledge-intensive business services studies have looked at many elements of procurement of professional business services from both the customers' and providers' viewpoints. (Andreini et al., 2015; Järvi, 2016). Dealing with vendors, including pricing, purchasing, and distribution, is another responsibility. The use of EP is a way to speed up and lower the cost of corporate buying activities, also in accordance with Gunasekaran et al. (2009) EP is providing opportunity to explore and access wider markets.

By the time we could notice that procurement, or EP is shifting its essence. its effect on each enterprise and total behavior of the supply chain can be simulated at the same time. (Matsuda et al. 2020) As a result, market makers use e-procurement to create value and build relationships with various stakeholders in the particular field or sector. According to Wee et al. (2015), the modern industrial landscape is undergoing a systemic shift toward a service model. Furthermore, the age of Industry 4.0 has made the industry sector more complex and dynamically affected. According to

Teo, Lin, and Lai (2009) the use of standard methods such as, web browsers or e-mails to advanced dedicated EP processes is just part of the EP process, such as inter-organizational information systems or as a part of supply chain management. (Ivanov, 2016)

In more detailed approach Wu et al. (2007) included two levels of EP intensity: A) usage of the coordination program - use of EP as a strategic tool to facilitate information exchange with suppliers, such as sharing product and inventory planning information with suppliers; B) transactional technology usage - using EP to make purchases easier, such as electronically placing orders with suppliers. According to Tornatzky and Fleischer (1997) there are three facets that might affect implementation: I. Size of company, II. Technical background, III. Environment of business.

In accordance with annual report for year 2019 of national public procurement office of Slovak Republic (2020) through the EP network, 865 procedures were completed with a total contract value of 1,829.818 mil. EUR, representing 30.9% of the total number of procedures and 39.5% share of the total value of completed contracts. Annual report also states that groups of economic subjects concluded 160 (5.7%) contracts worth 860.945 mil. EUR (18.6%). Purpose of this work is to determine the degree to which EP is used in the various economic subjects in Slovak Republic, and also if there are conceptual factors, organizational, environmental, and technological, as mentioned above, that might have been determining EP implementation by selected company.

2. Methodology

Data collecting for this work was realized through questionnaire. Before sending out questionnaire, interviews with administrators, researchers, and EP vendors were used to determine the questionnaire's overall accuracy. The questionnaire was marginally modified based on the findings of the pre-test to improve the response rate as well as the data validity and reliability. Variables that we are interested in purpose of our study are mentioned in table 1 below. Questionnaire was sent to 400 companies, where 100 companies were randomly selected for each size depending on the number of their official employees noted in database, also we sent questionnaire proportionally to each of 8 regions to preserve rational distribution among all regions. To find out how company perceive their view at competitors, innovation processes, supplier-customer market chain and usage of IT/IS in organization, there is used option to answer the questionnaire on Likert scale on range from less awareness to most interested. Overall, 141 questionnaires were collected, unfortunately 3 answers had to be removed, as they had missing values, final dataset consist of 138 entries.

Table 1 Variables included in analysis and their measurement

Conception	Measure	Scale	Adapted
EP implementation (EPI)	"1" =EP implemented, "0" = EP not implemented	nominal	Aguiar – Palma dos Reis (2008)
Company Size (CSZ)	number of employees	nominal	Fowler (1993)
Return on Sales (ROS)	percentage of ROS from previous accounting period	nominal	
EP implemented by competition (EPC)	perceived variable by respondent	interval, Likert 1-5	Teo et al. (2003)
EP used by trading partners (EPT)	perceived variable by respondent	interval, Likert 1-5	Zhu et al. (2003)
IT department (ITd)	"1" = ITd in company's structure, "0" = ITd not in company's structure	nominal	
Usage of IT/IS within company (ITIS)	perceived variable by respondent	interval, Likert 1-5	
Company location (LOC)	each region with own value	nominal	

Conception	Measure	Scale	Adapted
Innovation tendency (INNT)	perceived variable by respondent	interval, Likert 1-5	

2.1. Hypotheses formulation

For all three conceptual dimensions – organizational, technological and environmental, as mentioned in literature reviews, we formulate following hypotheses.

For organizational concept:

- H1.1: Companies implementing EP are generally larger in number of employees.

- H1.2: Companies which implemented EP are having better results in ROS.

- H1.3: Companies which implemented EP have tendency to focus on innovation processes.

For technological concept:

- H2.1: Company using IT and IS in larger role has tendency to implement EP.

- H2.2: Company with sole IT department has tendency to implement EP.

For environmental concept:

- H3.1: Company operating in Western Slovakia has tendency to implement EP.

- H3.2: Companies which perceive their competition using EP are likely to implement EP.

- H3.3: Companies which perceive their trading partners using EP are likely to implement EP.

As long as the variables are from interval and ratio and the assumptions for normal distribution were violated, the non-parametric test is necessary. *The Mann-Whitney U* test was used to compare companies that implemented EP with companies that did not adopt EP on each of the self-reported answers. (Deshpande et al., 2017) The use of nonparametric tests is more general than for parametric tests because they can be used both for data that do not correspond to the normal probability distribution and for data that do not correspond to the normal distribution as stated by Hančlova (2012). In this case, nonparametric tests are usually used for indicative evaluation, where the original measured data are not used for testing, but only their serial numbers in a variational series created by a certain procedure from the values of both compared sets. Accuracy and resolution *of nonparametric tests are not as high as for parametric tests*.

3. Results of study

Table 2 Hypotheses summary Mann-Whitney U Test

|	Null Hypothesis	Test	Sig.
1.1	The distribution of CSZ is the same across categories of EPI.	Independent-Samples Mann-Whitney U Test	.000
1.2	The distribution of ROS is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.000
1.3	The distribution of INNT is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.001
2.1	The distribution of ITIS is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.000
2.2	The distribution of ITd is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.000
3.1	The distribution of LOC is the same across categories of	Independent-Samples Mann-	.929

		EP implementation.	Whitney U Test	
3.2		The distribution of EPC is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.000
3.3		The distribution EPT is the same across categories of EP implementation.	Independent-Samples Mann-Whitney U Test	.000

As shown above in table 2, there was performed hypothesis test for all defined hypotheses. Only hypothesis 3.1 should be rejected, as null hypothesis would be retained, distribution of LOC is same across all categories of EPI. All other hypotheses could be retained.

Table 3 Mann-Whitney U test – mean ranks

Factor	EPI	N	Mean Rank	Sum of Ranks
CSZ	0	56	36.50	2044.00
	1	82	92.04	7547.00
	Total	138		
ROS	0	56	48.29	2704.00
	1	82	83.99	6887.00
	Total	138		
INNT	0	56	56.04	3138.50
	1	82	78.69	6452.50
	Total	138		
ITIS	0	56	44.32	2482.00
	1	82	86.70	7109.00
	Total	138		
ITd	0	56	40.86	2288.00
	1	82	89.06	7303.00
	Total	138		
EPC	0	56	29.44	1648.50
	1	82	96.86	7942.50
	Total	138		
EPT	0	56	34.71	1943.50
	1	82	93.26	7647.50
	Total	138		

As we can see above in table 3, the mean ranks are apparently in distance, the largest difference in mean ranks between companies implemented EP and not is in variable how they perceive their competition of using EP. Large difference is also in mean ranks between companies implementing EP and not and their perceiving of trading partners using EP.
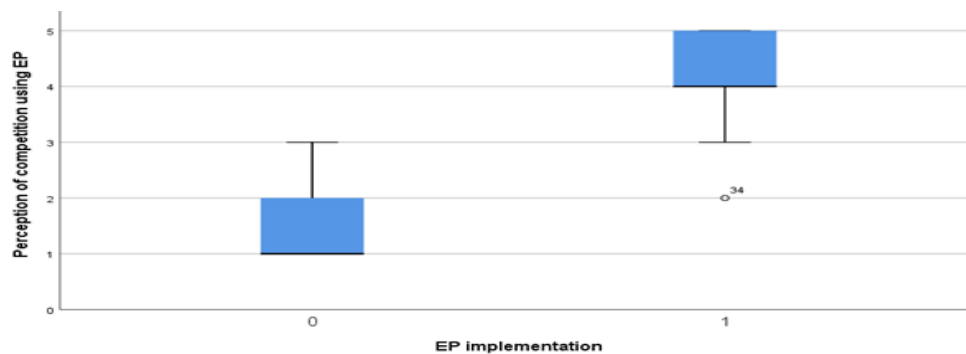
Figure 1 Boxplot of perception of competition using EP by EPI
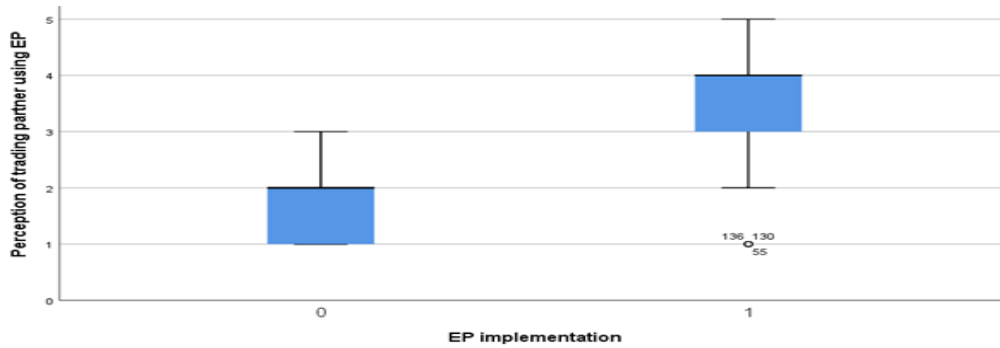
Figure 2 Boxplot of perception of trading partner using EP by EPI

After boxplot analysis there is executed correlation analysis in table 4 below. Relationship with statistical significance could be observed, but as was mentioned earlier strength of the test of nonparametric tests is not as high as for parametric tests. Results might be used for further research and examination but could not be disclosed in incidence of causality.

Table 4 Correlation matrix

|		EPI	CSZ	ROS	INNT	ITIS	ITd	EPC	EPT
EPI	CC	1.000	.710**	.465**	.290**	.551**	.691**	.854**	.739**
	Sig.(2tailed)	.	.000	.000	.001	.000	.000	.000	.000
	N	138	138	138	138	138	138	138	138
CSZ	CC		1.000	.519**	.341**	.629**	.798**	.561**	.461**
	Sig.(2tailed)		.	.000	.000	.000	.000	.000	.000
	N		138	138	138	138	138	138	138
ROS	CC			1.000	.289**	.465**	.401**	.386**	.355**
	Sig.(2tailed)			.	.001	.000	.000	.000	.000
	N			138	138	138	138	138	138
INNT	CC				1.000	.538**	.384**	.256**	.269**
	Sig.(2tailed)				.	.000	.000	.002	.001
	N				138	138	138	138	138
ITIS	CC					1.000	.673**	.440**	.359**
	Sig.(2tailed)					.	.000	.000	.000
	N					138	138	138	138
ITd	CC						1.000	.577**	.394**
	Sig.(2tailed)						.	.000	.000
	N						138	138	138
EPC	CC							1.000	.691**
	Sig.(2tailed)							.	.000
	N							138	138
**Correlation is significant at the 0.01 level (2-tailed).									

4. Conclusions

On grounds of collected data consisting of sample of 138 entries by companies, assumptions formulated as hypotheses before realizing Mann-Whitney U test were confirmed. From results of research, there could be statement that companies which are greater in size (mainly medium and large) are more likely to implement EP. Other factors from organizational conception showed relation, but not as significant as company's size. As seen in figure 1, boxplot of perception of competition using EP by EP implementors suggests that companies using EP are more sensible and more observe the competition. Median value for EP implementors is at value 4 while median value of EP non implementors is at value 1. We can see likewise relation when displaying perception of

trading partner, figure 2. From both boxplots we can conclude that environmental factors, such as competition and trading partners might influence company's attitude of implementing EP. From technological conception there is assumption that companies running IT department in organizational scheme and using broader scale of IT/IS within their activities would have positive relation of implementing EP. As the most intriguing factors how company perceive competition

and trading partners and their attitude to EP. As seen in results section, companies operating in business where both of factors reached higher values, respectively company perceive their competitors and (or) trading partners from supply chain actively using EP, it results in correlation with implementing EP. Below in figure 3 is histogram describing frequency of perceiving competition when using EP and not. Firms running business in sector with higher
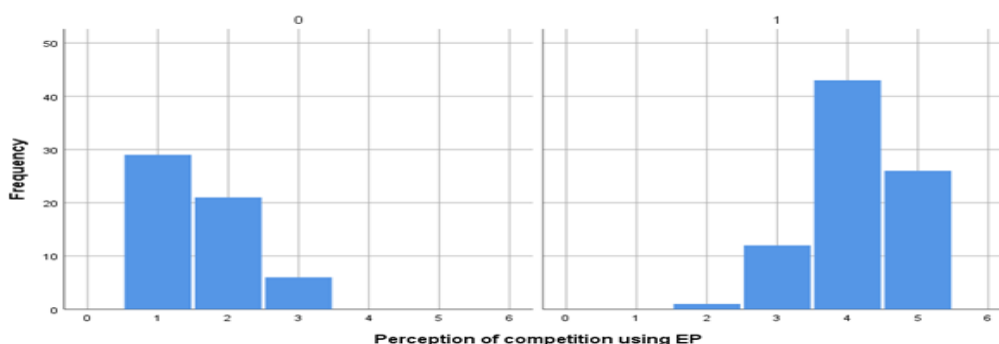
Figure 3 Perception of competition using EP

Histogram on figure 4 shows variance of ROS according to implementation or not of EP. From received answers there might be evidence and conclusion of higher ROS for companies running business via EP, what is in accordance with literature review. Increasing ROS supports one of main features of EP such as increasing transaction speed, decreasing costs and standardized buying.
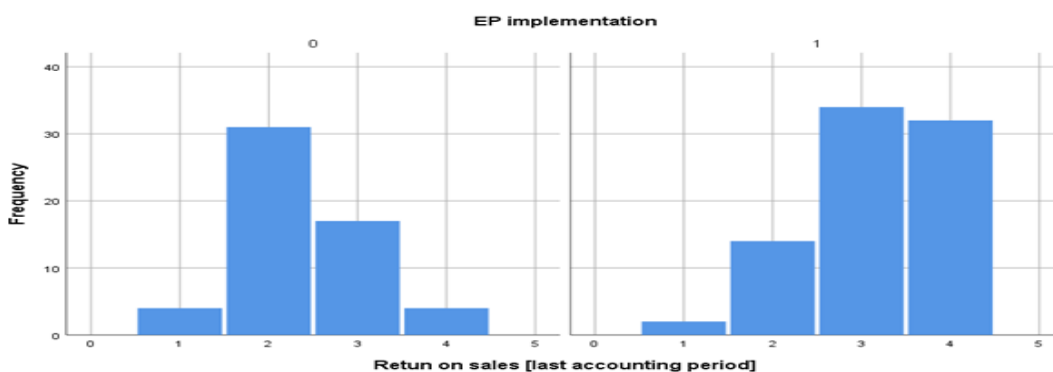
Figure 4 Frequency ROS based on EPI

Topic of EP is still actual, and this study will serve as fundament for future research related with EP and digitization of processes. Digitization is key factor for the future supply chains as the volume of trades and their speed can be increased by using EP. Following step for further analysis is going to be analyzing companies according to sectors to find out if there are differences among companies that implemented EP in dependance on sector they operate. Analyzing available sample offers conclusion that companies are following their competitors and trading partners to sustain competitive. Mentioned assumption leads to conclusion, highly competitive sectors with demand in high productivity such as logistics, automotive, technologies and telecommunications are more probable to implement EP as the environment of business and supply chain shows signs of influence to adapters. Another potential research topic might be related to level of implementation

of EP in state-owned firms as EP provides transparency in spending resources and reducing errors. As seen from results, larger companies managing more complicated processes and higher volume of requirements with accent to profitability, this conclusion might be transformed to state mechanism as state operates with the largest institution in Slovak Republic.

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ANALYSIS OF SAVINGS IN SLOVAK PUBLIC PROCUREMENT ENVIRONMENT

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Public procurement, CPV, savings, Slovakia

Abstract

Public procurement is the main mechanism for state funded organisation to procure their sources. The efficiency of public procurement is often measured by savings. The paper focus on savings generated from Slovakian public procurement environment. Based on the analyses of more than 150 000 real public procurement contracts, the research tries to describe how distribution of savings varies across different CPV categories of procurement contract during the seven year period from 2014 to 2020.

1. Introduction

The public procurement can be understood as the "overall process of acquiring goods, civil works and services, which includes all functions from the identification of needs, selection and solicitation of sources, preparation and award of contract, and all phases of contract administration through the end of a services' contract or the useful life of an asset" (UNDP, 2010 Patrucco et. al, 2017). In the EU-27 government spending represents around 22% of GDP (Vogel, 2009). Furthermore 14% from

that is procurement oriented. (García Rodríguez et al. 2019). Therefore efficiency of public procurement play important role in management of government expenses. Changes in the legislation and public procurement processes which can shrink profit margins can substantially reduce procurement oriented portion of the budget and have macroeconomic impact on the growth of the country. (Vogel, 2009) According to Vogel, (2009) the impact on economy of the country (e.g. employment and consumption) is directly corelated to the size of cost savings. Therefore savings generated from public procurement represent important performance measure of public procurement efficiency. In order to improve this efficiency, the key characteristics of public procurement processes, request for tenders as well as closed procurement contracts have to be studied and analysed. (García Rodríguez et al. 2019) This is an area where digitalisation can play a significant role. The digitization can lead to leaner, simpler processes as well as to efficient data management and enable better automation of labour-based processes. (Zgodavova et al., 2019). Having that in mind in addition to better accessibility and transparency of transactions, its obvious why the European Commission strongly support full integration of e-procurement into European procurement markets. (Alvarez et. al, 2011) On the other hand, as Alvarez et al. (2011) claim absence of standards in e-Procurement processes, and absence of tools for utilisation and interconnection of national electronic platforms present serious challenges which obstruct such integration. One way to improve the standardisation and cooperation of national electronic solutions is development of conceptual and terminological maps which can operate as frameworks for organisation and categorization of knowledge and allow execution of various search oriented, data discovery oriented and categorisation oriented commands (Alvarez et al., 2011) as well as enable better transparency and understandability for systems, which used them. The European union's eGovernment initiatives provides, few domains based conceptual and terminological maps available in Eurostat's RAMON (Reference And Management Of Nomenclatures). Despite their heterogenous nature, these concepts altogether can be determined by their hierarchical structure and multilingual character of information. (Paredes, 2008) In e-procurement area they are mainly represented by "Common Procurement Vocabulary", hereafter CPV. (Alvarez et al., 2011) CPV can be understand as catalogue based classification of product scheme use to categorise nature of public bids and enable straightforward finding, processing, evaluating of bids and contracts with similar characteristics. CPV plays main role in standardisation of e-procurement codes which will contracting authorities used to describe items, products and services included in the same category. From February of 2006, the CPV is mandatory within EU. (Paredes, 2008)

2. Methodology

The research in this article focuses on analysis of procurement savings in Slovakian public procurement environment. It can be divided into three parts. The first part tries to analyse volatility of savings generated from Slovak public procurement competitions in general. Here we try to measure how the distribution of savings from all the contracts in the research sample changes from 2014 to 2020. Rest of the research concentrate more on analysis of savings based on CPV of the public contracts. Use of CPV categories enables classification of public procurement contracts lead to detailed analysis of the distribution of the savings. The second part of research tries to pursue this goal. Here we analyse which categories of public procurement contracts are most frequently closed in the Slovak public procurement environment and how the savings vary between categories. The last part of the research is putting together CPV approach, and the time-based approach. By use of statistical tests we will test 44 hypotheses in order to determine how the distribution of savings changes within the years for contracts in the same category.

The study is based on real public procurement contracts. The research sample consists of public procurement offers published in Slovak Public Procurement Journal (known as "Vestník verejného

obstarávania") and Slovak Electronic contracting system (known as "Elektronický kontraktačný systém") from 2014 to 2020. It includes information about more than 150 000 public procurement competition. The entries in the dataset provide information regarding, year of the realization of competition, CPV category of competition, estimated value of contract and the value of winning bid. For the purpose of this study savings form public procurement contracts represent difference between estimated value and winning bid as a percentage of estimated value. This approach enables to compare savings from contracts of various sizes.

3. The research

As was mentioned in the methodology, the initial part of the research tries to analyse how distribution of the savings from public procurement contracts changed from one year to another for seven years' period from 2014 to 2020. Motivation for this approach is to determine the size of saving, that can be expected from contract realized in Slovakian public procurement environment as well as determine whether savings from public procurement contract have tendency to growth or decline from one year to another. The boxplot analysis of the distribution of savings is presented in Figure 1.
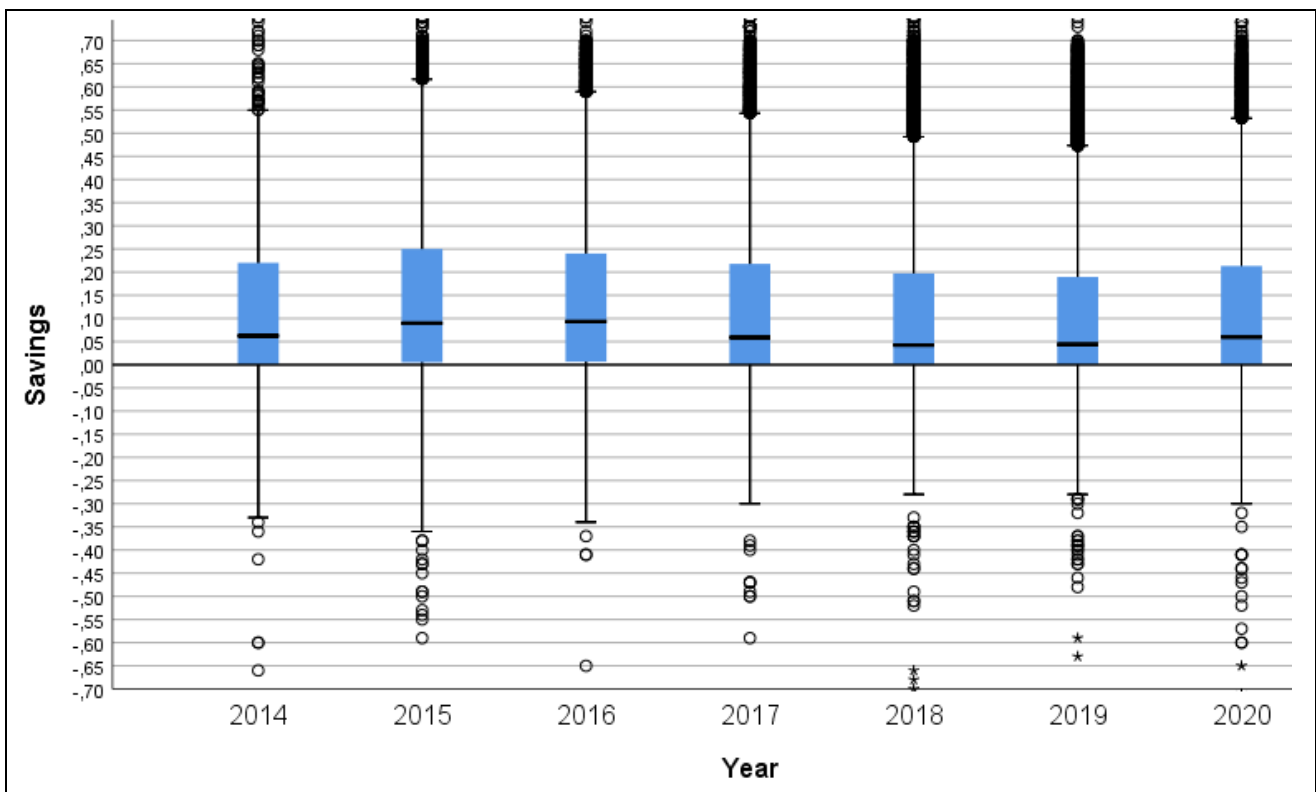
Figure 1: The boxplot analysis of the distribution of savings Source: Author

As can be seen in Figure 1, the distribution of savings is significantly changing during the reviewed period. This finding is also confirmed with the Kruskal-Wallis test which on significance level of α= 5% reject null hypothesis that distribution of saving is the same across the years. Moreover, the position of medians and interquartile ranges do not suggest existence of growing and declining trend which forms over the years. Although it seems that volatility of savings varies randomly through the years, there are also some characteristics of saving distribution which do not change over the time. For example, mode of the distribution seems 0,00 for all the studied years. The median of the savings varies from 4% to 9% and first quartile varies from 0% to 1%. The

distributions of savings are heavily left or right skewed and have long tails. That can be the reason why mean varies from -64% to 15%.

Next part of the research provides more detailed analysis of Slovak procurement environment by focusing on CPV categories. Motivation behind this investigation is to determine which kind of public procurement contracts are more frequently closed in Slovakian public procurement environment and also analyse how distribution of saving vary across different public procurement contract categories. In order to estimate which types of contract are usually closed within public procurement we conduct a Pareto analysis which is illustrated in Figure 2.
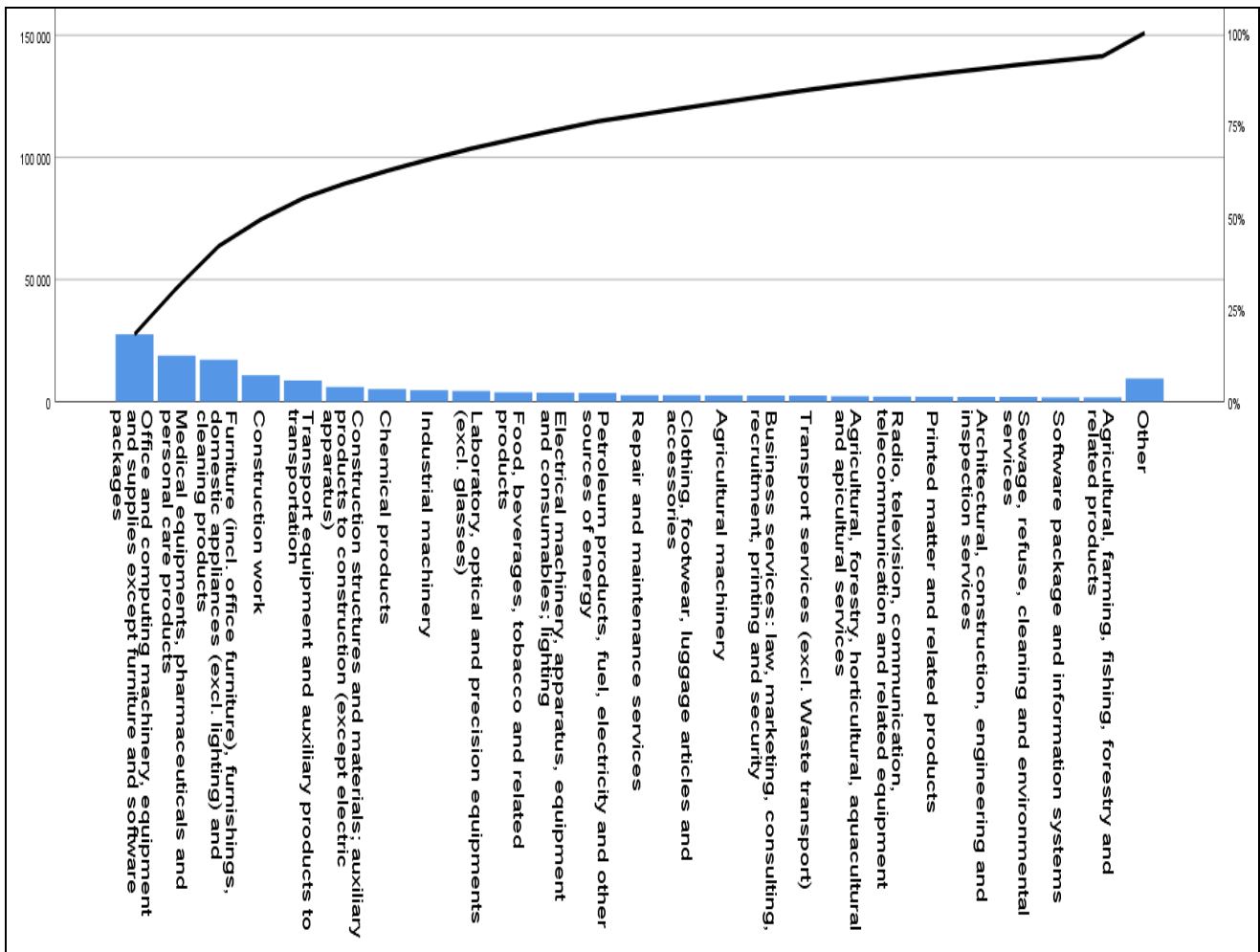
Figure 2: Pareto analysis of Slovak procurement environment by focusing on CPV categories Source: Author

Based on the Pareto analysis presented in Figure 2, it can be assumed that public procurement contracts covering Office and computing machinery, equipment and supplies are most frequently closed contracts in Slovakian public procurement environment. They represent 18,3% of the sample. Contracts covering Medical equipment, pharmaceuticals and personal care products are on second place and represent 12,5% of the sample. The contracts covering furniture (11,4%) and contracts covering construction work (7,2%) conclude Top four categories and all four together represent almost half of research sample (49,4%).
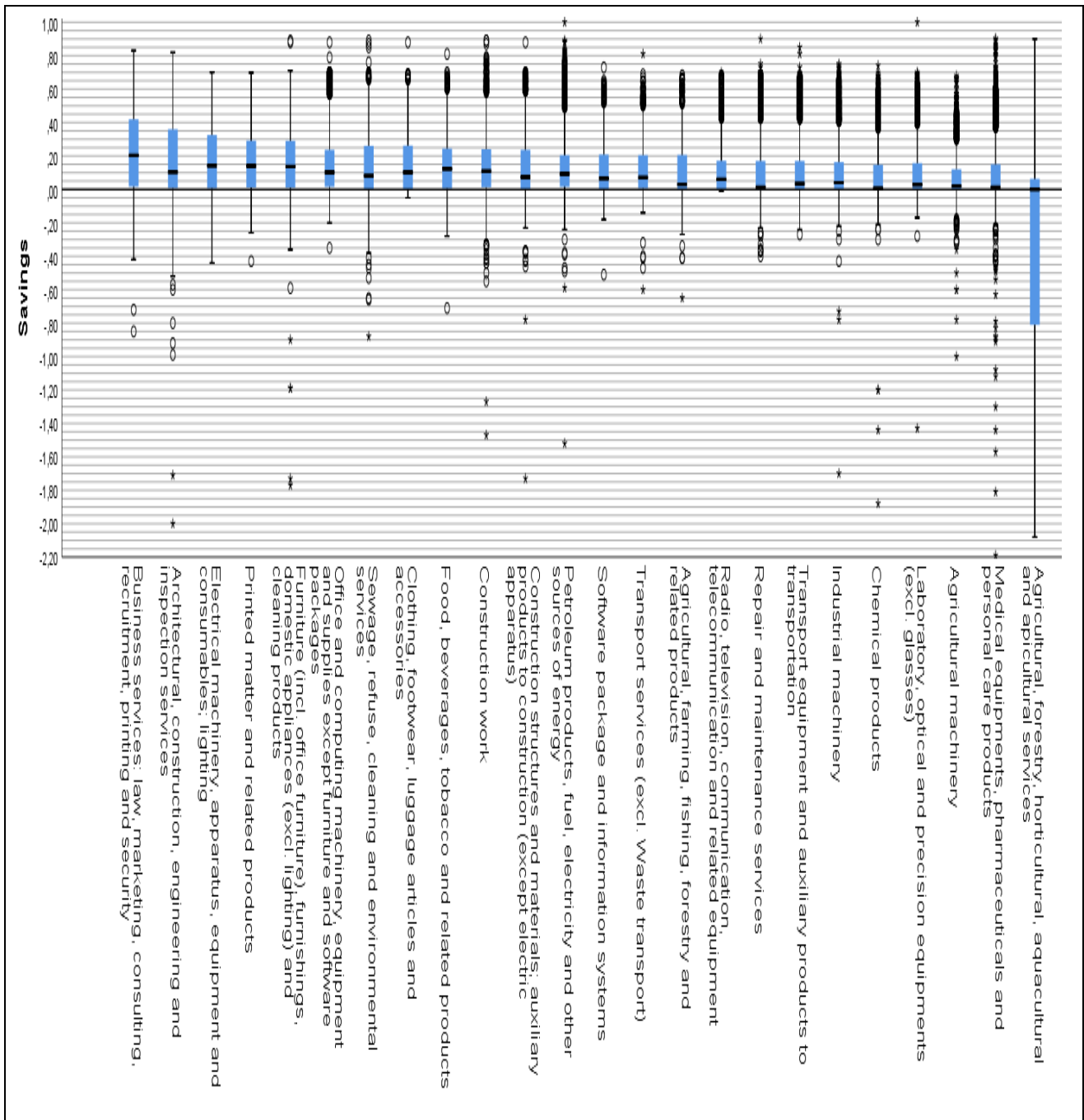
Figure 3: Distribution of savings across different CPV categories Source: Author

The situation is quite different when the distribution of savings is compared across different CPV categories. The result of such analysis is presented in Figure 3. Competition in public procurement can generate decent savings for three of four most frequently represented categories. Contracts covering Furniture have median of savings equal to 14%, Office and computing machinery, equipment and supplies contracts have median of savings equal to 10% and median of Construction contracts is equal to 7%. On the other hand, Public procurement contracts covering Medical equipments, pharmaceuticals and personal care products have median of savings equal to only 1%. In term of CPV categories, worse than that is the distribution of savings for contracts, which covers Agricultural, forestry, horticultural, aquacultural and apicultural services which has the median of saving equal to zero and first quartile equal to -81%. The highest median of savings has contracts

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covering Business services: law, marketing, consulting, recruitment, printing and security. The median of savings in this category is equal to 20%.

The last part of the research study differences in distribution of savings from one year to another for every CPV category. Motivation for this kind of the research is to identify the categories of Public procurement contract which significantly change the distribution of saving during the years as well as categories which have distribution of savings stable over the time. For such analysis we use Kruskal-Wallis test and form unique null hypothesis for every CPV category in the research sample. The null hypothesis has following structure: For particular CPV category we test whether the distribution of savings is the same across years from 2014 to 2020. Results of the analysis are presented in Table 1.

Table 1: Tests of differences in distribution of savings for CPV categories

The null hypothesis: For CPV category, the distribution of savings is the same across years from 2014 to 2020			
H*	**CPV description**	**p-value**	**Decision**
3	Agricultural, farming, fishing, forestry and related products	0,000	Reject null
9	Petroleum products, fuel, electricity and other sources of energy	0,000	Reject null
14	Mining, basic metals and related products	0,000	Reject null
15	Food, beverages, tobacco and related products	0,000	Reject null
16	Agricultural machinery	0,000	Reject null
18	Clothing, footwear, luggage articles and accessories	0,000	Reject null
19	Leather and textile fabrics, plastic and rubber materials	0,000	Reject null
22	Printed matter and related products	0,000	Reject null
24	Chemical products	0,000	Reject null
30	Office and computing machinery, equipment and supplies except furniture and software packages	0,000	Reject null
31	Electrical machinery, apparatus, equipment and consumables; lighting	0,015	Reject null
32	Radio, television, communication, telecommunication and related equipment	0,361	Retain null
33	Medical equipment, pharmaceuticals and personal care products	0,000	Reject null
34	Transport equipment and auxiliary products to transportation	0,000	Reject null
35	Security, fire-fighting, police and defence equipment	0,005	Reject null
37	Musical instruments, sport goods, games, toys, handicraft, art materials and accessories	0,000	Reject null
38	Laboratory, optical and precision equipment (excl. glasses)	0,000	Reject null
39	Furniture (incl. office furniture), furnishings, domestic appliances (excl. lighting) and cleaning products	0,000	Reject null
41	Collected and purified water	0,787	Retain null
42	Industrial machinery	0,000	Reject null
43	Machinery for mining, quarrying, construction equipment	0,588	Retain null
44	Construction structures and materials; auxiliary products to construction (except electric apparatus)	0,001	Reject null
45	Construction work	0,000	Reject null
48	Software package and information systems	0,008	Reject null
50	Repair and maintenance services	0,000	Reject null
51	Installation services (except software)	0,553	Retain null
55	Hotel, restaurant and retail trade services	0,000	Reject null
60	Transport services (excl. Waste transport)	0,000	Reject null
63	Supporting and auxiliary transport services; travel agencies services	0,025	Reject null
64	Postal and telecommunications services	0,000	Reject null
65	Public utilities	0,029	Reject null
66	Financial and insurance services	0,020	Reject null
70	Real estate services	0,278	Retain null

71	Architectural, construction, engineering and inspection services	0,000	Reject null
72	IT services: consulting, software development, Internet and support	0,000	Reject null
73	Research and development services and related consultancy services	0,268	Retain null
75	Administration, defence and social security services	0,794	Retain null
77	Agricultural, forestry, horticultural, aquacultural and apicultural services	0,000	Reject null
79	Business services: law, marketing, consulting, recruitment, printing and security	0,000	Reject null
80	Education and training services	0,000	Reject null
85	Health and social work services	0,002	Reject null
90	Sewage, refuse, cleaning and environmental services	0,000	Reject null
92	Recreational, cultural and sporting services	0,003	Reject null
98	Other community, social and personal services	0,063	Retain null
*The hypotheses are numbered based on the number of CPV category			

Source: Author

Table 1 showed that from 44 tested hypotheses, the null hypothesis was rejected at level of significance α=5% in 36 cases. In other words, there are statistically significant differences between yearly distributions of savings over the seven years' period for 36 CPV categories. The trend of growing or declining yearly median of savings was not identified in any of 36 categories. On the other hand, the distribution of saving tends to be stable over time for contracts covering: a.) Radio, television, communication, telecommunication and related equipment, b.) Collected and purified water, c.) Machinery for mining, quarrying, construction equipment, d.) Installation services e.) Real estate services, f.) Research and development services and related consultancy services, g.) Administration, defence and social security services, h.) Other community, social and personal services.

4. Conclusion

The public procurement represents essential mechanism for government and state funded organisations and institutions to acquire sources. Frequently use metric to measure efficiency of public procurement are savings from public procurement contract. This paper focuses on such savings in Slovak public procurement environment. By analysing more than 150 000 real contracts closed within the years from 2014 to 2020, the research in the article tried to describe changes in distributions of savings over the time and through the different categories of procurement contracts. Results showed that distribution of savings changes significantly from one year to another. These changes seem to be random and without any trend, which lead to the conclusion that Slovakian public procurement environment does not seem to be improving its efficiency over the time. It should be also mentioned that every reviewed year at least 75% of contracts do not exceed estimated contract value or achieve some positive savings. Through the reviewed period median varies in 5% percentage range (from 4% to 9%). On the other hand, heavily skewed yearly distributions of savings characterized by heavy long tails caused that year-on-year means of savings varies in 79% range (from -64% to 15%). Conducted Pareto analysis suggest that public procurement is mostly used to procure office supplies, ICT machinery, furniture, construction work and medical equipment and pharmaceuticals. Procurement contract covering all these categories except for Medical equipment and pharmaceuticals generate decent savings with medians higher than 7% however public procurement contract covering Medical equipment and pharmaceuticals generate savings with median value of 1%. On the other side of the barricade stands contracts covering business services like law, marketing, consulting, recruitment, printing and security. They generate biggest savings. Last part of the research analyses changes in distribution of savings for every CPV category during the mentioned seven-year period. Results showed that for 36 of 44 categories distribution of savings significantly changes from one year to another. These changes

seem to be random and without any trend for all the categories. This also led to conclusion that even on the CPV level, the Slovakian public procurement environment does not seem to be improving its efficiency over the time. The study also identified 8 not so frequently used categories which seem to have stable distribution of savings over the reviewed period.

5. Acknowledgement

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CYBER SECURITY IN A DIGITAL WORLD

ANONYMOUS PROOF OF LIVENESS

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Keywords

Abstract

Sometimes it is necessary to prove that a certain person/machine/computer is still alive/active/working etc, while that entity should remain anonymous and hidden to third parties. I.e. neither its location nor its exact identity (e.g. IP/MAC address, certificate/public key) should be disclosed to any third parties, and only the identity but nothing else to the verifier. Further requirements are that impersonation should not be possible (some other entity submitting the liveness signal) and that even getting hold of the entity should not allow anyone to prove that it was this specific entity that sent some signals in the past. A practical example is a whistleblower: confidential data was deposited as insurance, and as long as the "liveness" signal arrives at the expected times, nothing happens. But if it is missing e.g. two times in a row, the data is published. This paper presents an approach towards such a system, which is both simple and secure.

1. Introduction

Proving a system is "alive" (in whatever sense this means for the entity in question), is often a requirement, e.g. for servers, software, or remote devices. Comparatively rarer is that this should be done anonymously, i.e. with third parties not being able to identify any of the parties (note that e.g. an encrypted connection trivially allows identifying whether an observed system is alive or not, and where this confirmation is sent to). This is harder than it looks at the start, as liveness signals are by definition sent repeatedly, so correlation attacks become possible, as well as replay, refinement of location etc. A naïve approach would be to sign e.g. a timestamp with a self-signed certificate (issued on a random name for anonymity) and post it somewhere online. But this would be easily traceable through multiple signals (if included) and trivially allow to prove involvement if found on a computer (both for the certificate of the verifier as well as the private key of the sender). Plausible deniability should be provided for both the entity proving their liveness as well as the verifier, so that even if they are discovered, previous signals cannot be tied to them, or it be proven that they participated in such a scheme (absent direct observation of sending a signal or verifying one). This is therefore more than keeping just some data secret and deniable (Monshizadeh/Tabuada 2019); any participation in the scheme at all should be deniable.

This paper presents a scheme in the Internet which uses simple hash values as signals and is suitable for humans on both sides (if solely computers are involved some problems cannot be solved, e.g. the computer would need access to secret data, but this data's existence is impossible to deny if access to all its storage is present, so no deniability exists anymore; basically a small "unbreakable" storage is required: the human brain. Substitution could be possible e.g. by TPMs,

but even these might be tricked into creating a signal and thereby proving their involvement). Such signals could originate from anything (hash values are not rare in IT), so they cannot be recognized as "liveness signals". Also, as no further data needs to be included/published (sender, some id number, certificate, timestamp etc), the signals are very short, look like random data, and could therefore be hidden easily by e.g. steganography too. Using an anonymization system (e.g. Tor) to send and check for such signals keeps the identity and location of those entities hidden too. However, a problem not completely solved in this scheme is the location where such signals are stored. This could e.g. be a hidden server in the Tor network. Privacy protection via hash chains seems to have been explored mainly in the area of RFID, as there computing power is often at a premium (see e.g. Yeo/Kim 2005 and Zhang/Guo 2010) and vehicular networks (see e.g. Hakeem/El-Gawad/Kim 2019), but as far as could be determined not in the aspect of plausible deniability.

2. Definitions and requirements

For defining the requirements and the proposed solution some definitions are needed:

- "Proofer": The entity wishing to prove their liveness/existence/activity.

- "Verifier": The entity wishing to check on the state of the Proofer.

- "Signal": Data that can be uniquely associated with the Proofer by the Verifier (but nobody else) and which can be verified as "recent", i.e. it was sent no longer than some known time ago (at the moment of retrieval).

- "Third party": Any entity other than the Proofer and the Verifier.

The following detailed requirements were derived from the general scenario of proving the liveness, while remaining anonymous and providing deniability:

1. A Signal should not be recognizable as such and very small: If a Signal is stored/posted/published/mentioned somewhere, it should not be apparent that it is in fact a liveness indicator. Some suspicion might exist, but it should be impossible to prove this, and there should be numerous reasonable other explanations available. In this way a Signal can be posted anywhere, and even if posting/retrieval is proven, this still affords deniability regarding being involved in a scheme verifying some entity's liveness.

2. The identity of the Proofer should not be discernible from the Signal: If a Signal is discovered and identified as such, this data itself should not allow identification of its source. Even if a specific source is suspected, proving that some Signal originated from this entity should be impossible (apart from observing the sending/publication process itself), and even if access to all data stored on its device is possible.

3. The identity of the Verifier should not be discernible from the Signal: Similarly, the recipient should not be discoverable from the Signal, unless either the process of receiving it is observed or the Signal itself is found on that entity. The latter should not be a requirement for the scheme to work, i.e. it should be possible to delete any Signal immediately after verification.

4. Third parties should not be able to identify that two Signals are related to each other by Proofer, Verifier, or both: Every Signal should be completely independent and in no way related to any other in any way discernible by Third parties. Their content therefore must change every time they are sent. Ideally there should also be no relation between Signals regarding timing, location of publication, or transfer.

5. Signals can be checked for "freshness": A signal may be old (e.g. published a long time ago), but the Verifier should be able to identify a point in time before which is was not created if the Proofer is trustworthy.

6. Third parties and Verifiers should not be able to create valid Signals: This applies both forward from now (creating a Signal to replace a dead entity) as well as for the past (claiming that an entity was still alive), even if the current and all past Signals are known. While the Verifier should be able to validate a Signal, it should not be able to create a valid one, e.g. to later claim that a signal was received.

7. Third parties should not be able to destroy published/prevent publishing of new Signals: If a Signal has been posted, it should be/remain available to the Verifier. This might be limited as even non-attacking Third parties might delete data, be unreachable etc. So it is recommended that only multiple consecutive missed Signals are considered as a failure. This similarly pertains to delaying (or more unlikely: speeding up) publication of Signals.

8. No information on the location of the Proofer should be discernible from the Signal: It should not be possible to trace the Signal back to where it came from.

9. No information on the location of the Verifier should be discernible from the Signal: It should not be possible to trace the Signal to who verifies it.

10. If a Signal is lost, the Verifier should be able to recover from this problem and recognize later signals as valid: If one or more consecutive Signals are lost (server unreachable, message deleted, temporary failure etc), but a later Signal reaches the Verifier, it can still be verified successfully. After what time/how many missed Signals a Proofer is considered "dead" and recovery is no longer possible remains for the Verifier to decide.

11. If the Proofer is discovered, it should be impossible to tie past Signals to it: Even if full access to all device data is obtained (but the human refuses to cooperate) it should be impossible to prove that some previous Signal actually originated from this device. Even if directly observing the device sending a new Signal it should remain impossible to tie previous Signals to it.

12. If the Verifier is discovered, it should be impossible to tie Signals to it: Even if full access to all device data is obtained (but the human refuses to cooperate) it should be impossible to prove that the information present can be used to verify any previous or future Signals. Even if the Verifier is observed validating a Signal it should remain impossible to tie previous or later ones to it.

13. If the Proofer or Verifier is discovered, they should be able to deny their role: Even if full access to all computer data is obtained (but the human refuses to cooperate) it should be impossible to prove that this computer is involved in such a scheme in any capacity at all.

3. Proposed system

The system proposed is based on hash chains (Lamport 1981), i.e. values that are hashed multiple times after each other. First, it is necessary to define the "basic knowledge" of each side: the Proofer and the Verifier. Note that this data needs to be stored somewhere, typically on a PC (with potential consequences for deniability; discussed below) or in human memory. Not explicitly listed is that both Proofer and Verified need to agree on a hash algorithm H.

Proofer: the proofer needs to store (somewhere) these data elements. The only changing element is the next signal number; everything else is constant.

1. Initialization vector (IV): Some random data of reasonable length, i.e. at least the length of the hash value and not too long for speed reasons (needs to be read and hashed once on creating a signal; so even several hundred MB should not be an issue). This can be a true random value or simply any file on a computer that will remain unchanged. Operating system files are therefore possible, but potentially dangerous because updates may modify them. Some unrelated media file is perhaps best, as these are usually not edited, are typically long enough to provide enough randomness, and are inconspicuous.

2. Proofer Password (PP): Some additional value kept only in the memory of the human. Might also be stored in a TPM, an encrypted volume, some data file etc, but then access needs to be granted (or its identification if a file) by a human or some requirements cannot be fulfilled. Completely automatic operation is therefore not possible on insecure devices, as it could then be tricked into falsely creating a Signal.

3. Verifier Password (VP): Similar to the proofer password, but must be shared with the Verifier.

4. Signal count (END), delay between signals: How many signals should potentially be sent and in which frequency, i.e. the delay between signals? The count can easily be set very high, but it must remain the same and cannot change later. It doesn't have to be disclosed to the Verifier. The delay between signals is to be determined by the application needs and doesn't have to be static, as long as it is predictable for both Proofer and Verifier. If more Signals are required, either a new setup has to be created, or an extension function (Goyal 2004) could be used at the cost of additional local storage and negatively impacting deniability.

5. Next Signal number (CNT): The Proofer must be able to calculate which "number" the next Signal is. This could be a counter (needs to be stored) or simply a calculation from a starting timestamp, the current time, and the delay between signals (see previous point), so no stored data needs to change. Using an arbitrary timestamp as the "start time" - which need not match the actual begin of the protocol! - is recommended, e.g. installation time of the operating system or some file date (e.g. of the file used as initialization vector). This is the only changing data of the Proofer. While the same data as the Verifier could be used (see below), this would remove deniability if obtained by an attacker.

Verifier: The Verifier needs to store the following data. The only changing elements are the verification data, which must be updated after each successful Signal validation, and the time of the last valid signal (could again be e.g. an arbitrary starting time and a counter).

1. Verifier Password (VP): See above; shared with the Proofer. Should be kept in human memory only, but can (see before) also e.g. be a file identified by a human.

2. Verification data (VERIFY): Data derived from the last valid Signal. The first value must be obtained from the proofer at initialization. This and the last valid signal time are the only variable data of the Verifier.

3. Last valid signal time: When the last valid Signal was received to determine together with the delay when to check again, respectively - together with the count of missing Signals acceptable - when the alarm has to be sounded.

4. Delay between Signals, i.e. when to check again after the last valid Signal. Must be predictable and identical to the schedule of the Proofer.

5. Number of consecutive missing Signals that produce a "dead" response and what to do in that case.

The algorithm works as follows and is separated into initialization and the actual Signal generation and verification. The symbol "|" is used to signify string concatenation.

Initialization: This phase is needed only once to calculate the starting value that has to be sent to the Verifier, but does not need to be locally stored. The Verifier also needs to receive the Verifier password VP used by the Proofer:

1. Ensure both Proofer and Verifier share a common VP (transmit, secure agreement…)

2. SIGNAL0 = H(IV | PP | VP)

3. SIGNALx+1 = H(H(SIGNALx | VP) | VP)

4. VERIFY = H(SIGNALEND | VP)

5. Transmit VERIFY to Verifier for storage and discard the value afterwards

6. CNT = 1

Signal creation: This phase has to be performed whenever a new Signal is to be sent. Note that this entails recalculating almost the whole hash chain (on secure - and only on such - hardware intermediate values might be stored for speedup, if absolutely necessary). If an "explicit death" Signal should be sent then any modified Signal or just random data can be transmitted.

1. NUMBER = END – CNT

2. NUMBER<0? Then the maximum signal count was exceeded and the liveness protocol cannot continue

3. SIGNALNUMBER: Recalculate as in initialization steps 2 and 3 and "transmit" (e.g. post on public website, anonymously post somehow etc) to Verifier. Discard the value afterwards.

4. CNT = CNT+1

Signal verification:

1. Signal is valid iff H(H(H(SIGNAL | VP) | VP) | VP) == VERIFY

2. VERIFY = H(SIGNAL | VP) Overwrite the previous value/discard the old one

Note that here in all instances a simple concatenation of the signal and the Verifier password is hashed for easier understanding. While this approach has been tested and works, for improved security a keyed-hash MAC (HMAC) should be used in practice, which is slightly slower but otherwise doesn't change anything.

This system creates a hash chain, so attackers obtaining a Signal cannot calculate any further (neither later nor previous) Signals. This includes the Verifier, which cannot create "earlier" elements of the chain (to be sent later) because of the lack of knowledge about the initialization data. If the Verifier retains the initialization value, old values can be recreated, negatively impacting deniability, so this is discouraged. The IV is present to ensure that the starting data is "random": passwords are often not good enough. A substitute for both IV and PP could therefore be a password-based key derivation function and a secure password.

Regarding the "transmission" of the Signal from the Proofer to the Verifier, the following approach is suggested: Signals should be stored on some public server to be retrieved from the Verifier at its convenience. Sending a Signal as well as checking should take place via Tor or some other anonymization service, in this way hiding the location/IP address of the entity, and simultaneously ensuring encryption on the connection. Wherever the Signal is stored, any communication should be encrypted, so that merely observing the communication does not provide information about

checking for a/some specific Signal. The site to store a Signal could e.g. be a hidden server in the Tor network, in this way enforcing not only encryption, but also preventing trying to deduce the sending/checking for a Signal based on communication size or patterns. Another option is a "message board", i.e. publicly accessible data stored by other persons on a public server. Note that no authentication should be necessary on the server for posting or retrieving the data to prevent this platform from tying the Signal to specific pseudonyms. This, however, potentially opens the platform up to DoS attacks (if everyone can post). As rate-limiting does not work with anonymous clients, only quick expiry and deletion of "stale" data is possible.

4.   Comparison of the system against the requirements

This chapter analyzes whether the proposed systems fulfills the requirements identified above, to what degree, or how it could be further enhanced to fulfill them.

A Signal should not be recognizable as such and very small: The signal consists of a single hash value. If e.g. SHA3 is used, this might be 256 or 512 bits, i.e. 32 or 64 bytes. This is very small and hash values occur in many different applications for lots of reasons, although they are exceedingly rare in human communication. The data could also be hidden by steganography (even in longer normal text messages), as it is short enough for this to work reasonably well.

If a Signal is stored/posted/published/mentioned somewhere, it should not be apparent that it is in fact a liveness indicator: As a hash value has no discernible meaning in itself, it is impossible to distinguish a liveness Signal from e.g. a session ID, a stored password etc. However, in normal human communication hash values typically do not occur, so some "technical background" is necessary to effectively hide them. Metadata often contains hash values (as do signatures), but these can typically be verified by anyone so Signals would stand out as invalid (coupled with ostensible "transmission errors" this could still be useful).

The identity of the Proofer or the Verifier should not be discernible from the Signal: From the hash value no information can be gleaned, neither about the Proofer or the Verifier. Note that their identity does not influence the system anywhere – the passwords are completely arbitrary. Even if one of the participants is suspected, the information found there (IV, PP etc) cannot be used to tie them to any observed Signal – unless the VP is known (or the sending/receipt of a Signal is observed directly). As the Verifier stores only "odd" elements of the hash chain while the potentially observed Signals are the "even" elements, even finding VERIFY on a computer does not disclose a relation to any Signal.

Third parties should not be able to identify that two Signals are related to each other by Proofer, Verifier, or both: Again, no information can be deduced solely from a hash value. Unless the VP is known, no Signal can be related to any other of the hash chain.

Signals can be checked for "freshness": If the Verifier stores the initial value of VERIFY, it can validate any past and future signal. Otherwise (always updating the stored data after successful validation) only future Signals can be checked. If the Proofer is trustworthy (i.e. does not publish a Signal too early), the Verifier can check that the Signal is a certain position of the chain, and based on the start time and the delay between Signals can determine the earliest time it was generated. It can also detect if a Signal is published too early, e.g. if intermediate Signals were skipped (or if it checks more frequently than the delay requires, but which is discouraged).

Third parties and Verifiers should not be able to create valid Signals: Without knowing the IV/PP, nobody can create a new valid signal, not even the Verifier. Knowing any past Signals does not improve the situation. Regarding the past, old signals can obviously be stored and/or "replayed", but these will not be accepted by the Verifier; they will be seen as invalid, as long as the Verifier

updates its stored VERIFY value and therefore accepts only later Signals from the hash chain (but not any previous/older ones). The Verifier cannot create a Signal in the future, as this would require reversing the hash function.

Third parties should not be able to destroy published or prevent publishing of new Signals: The proposed system addresses this issue via anonymous communication. Unless the hidden server is physically discovered or hacked, it cannot be shut down, Signals be deleted, modified, or added. However, as mentioned above, if the location becomes known (which is only possible via obtaining data from one of the participants), a DoS attack becomes possible by posting enormous amounts of fake Signals to overwhelm the server or render checking Signals too costly (because the Verifier has to validate all of them).

No information on the (current) location of the Proofer or the Verified should be discernible from the Signal: This is fulfilled by contacting the Signal storage, whatever/wherever it is, solely via Tor. The hash value itself again does not provide any location information.

If a Signal is lost, the Verifier should be able to recover from this problem and recognize later signals as valid: The system trivially supports this as the Verifier can check any Signal candidate it received for as far in the chain as it deems necessary (i.e. typically until the Signal would not yet have been sent). E.g., if two delays have elapsed/one Signal was missing, then calculating two candidates is necessary – the missed/delayed one and the "current" one. When the Verifier considers the Proofer dead is up to it and can be decided autonomously.

If the Proofer is discovered, it should be impossible to tie past Signals to it: Without the knowledge of the VP, even correctly identifying all the other data (IV, PP, END, CNT, timing data) does not allow recreating a Signal, which would therefore be proven to have originated from this data.

If the Verifier is discovered, it should be impossible to tie Signals to it: As the VERIFY data does not appear anywhere in the chain of Signals transmitted, without knowledge of the VP it cannot be tied to any Signals observed. However, obtaining a previous Signal and disclosure of the VP allows tying the Verifier to that old signals, as the chain from that previous Signal can be recalculated up to the current value of VERIFY, thereby tying the Verifier to the old Signal.

If the Proofer or Verifier is discovered, they should be able to deny their role: As long as VP remains unavailable, no Signal can be computed, verified, or related to. Also, all the other data can be easily hidden or credibly explained as having a different use (e.g. a music file as IV or even PP/VP).

Therefore, all requirements are fulfilled and the only open problem are DoS attacks against the Signal storage if an attacker manages to identify it.

5. Limitations

Still, some limitations exist, e.g. that the software for the scheme is required. If it can be found on a system, it is (or was) potentially involved in some (but not a specific!) such scheme. This is less of an issue for the Verifier, as there the algorithm is so simple that it might even be memorized and issued as a brief script on (manual) validation. But for the Proofer this is more difficult. Note that the data can be hidden easily, so that only the software might be found, but not necessarily a proof that it was actually used and in concert with which Verifier.

If the storage location of the Signal is somehow discovered, it can be monitored (e.g. if a public server is used or the hidden server is discovered). In this case correlation attacks against entities suspected of being Proofer or Verifier become possible. It is therefore recommended to hide the sending/checking amidst other Tor activities and ask for numerous Signals on verification. In this

way a Verifier can hide which Signal it is interested in, but at the cost of having to check all those retrieved whether it is the expected one and valid. Also, sending/verification times can be somewhat randomized or might depend on a formula, rendering it more difficult to detect them based on the server and predicting when a Signal might have to be "swamped" by DoS, but this could render it potentially easier to prove the fact of being a Proofer/Verifier.

Should the Signals be stored on a public server (or the hidden server be discovered), Signals can easily be deleted or rendered invalid, in this way forcing the Verifier to conclude on "death", even though the Proofer is still alive.

The biggest limitation is that both sender and receiver share the VP. This means, if the Proofer discloses this data, the Verifier loses plausible deniability, as from the Signals the stored data can be reconstructed. If the Verifier provides the VP, the Proofer does not immediately loose deniability. But as soon as he sends a Signal it can be proven to match the data from the Verifier. I.e. plausible deniability is based on either remaining anonymous ($\rightarrow$ not actually needed), or *both* parties keeping the shared password secret.

6. Testing

The mathematical part of the system (i.e. excluding the submission via Tor to a hidden server, storage there, and retrieval for verification) was implemented in Java. Without optimizations the implementation works and achieves the following speeds (which are solely indicative and of course depend on the speed of the computer): If the limit is set to 100.000 signals, then initialization/calculation of the starting value takes approx. 460 ms (probably startup/optimization time), generating further signals approx. 260 ms each time, and validation about 2 ms. Even on slow computers therefore validation (which consists of calculating four hash values of typically only a few bytes; depending on the length of the Verifier password) is trivial. Signal generation might take some time, but if it takes place only rarely, e.g. once a minute/hour this should not be an issue either. Note that because of the need for human intervention much longer delays should be anticipated (daily/weekly). Even with a single hour delay this produces liveness signals for more than 11 years; probably enough for most applications. While the computing time scales linearly, longer duration schemes are not recommended, as the system also depends on the security of the hash algorithm, which might not be secure anymore after that many years.

7. Summary

A system to anonymously send and receive a liveness signal with plausible deniability was presented. Very little information has to be stored locally for both sender and receiver, and what exists can be hidden very well. The biggest drawbacks are, that some shared data is needed that has to be kept secret, therefore the system is not suited to full automatization unless secure hardware is involved. An advantage is that the liveness signal is very small and no actual protocol between the participants is needed: it is merely data that one party creates, which somehow the second party gets hold of and can verify independently.

A currently unsolved problem is the transmission of the signal: if directly sent to the Verifier, anonymity and plausible deniability no longer exist. If a third party is used, this third party, as well as the system, becomes potentially open to DoS attacks if discovered as being used for that purpose. The best solution therefore seems to be to hide the Signals and post them as "normal" messages to a third party not knowing about this.

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LEGAL ASPECTS OF ARTIFICIAL INTELLIGENCE

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Keywords

Abstract

At present the implementation of artificial intelligence, unfortunately also affected by the coronavirus pandemic, is constantly accelerating. Our community is implementing artificial intelligence with the vision of streamlining its processes and saving costs. This paper is focused on some of the basic issues that the legal community or the European Union is solving in relation to application of artificial intelligence both now, as well as in terms of the need for future solution. The main areas addressed in this paper are the impact of AI and its decision-making on rights of individuals affected by this decision and liability for harm caused by AI. Within the area describing impact of AI on the rights of individuals, the paper summarizes some aspects of the legal framework in which the AI and its decision-making should operate. For the time being, the area of liability for damage caused by AI is insufficiently prepared for the incorporation of AI into everyday life. Even the legislator finds the need to amend this area.

1. Introduction

At present, the implementation of artificial intelligence, unfortunately also affected by the coronavirus pandemic, is continuously accelerating (Wiebke Reim, Josef Åström, Oliver Erikson, 2020). Our community is implementing artificial intelligence with the vision of streamlining its processes and saving costs (Rogan 2020). The legal community must also respond to rapid technological developments. In some cases, the existing legal framework can be applied by analogy to new technologies. However, in other cases, legislation is not able to fully cover new technologies and their aspects to the extent that AI application would mean a fair regulation of rights of individuals and obligations affected by use of respective technology. In this paper, I will focus on some basic issues that the legal community solves in relation to application of artificial intelligence (hereinafter "AI").

Reports and assessments of the current legal situation both at the national and international levels have recently been published more frequently, describing the risks of the AI's impact on legal relations and, if appropriate, proposals for the future legal framework. We are also striving for the establishment of a legal framework for AI at the European level; therefore several documents have already been issued to evaluate the readiness of legislation for the application of AI. These documents include in particular:

- White Paper on Artificial Intelligence, which should be the basis for future European regulation,

- A report issued by the European Union Agency for Fundamental Rights on the impact of artificial intelligence on fundamental rights,

- European Parliament resolution of 16 February 2017 with recommendation to the Commission on Civil Law Rules on Robotics (2015/2013 (INL)),

- Proposal for a regulation of European Parliament and of the Council laying down harmonised rules on artificial intelligence (artificial intelligence act) and amending certain union legislative acts, COM/2021/206.

The issue of AI legal regulation represents a very extensive and complex area; therefore due to the limited space I will mention only the basic points that are resolved in the legal area in relation to AI.

There is no uniform definition of AI, however, it can be based on the definition formulated by the European Commission, stating that: "*Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g. voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or Internet of Things applications).*" (European Commission, 2018)

2. Objectives of the paper

The main areas to be dealt with from the legal point of view when implementing AI, and which this paper will address, are as follows:

- The impact of the AI and its decision-making on the rights of individuals affected by the decision, and

- Liability for harm caused by AI.

The definition of fundamental rights may slightly vary from one European country to another, thus in the sections where I will focus on the impact of AI on fundamental rights, I will assess the impact of AI on fundamental rights as defined in the Charter of Fundamental Rights of the European Union (hereinafter "the Charter"), which is binding on all Member States of the European Union and therefore contains the minimum legislative standards to be followed by each member state.

The paper is divided into two main parts, each of which deals with a specific goal as mentioned above.

3. Impact of AI on the rights of individuals

The use of AI and the issues which may arise from it can be viewed from a large number of different perspectives. Some of the most discussed ones, for example, are the issues of influencing human behaviour through news and advertising, which the AI displays to us, the issue of using AI for cyber attacks or the use of AI for repressive purposes, where the state will use AI to monitor its citizens. In this paper, I will focus on some of the legal pitfalls of using AI.

The rights that can potentially be affected by the implementation of AI according to European Union Agency for Fundamental Rights are mainly in the following three areas:

- The right not to be discriminated,

- The right not to be the subject of automated decision-making,
- The right to be compensated for harm.

In the case of AI application by administrative authorities the right to good administration may also be affected.

The areas mentioned above are explained in greater detail in the following text, wherein the author makes an effort to put this issue into context and expand on it with his recommendations on how to deal with each respective area.

3.1. **Prohibition of Discrimination**

Prohibition of discrimination is defined in Articles 20 and 21 of the Charter. As stipulated in Article 20 of the Charter, everyone is equal before the law and Article 21 prohibits *"discrimination based on any ground such as sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation shall be prohibited"*. As provided in Article 52 of the Charter, exceptions are possible only in cases stipulated by law; they must respect the essence of these rights and freedoms and be proportional. A prerequisite is also the necessity of the mentioned exceptions and compliance with the general interest.

Therefore, when designing AI decision algorithms, it is necessary to ensure that respective decisions are not discriminatory. It would be considered unacceptable if, for example, the AI statistically evaluated women as better drivers than men and therefore automatically set higher insurance premium for men. Even if it were indeed true that women in general drive more safely than men, it would be a decision based on the sex of the subject, where a man would automatically be disadvantaged solely on the basis of his gender, even if such a man presented a deviation from the average and were a better driver than most women.

Unfortunately, the simple assumption that if the above mentioned attributes (gender, race, skin colour) are not included in the respective decision, the resulting decision cannot be considered racist, does not apply. The AI must not take them into account, even indirectly. For example, when evaluating the insurance risk, if a higher insurance premium were calculated by the AI due to the policyholder's residence in a place with a predominance of residents of a certain minority ethnic group, with the AI also evaluating this person as a member of that ethnic group with higher insurance risk and therefore setting a higher insurance premium, it would be a decision based on ethnicity, albeit indirectly.

AI deficits and its "racist and discriminatory tendencies" have been already monitored in several cases during its application. Let us mention an HR system that preferred men to women in recruitment, a face recognition program that more successfully recognized white men than black women (European Union agency for fundamental rights, 2020) or a Microsoft-created Chatbot designed to learn from other published posts and then post the most popular posts on the social network Twitter. The posts became increasingly hateful and racist and the Chabot did not hesitate to label other people as "niggers" or called for hatred against a certain group of people. Microsoft eventually shut it down (Sophie Kleeman, 2016).

A possible solution could be to test AI databases for discriminatory conclusions both before their implementation, as well as during their implementation through regular testing, to make sure their „learning" did not result in them basing their conclusions on discriminatory assumptions.

3.2. The right not to be the subject of automated decision-making

Pursuant to Article 22 of the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (hereinafter "GDPR") any natural person (pursuant to Article 4 (1) of the GDPR only a natural person may be a personal data subject) is entitled not to be the subject of a decision based solely on automated decision-making. According to the guidance issued by the WP29 group (European advisory body set up to ensure the uniform application of GDPR rules), the creation of a decision by technical means without human intervention is considered to be an automated decision-making. Therefore, automated decision-making is also an AI decision-making, where the AI can make decision based on set algorithms without any need for human intervention into the decision-making.

If natural persons are the subject of automated decision-making, they must be informed of this fact. Information on automated decision-making is in most cases included in contracts or eventually in information on personal data processing. Therefore, fulfilment of this obligation should not present a problem in practice. Other rights of subjects of the data are the claim to human intervention in decision-making, furthermore to express their opinion, to obtain an explanation of the decision made on the basis of the AI's assessment, and to contest this decision (recital 71 of the GDPR). Nevertheless, a survey conducted by the European Union Agency for Fundamental Rights found that only 40% of the population is aware of their right to submit a complaint against a decision made automatically without human intervention (European Union agency for Fundamental Rights, 2020). The subject of the data also has the right to be explained the logic of automated decision-making (recital 63 GDPR). Should a person being the subject of such a decision be able to successfully defend his or her rights, then he or she must also know how AI came to its decision. This however, can be relatively difficult to explain. For this reason, some companies choose not to implement fully automated decisions. At the same time, the above-mentioned obligations associated with automated decision-making cannot be exempted only by the fact that at the end of the decision-making process there is a natural person who would merely formally approve the decision made by the AI. The person should also be entitled to change the decision. However, there is a paradox that can partially devalue the importance of AI involvement. According to research, the involvement of the human factor in decision-making control has two pitfalls. The first is that people often trust automated decision-making to the point that they do not change the decision even when they have doubts about its correctness (Kolaříková & Horák, 2020). The second pitfall is that even if they end up changing the decision, according to the research of European Union Agency for Fundamental Rights, human intervention usually only comes in cases where the respective decision (even if it might be objectively correct) does not correspond to the experienced stereotypes of the controlling person. The advantage of impartiality thus disappears due to human intervention in these cases.

In most cases, the more complex the process leading to a decision is, the more difficult it could be to reconstruct the decision. The legislator has established a legal framework in this regard, which in practice may in some cases be difficult to enforce. From the point of view of AI development, the given condition may seem to be an unnecessarily burdensome and complicating development. From a legal standpoint however, this legal framework grants the subject equal rights as if a natural person had decided instead of AI. The solution to this issue is thus more in the area of AI development, when the law has set the conditions and now it's up to AI developers to meet these conditions to make sure that the AI decision-making process can be sufficiently reconstructed, so that the subject of the decision can successfully defend himself against this decision.

3.3. Violation of the right to good administration and the right to an effective remedy and to a fair trial

AI is not only implemented by private companies but private companies are also entrusted some tasks in the public sector. Let´s mention, for example, algorithms for finding new work for jobseekers or processing applications for social support. AI may therefore be in conflict with Article 41 (2) (c) of the Charter that stipulates the obligation of the administrative body to give reason for its decision.

Similarly, under the right to a fair trial, everyone has the right to a trial before an impartial court (Article 47 of the Charter). However, the decision of the AI may lack sufficient transparency when the subject of the decision did not have all necessary information as to why the respective decision was made and therefore they had a diminished opportunity to defend against such a decision.

These two fundamental rights can be affected if the persons applying AI in decision making are not able to duly justify why such a decision was made. From a legal point of view it is therefore necessary to always ensure the possibility to explain why such a decision was made by AI. However, it should be emphasized that the disclosure of AI decision-making processes may be in conflict with the copyright protection of the person who set up these processes (EU Agency for Fundamental Rights, 2020).

If we summarize all the above-mentioned points it is always necessary to ensure in implementation of AI, that:

- The decision is not discriminatory,

- The person is informed about the application of AI in decision making,

- A process is set up to exercise the right to human intervention, as well as to explanation and possibility to file a complaint,

- It is possible to explain the reason for the AI decision to the person under consideration.

As AI decision-making can have an impact on a large number of persons, it is being discussed that all aspects of any planned initiation of AI application should be considered in advance. This is a similar solution to the one that was chosen in the case of assessing the impact of the processing of personal data in cases where the intended processing may have a significant impact on the protection of personal data. If this is the case, the person is obliged to assess, inter alia, the risks of the respective processing, its necessity, proportionality, and the risk mitigation measures (Article 35 of the GDPR). Such a solution is also proposed, for example, by the EU Agency for Fundamental Rights (European Union agency for fundamental rights, 2020).

3.4. Liability for AI decision

The issue of AI decision-making's compliance with fundamental rights needs to be solved mainly by its developers (with the exception of obligations arising from automated decision-making). In this section, on the other hand, we will focus on the area that needs to be solved at legislative level, namely the area of liability for incorrect decisions by artificial intelligence. If an incorrect AI decision has already been made, there must be rules for determining the subject liable to the injured party for the incorrect AI decision. In law, we distinguish between two types of liability. Personal liability, i.e. the damage is paid by the person who caused it negligently or intentionally, and no-fault liability, when harm is compensated by the designated person irrespective of his fault.

Now, if some damage caused by the AI occurs, it would probably be decided by analogy with cases of damage caused by a product defect. Nevertheless, according to Bertolini (Andrea Bertolini,

2020), the application of this type of liability is not appropriate for AI. The reason is its specifics related to the involvement of a large number of different persons in the development of AI (research, development, production, distribution…). Likewise, according to Radim Polčák, the problem is the stratification of the system in determining liability. One person may own the hardware, another person may own the network from which the system takes data, and different people may own data or code that affect the behaviour of the system. Another problem, according to Polčák (Polčák, 2018), may be that *"an autonomous system (…) constantly and independently of its original creator generates its own code (program)."* Thus, the operational code of the system is constantly changing; its retroactive reconstructability at the moment of decision making, due to which the system caused damage, might not be possible (Polčák, 2018). Therefore, according to Bertolini, the primary issue to be resolved is a clear identification of the person against which the injured party can file his/her claims. A solution is offered that this person could be the seller. It is then up to this person, if necessary, to identify other persons involved in the product development chain, from which he can regressively claim compensation for the paid damage (Bertolini, 2020). The possibility of compulsory product insurance (AI) (European Parliament, 2017) is also being discussed as a solution. However, the disadvantage of insurance seems to be, at least in the beginning, that in case that there are no records of relevant data, it is difficult to determine the insurance risk based on which the amount of insurance premiums are also determined consequently.

There are also academic discussions as to whether the AI itself could be responsible. However in the near future, this concept seems unrealistic to me, when in fact there is no way for AI to compensate for the damage.

It is possible to state that in order for the consumer to have the simplest and easiest way to compensation, the legislator can introduce eventual strict joint and several liability of the seller e.g. with manufacturer or distributor. In some cases, where a large damage can occur due to AI defect, in my opinion, it would be appropriate to establish strict liability as absolute liability (without possibility of exemption) for the protection of third parties. This would be the case, for example, of liability for damage caused by "self-driving" vehicles, wherein it would be unfair to the injured party if the wrongdoer had the opportunity to exculpate from the liability, by referring e.g. to the fact that production proceeded in accordance with scientific and technical knowhow when introducing the product with AI to the market which made it impossible to detect the product defect (reference is made to one of the liberation reasons stipulated by Czech law for liability for product defects).

4. Conclusion

The use of AI unambiguously represents a very interesting area not only from technical point of view, but also from legal point of view, as the use of AI must be evaluated according to intentions, possibilities and limitations imposed by law, either directly or indirectly, both at the national level as well as e.g. by legal framework being set up by the European Union.

Each of the three areas analysed, in particular the right not to be discriminated, the right not to be subject to automated decision-making and the right to compensate harm, is specific and requires specific approach to ensure compliance with the legal environment.

The last area can be considered the most complicated, in particular the liability for the AI decision, which is extremely important also in the current trend of autonomous vehicles and systems. Its significance consists mainly of the identification of the person against which the injured party can assert his claims, if, for example, an AI-controlled car causes fatal accident, traffic accident, etc.

We expect that legislation of this area will be under significant scrutiny in the coming years and will develop dynamically.

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USING ISO/IEC 27005 FOR CLOUD COMPUTING RISK ASSESSMENT

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Keywords

Abstract

Cloud computing gets more popular every day and many companies implement various forms of cloud environments. Cloud computing has many benefits but can also represent various risks. In order for companies to limit the exposure to cloud specific risks, the risks should be assessed throughout the whole lifecycle of the cloud service. Based on previous research by the author applying the CURF method, ISO/IEC 27005 was identified as the most comprehensive risk management framework, which can be further adjusted for cloud risk assessment and simplified for individual stakeholders to include asset evaluation in the risk assessment. This paper proposes usage of the ISO/IEC 27005 framework and applying methods of risk evaluation which can be followed when assessing a cloud service.

1. Introduction

Cloud computing is an environment which allows on-demand network access to a shared pool of various resources to various users. The resources could be specific networks, servers, storage, applications, and other services. Based on the user demand resources can be rapidly provisioned to cope with the demand and such provisioning can be easily automated. (Mell & Grance, 2011). Due to the nature of cloud computing, there are various cloud specific risk (Shaikh & Meshram, 2021) which should be identified and assessed prior to deciding on moving internal infrastructure to the cloud. Risk assessment should therefore be a key part of cloud lifecycle to be included from the very beginning – the selection, to the very end – exiting the cloud.

Usage of cloud computing is on the rise and according to Gartner (Costello & Rimol, 2020) it is predicted to grow in the upcoming years as the growth has been accelerated due to the COVID-19 pandemic. As a result, organizations will be forced to consider cloud computing risks in day-to-day activities and continuously identify potential vulnerabilities and threats which could endanger existing processes while being performed in the cloud.

There have been several initiatives to introduce a cloud risk assessment methodology such as a methodology by Cloud Security Alliance (Cloud Security Alliance, 2019), ENISA (ENISA, 2009), Microsoft (Stone & Noel, 2015) and others. There also exist some generic risk assessment methodologies such as ISO/IEC 27005 (ISO/IEC 27005:2018, 2018), OCTAVE (Alberts et al., 1999) and many more. There has also been lots of research with regards to identifying the most optimal risk assessment methodology, e.g. CURF (Wangen et al., 2018) or ABISF (Tariq, 2019),

which concluded that the ISO/IEC 27005 framework is the framework suited best for cloud risk assessment, although it is not fully specialized in cloud risk assessment. Moreover, the author applied the CURF method on other assessment methodologies not originally covered by the research and concluded that even with other new cloud specific risk assessment methods, ISO/IEC 27005 can still be considered the most comprehensive one (Andraščík, 2021).

The main contributions of this paper are summarized as follows:

- Application of ISO/IEC 27005 framework to cloud risk assessment,
- Mapping of existing cloud threats and vulnerabilities to ISO lists of threats and vulnerabilities,
- Simplification of the ISO approach for the assessors.

The paper is organized as follows. Section 2 describes work related to cloud risk assessment, Section 3 describes the ISO 27005 principles on risk management, and Section 4 discusses the usage of principles of ISO 27005 for cloud risk assessment. Section 5 then evaluates the output and concludes the paper.

2. Background and related work

Many papers have already been written on the topic of cloud risk assessment – some using a custom risk assessment method, some utilizing a well-known method customized for cloud environments.

2.1. Existing risk assessment methods

In their paper Masky et al. (Masky et al., 2015) introduce the OCTAVE Allegro method for cloud computing risk assessment. In this method, the author focuses on information assets, in these assets where information can be stored or processed, and only such assets are then analyzed for risks. For each such scenario, threats (or threat scenarios) and impact are analyzed. Product of both is a final risk.

In another research Djemame et al. (Djemame et al., 2016) propose a risk assessment methodology aimed at infrastructure provides, i.e. IaaS. The framework calculates risk based on vectors of vulnerabilities and threats combined with an impact. The framework as such can be used for a real-time monitoring of risk as it can consume data provided by the infrastructure provider.

Yuxia Sun et al. (Sun et al., 2015) in their paper propose to perform risk assessment based on a probability of an attack and probability of a successful defense. Both probabilities take into account the resources that attackers/defenders need to use to attack/defend a specific asset, as well as the value of a specific asset and potential damages to such assets.

Damenu and Balakrishna (Damenu & Balakrishna, 2015) in their paper critically review two frameworks for risk management - one adopting a PDCA cycle and one based on ISO 27005. While the PDCA based can be primarily used by the cloud providers, the framework based on ISO 27005 is usable by both cloud providers and their customers. That shows that ISO 27005 provides a more comprehensive approach to the risk assessment.

Another paper by Lalanne et al. (Lalanne et al., 2013) applies the ISO 27005 standard on risk management of web and cloud services. They propose a way to identify assets and describe basic threats and vulnerabilities of such services. In the end they propose an update of the standard to include threats and vulnerabilities of such services.

Also a comparison of various risk assessment methods by Wangen et al. (Wangen et al., 2018) in their paper lead to the conclusion, that from all the analyzed risk assessment method, the method described by ISO 27005 was identified as the most comprehensive one from all the analyzed.

2.2. Methodology

To define the approach, the asset classification method as defined by Singh et al. (Singh et al., 2018) is used to make the classification seamless for the assessor. The classification evaluates individual assets based on their confidentiality, integrity, and availability values. The threats and vulnerabilities are based on the threats and vulnerabilities catalog present in Appendix D of the ISO standard (ISO/IEC 27005:2018, 2018) which were compared with the threats and vulnerabilities identified by the Cloud Security Alliance (Cloud Security Alliance, 2018). The likelihood definition is based on an existence of past incidents, existence of vulnerabilities, or existence of potential methods of abuse. Finally, risk evaluation is based on an example defined in Appendix E of the ISO standard (ISO/IEC 27005:2018, 2018).

3. ISO/IEC 27005 framework

The ISO/IEC 27005 (ISO/IEC 27005:2018, 2018) is a generic information security risk management approach which can be used in any type of organization. The framework is based on ISO/IEC 27001 (ISO/IEC 27001:2013, 2013) and consists of six main steps.

3.1. Context establishment

During this phase an organization should decide which part of the organization would undergo the risk assessment. As part of the cloud risk assessment, the context should be the assessed cloud environment. Also, criteria for the evaluation should be specified, e.g. scale of impact and likelihood etc.

3.2. Risk assessment

As part of a risk assessment process, an organization should identify main and supporting assets and their threats and vulnerabilities. Based on the identified threats and vulnerabilities, the organization should evaluate probability and impact of threats and vulnerabilities. The evaluation could either be performed using an estimation of individual stakeholders or additional information can be used, e.g. reports from penetration testing, vulnerability management etc. Based on individual values the extent of a risk can be measured.

3.3. Risk treatment and acceptance

Based on a defined risk appetite and risk tolerance of an organization, the organization can choose among four options of risk treatment: risk mitigation, risk acceptance, risk avoidance and risk transfer.

Once a risk treatment approach is selected and appropriate measures are applied, the organization can accept the residual risk unless the risk was fully mitigated.

3.4. Risk communication and consultation

Throughout the whole process there should be a communication between the risk manager and appropriate stakeholders, such as business owners, IT owners etc. They should evaluate the risks together and decide on the best way to treat the risks.

3.5. Risk monitoring and review

Once all residual risks are accepted, they should still be monitored as conditions can change and impact the evaluation of the residual risk. Moreover, as technologies mature in time, new risk can appear and should be timely evaluated.

4. Proposed risk assessment approach

To make the risk assessment process easier for all stakeholders, company can introduce its own risk assessment process based on the ISO 27005. As noted by Appendix E of the ISO standard, the process can be based on asset classification/value and likelihood of a threat occurring. The product of both can be the risk estimation (ISO/IEC 27005:2018, 2018).

4.1. Asset classification

To obtain the real business value of a specific asset for a company, the assets should be classified by their respective business users. Security personnel performing the classification would not be able to adequately evaluate the importance from the business point of view. To simplify the classification for business representatives, individual assets can be classified in three essential security domains – confidentiality, integrity, and availability (ISO/IEC 27005:2018, 2018) which represent a security triad and are a globally accepted standard for measuring the security requirements of any digital system (Jan et al., 2020). To assess a cloud solution, the whole cloud solution could be defined as a single asset. Such a definition is suitable during an initial selection of a cloud solution to assess the overall risk of the solution. Once the solution is in use, it is advisable to assess individual services used within the solution as each of them can represent a different risk with its own likelihood and impact.

The asset's value can be assessed on a three-point scale of confidentiality, integrity, and availability. The value should be based on a Sensitivity Rating (SR) of the data therein taking into consideration its importance to business functions. The value would then determine the importance of data therein.

To determine the SR of data to be used within a cloud, the confidentiality, integrity, and availability of the data needs to be rated by their owner on a scale from 1 to 5, or to simplify it for the owners on a scale of Very Low, Low, Medium, High, and Critical where each value has a respective numeric value assigned. The rating is then considered as below:

$$C = Value\ of\ Confidentiality$$

$$I = Value\ of\ Integrity$$

$$A = Value\ of\ Availability$$

$$SR = MAX(C, I, A)$$

The overall value of an asset is represented by the maximum value of the security triad (Jan et al., 2020). The value of SR also represents a potential impact should confidentiality, integrity, or availability of the data in the cloud be compromised by a materialized threat.

4.2. Threats and vulnerabilities

To properly identify risks, it is necessary to identify individual threats and vulnerabilities. There are several threats and vulnerabilities already specified within ISO/IEC 27005 which can be used as a baseline for risk assessment. The threats defined in ISO/IEC 27005 can also be mapped with threats or vulnerabilities identified by the Cloud Security Alliance (Cloud Security Alliance, 2018):

- Unlawful processing of data,
- Privilege abuse,
- Incorrect setup of parameters,
- Not fully developed system,
- Insufficient security awareness,
- Inadequate onboarding process,
- Loss of data,
- Insufficient ISMS,
- Insufficient security training,
- Denial of Service,
- Well known vulnerabilities.

The list above represents the most common threats and vulnerabilities identified by the Cloud Security Alliance. The list is non-exhaustive, and every organization can identify more threats and vulnerabilities based on their environment conditions.

4.3. Likelihood

To assess a final risk, the assessor should estimate the likelihood of a threat occurring. The likelihood can be based on:

- past incidents for the specific provider or specific service,
- intentional resources: motivation, skills, and resources available to attackers,
- unintentional resources: geographical factors, human errors, and system failures,
- vulnerabilities,
- existing measures and their effectiveness (ISO/IEC 27005:2018, 2018).

Having the likelihood areas in mind, following likelihood scales in Table 1 as created by the author based on a business experience could be used:

Table 2: Likelihood scale

Likelihood	Past incidents	Intentional resources (Dugal & Ritch, 2019)	Vulnerabilities
5 – Critical	An incident occurred within last year	Widely available information on threat abuse	A critical vulnerability exists
4 – High	An incident occurred within last two years	Functional exploit available	A high vulnerability exists
3 – Medium	An incident occurred within last three years	Detailed information on specialized sites available	A medium vulnerability exists
2 – Low	An incident occurred	Proof-of-concept available	A low vulnerability

Likelihood	Past incidents	Intentional resources (Dugal & Ritch, 2019)	Vulnerabilities
	within last five years		exists
1 – Very Low	An incident did not occur within last five years	No known exploit or attack existing to materialize the threat	No vulnerabilities exist

4.4. Risk evaluation

For each of the identified threats and vulnerabilities of an asset, in this case a cloud solution, a risk evaluation can be performed. To properly evaluate the risk, each threat and vulnerability should be mapped to an asset, SR of which would be an input for the evaluation. The SR value would then be multiplied by the identified likelihood. The product of those numbers defines the risk value for the specified asset.

$$RISK = SR * likelihood$$

Risk evaluation could then be performed as indicated by the list below and shown in the table as an example.

Table 2: Exemplary risk evaluation

Asset	Asset SR	Threat	Vulnerability	Likelihood	Risk value
Cloud solution	5	Denial of service	Inadequate management and control of network	2	10
Cloud solution	5	Privilege abuse	Incorrect assignment of privileges	4	20

Based on the calculated risk value, risk could then be classified as follows, where each risk level represents 20% of a maximum value:

- Risk value <= 5 – Very Low

- Risk value <= 10 – Low

- Risk value <= 15 – Medium

- Risk value <= 20 – High

- Risk value > 20 – Critical

5. Conclusion

This article introduced cloud computing and describes an ISO/IEC 27005 approach to risk assessment. Furthermore, the ISO approach was simplified using an asset classification for definition of impact. To identify a likelihood, assets need to be mapped with a threat and a vulnerability. Combination of both threat and vulnerability can then be evaluated for likelihood of its occurrence. To simplify the likelihood evaluation, the evaluation can be based on previous experiences, existence of resources for abuse or existing vulnerabilities.

To further improve the risk assessment of cloud risks, the work will continue to expand the risk assessment process by identifying typical cloud risks and cloud risk scenarios.

6. Acknowledgements

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PRIVACY AND LINKED DATA ON THE INTERNET – WHAT TO ANNOTATE AND HOW?

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Keywords

Privacy, linked data, vocabulary, dataset, annotation

Abstract

The emergence of a growing number of lightweight vocabularies, in addition to the large number of datasets based on them, has increased the need to discuss potential privacy challenges in the context of Linked Data on the Internet. While existing research has identified a number of potential privacy issues and proposed some tailored solutions for them, we still lack a consensus for dealing with privacy challenges within Linked Data in general. In this paper we present two commonly used ways of handling privacy-sensitive data in a Linked Data environment: ontologies for representing privacy, and vocabularies for annotating of individual datasets. Then we proceed to propose a novel alternative approach: annotating individual vocabularies in their entirety, and annotating individual elements of those vocabularies.

1. Introduction

The Linked Data initiative was started by Berners-Lee (2006) as an innovative approach to the concept of the Semantic Web. He understood the idea of the Semantic Web as a web of data explicitly linked across different datasets, enabling both people and machines to integrate and explore them semantically – that is, with specific regard to meaning. Linking data implies that access to a piece of data enables a user to find pieces of related data iteratively. In the same way that standard HTML web hyperlinks relate documents to each other, linked data connects *entities* by using RDF formal language. Berners-Lee (2006) defined the following requirements for Linked Data:

- Use URIs as names for things.

- Use HTTP URIs so people can look up those names.

- When someone looks up a URI, provide useful information, using standards (RDF, SPARQL, OWL etc).

- Include links to other URIs, so that people can discover more things.

Those general principles provide only guidance for future development. They obviously lack any mention of privacy; in fact the issue of privacy was altogether neglected during the enthusiastic formative years of fulfilling this vision. Recent papers do however deal with specific privacy issues and attacks in the Linked Data environment (Heitmann et al., 2016; Miracle and Cheatham, 2016).

This paper discusses some more general approaches to protecting privacy within Linked Data technologies.

The rest of the paper is organized as follows: Section 2 provides basic characterization of the Linked Data project, its history, and associated standards and technologies. Section 3 provides the theoretical and legal motivation for privacy issues discussed in this paper. Section 4 presents two common ways of handling privacy issues in the Linked Data environment: ontologies for representing privacy, and vocabularies for annotating individual datasets. Then we proceed to propose two innovative alternative approaches: annotating vocabularies as a whole and annotation of individual elements of those vocabularies. Finally, Section 5 provides some conclusions.

2. Linked Data

Initial guiding principles of Linked Data as described in the previous section were later fully developed in a number of technical documents (Bizer et al., 2007; Sauermann et al., 2007) and overview papers (Bizer et al., 2008; Bizer et al., 2009).

Linked data can be queried e.g. through the formal query language SPARQL, which can be used to retrieve information in similar fashion to relational databases. Linked data can also be crawled with appropriate browsers, in a way comparable to usual web pages, by following RDF links. However, while HTML provides only a generic linking capability, the Linked Data environment enables the designer to create semantically different types of links: we can, for example, specify that an individual person is *author of* an individual paper – and instead of making a general link between person and paper it determines the specific type of link: *author of*. There are also search engines that are able to retrieve RDF information triplets and search across the whole universe of Linked Data, that at time of writing (January 2021) comprises more than 1,255 datasets with 16,174 links (see LOD cloud[18]). These datasets include some of the most popular data sources available on the internet, such as DBpedia that describes about 6 million entities.

The Linked Open Vocabularies[19] (Vandenbussche et al., 2017) initiative is an 'observatory' of the ecosystem of semantic vocabularies, started in March 2011 as part of the DataLift research project (Scharffe et al., 2012) and hosted by the Open Knowledge Foundation. To date it has registered more than 600 different mostly lightweight vocabularies.

Linked Data was built without any explicit regard for privacy and therefore it is in critical need of a review specifically targeted to identify potential privacy issues. Ontology schemata such as the DBpedia ontology and schema.org have been developed without marked regard for privacy and its enforcement in the Linked Data environment. Some vocabularies like *Friend of a Friend* (FOAF) explicitly focus on personal information and interpersonal relationships, and yet they do not have any features to handle privacy-sensitive information; thus, they may represent an extensive privacy risk (Vacura et al., 2016).

After the success of semantic technologies in the industry in recent years based on widespread use of lightweight vocabularies, it can be argued that a system of good practices, ensuring that all legitimate privacy concerns are being reflected and handled properly, is long overdue.

The key problem illustrated above is the vast amount of existing datasets and vocabularies. Discussion surrounding privacy issues has thus far been overlooked, so we already have to consider hundreds of vocabularies and thousands of datasets with no relevant information about possible

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[18] https://lod-cloud.net/

[19] http://lov.okfn.org/dataset/lov/

privacy issues connected to their use. In following discussion we analyze whether currently available solutions are viable and propose some new approaches.

3. Privacy in the Context of Complex Regulatory Framework

Any approach to annotation of linked data with regards to privacy issues has to take into account relevant EU regulatory frameworks. In this section we provide brief theoretical and legal context for privacy issues discussed in this paper, although we will not dive into details. The purpose of this section is to emphasize complexity of these considerations and pinpoint key terms, that are relevant for our projects.

The starting point for our discussion about privacy is Article 8 of the *EU Charter of Fundamental Rights*[20] that in general terms declares protection of personal data as one of our fundamental rights. Specifically, it is concerned with fairness and purposefulness of personal data processing, the right to access personal data, the requirement of consent of the person concerned or other legitimate basis written in law to process personal data and so forth. Those principles were recently further extended by the General Data Protection Regulation (GDPR).[21]

Alongside the concepts and regulations defined by GDPR are some notions closely related to them. *Relational Law* is understood as the intertwined complex of regulatory frameworks of law and programming (Casanovas, 2013). Regulatory *system* relates to the social concerns of relational law as well as procedural ways to manage and solve conflicts. *Relational justice* is shaped by regulatory systems and is a type of justice emerging from specific practices and strategies within technological situated contexts (Casanovas and Poblet, 2008).

Regulatory Models (RM) comprise of a normative suite implemented in computing environments that monitors compliance with regulatory systems and relational justice, the specific structure of principles, values, norms, and rules guiding technical protocols, multi-layered relation of organizations (multi-layered governance), and the interoperability of computer languages. In a case where such a regulatory model is based on semantic technologies, the term *Semantic Web Regulatory Model* (SWRM) has been introduced (Casanovas, 2015).

SWRMs can be integrated within a larger framework under the meta-rule of law in order to facilitate their use, e.g. the requirements of the *European Market Infrastructure Regulation*[22] as demonstrated by Casanovas et al. (2016).

The list of privacy challenges that is to be regulated and handled by SWRMs is extensive, and relative to applicable fields. Analysis and the list of privacy concerns can be found in Iacob and Bikakis (2016). Different approaches to annotating semantic structures as proposed in the following sections of this paper are envisioned to serve as a technical basis for future specifications of SWRMs, thus potentially assisting further implementation of the above-mentioned legal norms within real-world technology.

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[20] http://www.europarl.europa.eu/charter/pdf/text_en.pdf

[21] https://ec.europa.eu/info/law/law-topic/data-protection_en

[22] http://ec.europa.eu/finance/financial-markets/index_en.htm

4. Privacy Concerns and Light-weight Vocabularies

Complex theoretical and technological frameworks mentioned in the previous section rely on the ability to formally describe entities relevant to privacy concerns and facilitate automatic or semi-automatic management of privacy and data protection during instances of data transfer and data exchange.

Semantic Web technologies provide several approaches to semantically describe these entities and their relevance to privacy-related concerns. These approaches however differ in a number of respects and these differences influence their practical usability and effectiveness. However, when using Semantic Web (SW) tools, *Regulatory Model* (RM) turns into *Semantic Web Regulatory Model* (SWRM) as described in the previous section.

In following sections we firstly discuss two commonly used approaches: ontologies for representing privacy and annotations of individual datasets. Then we proceed to introduce two novel alternative approaches: annotating whole vocabularies and annotations of individual elements of vocabularies.

4.1. Ontologies for representing privacy

Privacy ontologies can be divided into *general* and *specialized* based on their intended use. General privacy ontologies are domain-independent and can be used in any scenario or context. They are not connected to any context-specific concepts or notions. Specialized ontologies focus on a specific domain or area and are reliably usable only within the boundaries of their intended coverage.

The most widely used ontologies for representing privacy today are specialized and focus only on a specific domain, such as IoT (Das et al., 2016). The terminology and structure of these ontologies reflects the area of their intended use. The main advantage of using them is that such ontologies are custom-made for a particular use, therefore, they are typically more effective and practical. A notable drawback is that their use is possible only within those boundaries, so their use in the context of Linked Data is limited to vocabularies related to domains covered by these ontologies.

An example of specialized privacy ontology is *HL7 Security and Privacy Ontology*, which serves to name, define, formally describe, and interrelate key security and privacy concepts within the scope of Healthcare Information Technology.[23]

A brief overview and evaluation of other specialized ontologies for representing privacy can be found in Casanovas et al. (2016) and Iacob and Bikakis (2016). The authors of the first of these papers however conclude that while those ontologies are very often comprehensively designed in terms of considering theoretical aspects, they are in practice difficult to learn and use.

An example of a general privacy ontology relevant to our discussion is *Privacy Preference Ontology* (PPO) for Linked Data (Sacco, 2011), that builds on the *Web Access Control* (WAC) vocabulary.[24] PPO restricts RDF documents to provide fine-grained privacy measures to specify access restrictions to the data. This example illustrates a common limitation of general ontologies – although such ontologies are not limited to a single domain, they usually focus on a single aspect of privacy, e.g. access rights. Based on our ongoing research we have found no single comprehensive general privacy ontology that would cover all aspects of privacy.

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[23] http://wiki.hl7.org/index.php?title=Security_and_Privacy_Ontology

[24] https://www.w3.org/wiki/WebAccessControl

These ontologies also focus on annotating individual data pieces (Abox): representing a privacy preference to share an individual e-mail address of one person that may be different than the preference of another person (PPO).

There is also another significant drawback of using existing comprehensive privacy ontologies in a Linked Data environment. Ontologies with heavyweight axiomatization may be useful for tasks that require complex reasoning. However, in a Linked Data context typically lightweight vocabularies are used and consequently only very limited axiomatization and reasoning is employed, if it is employed at all. Complex ontologies do not fit seamlessly into the Linked Data environment and sometimes even present a significant obstacle. Our brief overview shows that there is currently no general privacy ontology that could provide a technical basis for future specifications of SWRMs. If it existed, it could also serve as a starting point for approaches described in following sections.

Another problem stems from the amount of existing unannotated datasets mentioned in Section 2. Manual or semi-automatic interlinking of elements of those datasets with a privacy ontology is inconceivable. It may be possible to implement some form of automatic ontology mapping, but it is not clear whether this is feasible given the sensibility of privacy information and implied requirements for precision.

4.2. Annotating individual datasets

Another approach to privacy in Linked Data comprises annotation of datasets. As an example of this approach we propose the use of well-known standard *Dublin Core* together with *Linked Data Rights* (LDR)[25] vocabulary (Rodríguez-Doncel, 2013). The LDR vocabulary enables the user to create policies and expressions concerning rights for Linked Data resources. LDR focuses on intellectual property rights and makes it possible to say that some resource (ldr:Resource) has some legal status (ldr:ResourceLegalStatus) etc.

Dublin Core combined with LDR can be used to describe privacy information related to the dataset, however, the scope of privacy issues it covers is very limited. There are further drawbacks mentioned by Casanovas et al. (2016), for example some missing properties essential to effective utilization of this vocabulary. Those properties include the specific country where the personal data file has been registered, the privacy level of the dataset, and security measures that should be taken. Overall, available tools for annotating privacy of individual datasets are limited; there is a clear need for them to be extended and further interconnected.

A similar problem as noted in the previous section is related to the amount of existing unannotated datasets. Manual or semi-automatic annotation of those datasets is again inconceivable. It may be possible to implement some form of automatic annotation, but again this may not be feasible given the sensibility of privacy information.

We can also observe that there is currently no way to properly annotate individual datasets with regards to privacy that could provide a technical basis for future specifications of SWRMs

4.3. Annotating individual vocabularies

An alternative to the annotation of datasets is the annotation of whole vocabularies. The broad notion here is that while some vocabularies are typically used to handle privacy-sensitive information (e.g. *Friend of a Friend* – FOAF), other vocabularies may be marked as generally safe from privacy concerns (e.g. *Biological Taxonomy Vocabulary* – Botany). At the most general level, annotation would distinguish between safe and unsafe vocabularies, at a more detailed level it could

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[25] http://purl.oclc.org/NET/ldr/ns

distinguish between various types of privacy concerns that different vocabularies raise. So, while existing ontologies such as PPO assign annotations to individual pieces of data (concrete e-mail address of a person), in this case we will assign annotations to a vocabulary as whole. E.g. the FOAF vocabulary (identified by its URI) would be annotated as "unsafe" – optionally with some other fine-grained privacy related attributes; however, still related to the vocabulary as whole, while the Botany vocabulary would be annotated as "safe" regarding privacy.

Our research to date suggests that there is no ontology or vocabulary that is well suited for this method of annotation of vocabularies. However, considering the straightforward nature of such a vocabulary we believe that its development would not be an unduly difficult or time-consuming task. There could be some formal or syntactical technical difficulties that would need to be resolved, related to the fact that the entity to be annotated is the whole vocabulary, in which case the annotation would need to be attached to the respective namespace identifying that vocabulary. Given the number of vocabularies discussed in Section 2 it may be an extensive task but we believe that it is still plausible to consider the future of semi-automatic or even manual annotation. Annotations of vocabularies could also provide a technical basis for future specifications of relevant privacy SWRMs.

Annotation of whole vocabularies may also be regarded as a first step to more detailed annotation of individual elements of those vocabularies, as discussed in the following section. Exhaustive annotation of vocabulary elements would only be necessary for those vocabularies that as a whole handle some privacy-relevant data.

4.4. **Annotating individual elements of vocabularies**

After we have identified and annotated a vocabulary that may be used to describe privacy-sensitive information as described in the previous section it would be useful to analyze elements of this vocabulary separately and annotate them individually. While the total number of vocabularies is high, it should be possible to use annotations described in the previous section to select and annotate only those vocabularies that are used to handle privacy-sensitive information.

As in the case of annotating whole dictionaries, there might be some syntactical difficulties, correlating with our use of one vocabulary to annotate individual elements of other vocabulary. Nevertheless, given the nature of the RDF standard such annotation should be feasible.

There is currently no vocabulary comprehensive enough to make such annotation possible. However, there is a considerable number of specialized vocabularies that can be extended or complemented by new vocabularies to facilitate such an annotative project. Nonetheless, such a project would by necessity be more complex and time-consuming than the approach mentioned in previous section.

5. Conclusions

This paper explores the possible ways of dealing with privacy challenges in the Linked Data environment. The emergence of lightweight vocabularies and the large number of datasets based on them has increased the need to discuss potential privacy challenges. Existing research has already identified a number of potential privacy issues and proposed some custom-tailored solutions for them (Heitmann, 2016; Miracle, 2016).

In this paper we first provided a characterization of the Linked Data initiative then discussed some concepts of the theoretical and legal backgrounds of privacy issues relevant to our topic. The following section of the paper consisted of a presentation of two commonly used ways of handling

privacy-sensitive data in a Linked Data environment: ontologies for representing privacy, and vocabulary annotation of individual datasets. We proceeded to propose a novel alternative approach: annotation of whole individual vocabularies and annotating individual elements of those vocabularies. These annotations could also provide a technical basis for future specifications of relevant privacy SWRMs, the importance of which was described in Section 3.

In future work on this topic, we plan to fully develop the annotation framework foreshadowed in Section 4.4. Our aim is to develop a vocabulary that can be used for annotating other vocabularies, specifically regarding their privacy status.

6. Acknowledgement

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PERFORMANCE AND SUSTAINABILITY MANAGEMENT AND CORPORATE SOCIAL RESPONSIBILITY

COERCED APPLICATION OF E-LEARNING IN THE MANAGEMENT ACCOUNTING COURSE – CRITICAL REFLECTION

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e-learning, COVID-19 pandemic, management accounting, Czech Republic

Abstract

The COVID-19 pandemic disabled the traditional classroom learning at Czech Universities in the summer semester of the academic year 2019/2020 and coerced the application of the e-learning approach which lasts until now (spring 2021). This paper reflects both teachers' and students' experience with this change in the management accounting course for undergraduate students at the Prague University of Economics and Business.

1. Introduction

The COVID-19 pandemic disabled the traditional classroom learning at Czech Universities in the summer semester of the academic year 2019/2020. Following the decision of the Ministry of Health of the Czech Republic (Ministry of Health, 2020), the students were banned from the presence in classrooms at universities since the 11th of March, 2020. Simultaneously, it was decided not to suspend the educational activities. Both, teachers and students were encouraged to shift from traditional learning style to e-learning as soon as possible without any substantial impact on learning outcomes and time schedule of the courses.

In summer 2020, we published a paper reflecting the rapid change which has happened at the Prague University of Economics and Business in spring semester 2020 (Wagner and Křehnáčová, 2020) and we considered it echoes the extraordinary short story rather than the first episode of a soap opera. Yet, the man proposes, god disposes. The second and third episode of e-learning series has been released in the academic year 2020 – 2021 and this paper aims to resonate the changes in attitudes of both, teachers as well as students.

Facing the unprecedented situation in middle of March 2020, teachers and students were forced to change their habits and applied procedures within a couple of weeks (Kamarianos et al., 2020). In summer 2020, Sangster et al. (2020) provided the first global reflection of the impact of this change on accounting education based on collection of responses from university teachers in 66 countries. They pointed out the significance of the change in accounting education was amplified by the fact that accounting education was dominated by large group lectures and small group tutorials in the pre-COVID era. And they also remark the influence of socio-economic, technical and political

conditions which differ from country to country. As a follow-up, Fogarty (2020) comes with an essay about the impact of COVID era on "new normal" claiming that accounting education should be better prepared to change with the world.

Besides above-mentioned international collection gathered by Sangster's team, several local reflections of teachers' and students' experience in the field of accounting education has been published in the first twelve month since the pandemic appeared. E.g. Djajadikerta et al. (2021) come with the experience of Australian, Malaysian and Indonesian Academics, Sarea et al. (2020) refer to digitalization of accounting education in Gulf countries, Ackermann (2021) delivers a personal story of New Zealanders' accounting professor. Lacking the local reflection from the Central Europe, we decided to contribute by our personal experience and experience of our faculty members who participated in management accounting course.

The paper contributes to the debate about the efficiency of learning approaches comparing "traditional" classroom approach and e-learning approach. Moreover, it supports the teachers' readiness for unexpected or coerced changes in the learning style.

2. Methodology and data

This paper concerns the lesson learned from this coerced application of e-learning in the management accounting course for undergraduate students thought at the Prague University of Economics and Business, Czech Republic. This 6 ECTS course is the first management accounting course which is obligatory for all students in study programs on finance, accounting, banking, taxation and business management in the second or third year. First, the paper describes the applied changes in teaching methods. Second, it summarizes teachers' and students' feedback.

In particular, seven teachers and around 400 students are involved in the management accounting course in each semester. Thanks to good availability of online platforms and enormous effort of teachers, e-learning could start in less than two weeks after the decision to close university campus for students at the 10th of March, 2020. On-line synchronous lectures and tutorials were organized in MS Teams regularly for the remaining part of the spring semester 2020 and the same teaching and learning style has been continuing for the whole academic year 2020 - 2021. The university information system was used to share documents and the Sli.do platform helped to increase students' engagement via Q&A and short questionnaires. Teachers' coordination was ensured by regular on-line meetings and e-mail communication between course guarantor and other teachers.

The evaluation of students' learning involvement was ensured by weekly mini-tests. These mini-tests substituted the assessment of activity in tutorials, as the active contribution of students to the course of tutorials decreased substantially in spring semester 2020. To support students' active involvement in tutorials, mini-test were supplemented by assessment of their contribution to tutorials in fall semester 2020.

Further, the need for social distance influenced the procedure of final course evaluation. General recommendation for students' evaluation was published by Ministry of Education of the Czech Republic (Ministry of Education, 2020). In the management accounting course, the written test was realized on-line using the information system of the University with the obligatory application of surveillance by camera and microphone to guarantee the objectivity. To prevent copying answers, the principal aim was to individualize the test questions.

The results presented below are based on our personal experience and observation and based on unstructured interviews with other five teachers of the course. Further, we gain from the questionnaire distributed to all students of the course at the end of lecture's period. In the spring semester 2020, 143 of 392 students participated in the on-line questionnaire survey, so the response

rate is 36,5 percent. In the fall semester 2020, 118 of 414 students brings the response rate 28,5 %. We also used the data on students' course performance as recorded in the information system of the university.

3. Results and discussion

3.1. Teachers' reflection

Own experience and observation of authors and the unstructured multiple interviews with teachers revealed following remarks (Table 1).

Tab. 1 – Teachers' reflections of on-line teaching (source: spring 2020 - Wagner and Křehnáčová (2020), the other data based on own research)

Spring 2020	Fall 2020 and ongoing spring 2021
• Participation rate of students in on-line classes was the same or even higher compared to traditional classes. It could be caused by various reasons. First, working, social and leisure activities of students were limited due to the quarantine. Second, students were worried about the potential changes in course tasks and obligations. Third, students could participate in the class no matter where they were.	• Participation rate in on-line lectures decreased and corresponds with the pre-COVID situation. Participation rate in on-line tutorials is still very high. However, for both, lectures and tutorials some teachers feel increasing gap between students' participation rate and engagement rate as students are usually not willing to turn on the camera.
• Technical issues and problems on both, teacher's as well as student's side had just minor impact on the organization of on-line classes.	• Technical issues and problems are rare and occasional without any impact on the organization of on-line classes.
• Teachers spent much more time on preparation for the classes. The more detailed handouts which had to be prepared for students and the need of "fine-tuned" structure of an on-line class were the key reasons for a higher time demand. In the first weeks after the shift to e-learning, the workload was also increased because of "familiarization" of teachers with on-line platforms used in e-learning, however, this workload was reduced after the start-up face.	• Teachers' stress caused by specific tasks after the pivoting in spring 2020 decreased and it is perceived as similar to pre-pandemic situation.
• In case of lectures, the teacher considered the efficiency of on-line class to be even higher than in case of the traditional class. He stated that there was no waste of time caused by problems with the class equipment (data projector, microphone etc.), noise in the class etc. Further, the lecturer had a feeling that both, he and students could concentrate more on the course of the lecture. • In case of tutorials, the teachers considered the efficiency of on-line class lower compared to the traditional class. The principal reason was the substantial loss of interactivity which was crucial for an active involvement of students in the course of the tutorial.	• It is still quite hard to achieve targeted efficiency of on-line class. Although the communication between teacher and students is more interactive in general, teachers perceive it as difficult to reveal the shadows and pitfalls in the continuous progress of individual students. Lack of the time during the class, on one hand, and discourage of students to ask for help, on other hand, are considered as the key reasons for that.

Although teachers feel many advances in the on-line teaching and learning process as the next and next semester comes, technical skills are getting better and the on-line teaching routine consolidates, they don't perceive this situation as a "new normal". Further, our experience supports Dung's (2021) findings who recognized protecting individual health and community safety and saving the travel time as key advantages of virtual learning and vice versa, extensive time staring at digital screens, lack of body movements and lack of conditions for developing social interaction skills as disadvantages and obstacles of virtual learning.

3.2. Students' reflection

As the questionnaire surveys among students were realized in both semesters, it enables to deliver some interesting comparative findings (Table 2).

Tab. 2 – Students' reflections of on-line learning (source: spring 2020 - Wagner and Křehnáčová (2020), the other data based on own research)

Spring 2020	Fall 2020
• In case of lectures, 62 percent of students give priority to on-line lesson rather than traditional on-site lecture; in case of tutorials, 77 percent of students prefer traditional on-site tutorial in the classroom (see Table 3 for details).	• The popularity of on-line lectures increased as 73 percent of students stated the preference of on-line lectures in comparison with traditional on-site lectures; although the on-site tutorials have still above-average frequency of preference, more students support the on-line tutorials, namely 40 percent in fall instead of 23 percent in spring (see Table 3 for details).
• 97 percent of students would appreciate if the lecture had been recorded and they could listen it again whenever they needed.	• 99 percent of students appreciate the recording of lectures with the possibility to listen it again.

Tab. 3 – Students' preference of on-line and on-site classes (source: spring 2020 - Wagner and Křehnáčová (2020), the other data based on own research)

	Lectures		Tutorials	
All results in % (N spring = 143, N fall = 118)	Spring 2020	Fall 2020	Spring 2020	Fall 2020
On-line	27	33	8	16
Rather on-line	35	40	15	24
Rather on-site	20	14	29	32
On-site	18	14	48	28

The results presented in Table 2 and Table 3 lead us to consideration that students call for flexibility in terms of their pace to acquire general knowledge and they fully appreciate the recording of lectures. We also asked them to take their attitude on two options:

1. Lectures are recorded in advance and available on university website at any time and students can contact a lecturer for face-to-face consultation individually.

2. Lectures are performed for students in real time and life recording of lectures is then published on university website.

Surprisingly, 87 percent of students in spring semester and 85 percent of students in fall semester chose the latter alternative. It contrasts with findings of Islam et al. (2020) who found in their research realized in South Korea that more than 50 percent of students prefer pre-recorded lecture and 30 percent prefer a mix of pre-recorded and live lecture.

In fall semester 2020, all lectures were performed live via MS Teams and records were available to students in MS Stream. In spring semester 2021, we decided to implement mixed approach for lectures. It means each lecture consists of two parts. The first part is pre-recorded by the lecturer as the studio recording with the fixed scenario and published to students at the private Youtube channel. The second part of the lecture is performed live via MS Teams and this part is also recorded and available to students via MS Stream. This part doesn't have a strictly fixed scenario and it comprises teacher's explanation and feedback with regard to the students' questions and comments.

As we intended to make the pre-recorded lectures in spring 2021, we asked students in fall 2020 questionnaire which style of the pre-recorded lecture they would prefer. The presentation of the conceptual background of a particular topic was endorsed by 70 percent of respondents, the

solution of sample examples using white board by lecturer was supported by 34 percent of students and solution of sample examples using MS Excel by lecturer was preferred by 89 percent of participants. We decided to make a mix of the first and the third alternative. Presentation of the conceptual background of a particular topic is followed by solution of sample examples using MS Excel by lecturer.

Comparing spring 2021 and fall 2020, preliminary results show that the sum-up of the number of students' views of the pre-recorded video lectures and the number of students attending the live lecture in spring 2021 exceeds the sum-up of the number of students who participated in live lecture and the number of visits of the website with live recording in fall 2020. It shows the approach applied in spring 2021 reached more students in contrast to fall 2020. However, the structure changed as the number of students with synchronous participation in the live part of the lecture in spring 2021 decreased in the comparison with fall 2020.

In contrast to lectures, the majority of students would prefer on-site tutorials rather than on-line even though the quota of students who prefer on-line tutorials increased in fall 2020 compared to spring 2020. In the questionnaire survey realized at the end of the fall semester 2020, students were asked to complete the sentence "If I could change anything in the tutorials, I wish…". In the answers, the most frequently mentioned issues are the slower flow of the tutorial content, more detailed explanation of exercises and availability of all results in details. We consider these answers as timeless since they were addressed by students even before pivoting to on-line classes. However, two other identified issues can be bound with on-line classes, namely dissatisfaction with team learning during tutorials and big "desire" for recording of tutorials. In both issues, the approach applied by individual teachers was not unified in fall semester 2020 and teachers could decide if they use team learning or traditional learning as well as if they record the classes or not. Teachers who chose team learning and decided not to record classes received above mentioned (quite negative) feedback while the teachers who made the other choice received neither any negative feedback for their choices nor the call for the change of the approach.

The finding that some students who experienced the team learning were dissatisfied is in the contrast with the research realized by Opdecam and Everaert (2012). In their research, realized in on-site classes they found higher students' satisfaction in case of team learning. We suppose that the on-line vs. on-site teaching could be a relevant contingency factor moderating the link between learning style and students' satisfaction. In case of full on-line classes, students do not know each other in person, they cannot use non-verbal communication during the team work, free-riders are harder to be involved in the team, teachers cannot monitor all teams together.

The demand for the recording of tutorials – in junction with the preference of on-site synchronous class – supports the idea of blended learning, i.e. to mix face-to-face meetings with asynchronous learning.

4. Conclusion

Our paper shows that the application of e-learning in the management accounting course didn't undermine the principal learning goals and outcomes of the course although the change was unintended, rapid and unprecedent. It is also nice to realize that the technical and procedural advances mean that these issues are not limiting. The situation brought a great opportunity for teachers not only to face new challenges but also to compare the traditional approach and the e-learning approach. Our study shows that neither teachers nor students prefer e-learning approach although they are ready to use it (for example in case of re-establishment of quarantine measures). Some type of hybrid learning (blended learning) seems to be an efficient solution. The further discussion is needed about the blended learning model.

5. Acknowledgment

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CREATING PERFORMANCE MEASUREMENT SYSTEM WITH THE APPLICATION OF BALANCED SCORECARD

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Balanced Scorecard, Indicator, Logit, Measurement, Performance, System

Abstract

Knowledge of key performance indicators (KPI) is an essential part of business performance management. Therefore, the aim of the paper was to point out the accurate choice of measures and indicators of business performance. The study was conducted on a sample of 292 businesses operating in the field of heat management, whose performance needs to be measured and monitored from several perspectives. Performance measures were selected in accordance with the requirements of the Balanced Scorecard (BSC), while the selection of financial indicators was confirmed based on the results of the Logit model. The result of the research is the proposal of key performance indicators of the analyzed sample of businesses. The originality of the paper is the application of the Logit model when selecting financial indicators entering the Performance Measurement System (PMS), which is based on BSC principles.

1. Introduction

The company's performance is an important factor influencing its sustainability and competitiveness, in line with the quality of products and services, low costs, speed and flexibility to respond to customer needs and the innovation of products and processes.

Designing an effective Performance Measurement System, which includes the selection of suitable tools and approaches to analyze the results achieved, is an important element of the success of any business. Research suggests that organizations with more advanced Performance Measurement Systems perform better in terms of customer, financial and market performance and success (Evans 2004). Approaches to measuring business performance have undergone significant developments - from traditional performance indicators to Value-Based Management indicators.

In relation to the above-mentioned, the aim of the paper is to create Performance Measurement System with the application of key performance indicators and to measure the performance of a selected sample of businesses using this system. Performance Measurement System was created based on BSC principles, while the selection of financial indicators was confirmed based on the results of Logit model

The remainder of the paper is structured as follows. The first chapter states the aim of the paper. The second chapter describes performance measurement and Performance Measurement Systems. Special part of this chapter is devoted to the concept of BSC. The third chapter describes the data, the analyzed sample of businesses and processing methods. We used selected financial indicators,

Logit model and BSC to fulfill the aim of the paper. The fourth chapter lists the results of applied methods. The fifth chapter summarizes the essential conclusions and presents significant findings and limitations of the research. The process of the research is illustrated in Figure 1.
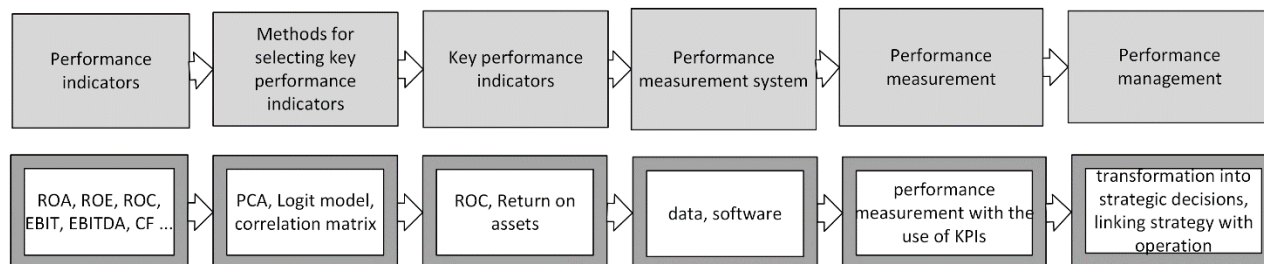
Figure 1: Flowchart of the research Source: authors

2. Theoretical basis of performance measurement

When measuring business performance, it is necessary to focus on PMS, as this system lies in the heart of performance management (Lebas, 1995; Bitici et al., 1997). In the initial period of development of performance measurement, the most frequently applied approach to performance measurement was the traditional approach derived from calculation and accounting systems. Such approach was based on financial performance indicators (Bourne et al., 2000; Nudurupati et al., 2011).

In the late 1980s and early 1990s, the scope of PMS research began to expand and led to the recognition of performance measurement as a multidimensional domain (Rosová and Balog, 2012). Despite some shortcomings and problems, research on PMS has continued and a large number of frameworks for PMS have emerged. These frameworks have focused on non-financial indicators, external indicators and forward-looking indicators (Bourne et al., 2000; Nudurupati et al., 2011; Bititci et al., 2011). As a result of these proposals, the dominant research issue in the mid-1990s became the "balanced system for measuring business performance". Lynch and Cross (1991), Brignall et. al (1991), Keegan et al. (1989) and Kaplan and Norton (1992) pointed out that classical performance measures are static and do not adapt to the changing effects of the external environment, are cumbersome to collect and process data, and what can be considered the biggest negative, are not a commitment for top managers in terms of their successful implementation.

BSC can be considered as one of the latest most important frameworks of PMS. It was developed by American consultants Kaplan and Norton in the 1990s.

The main goal of BSC was to replace the traditional performance evaluation model, which focused only on financial indices, with a more complex and effective evaluation of the company's performance. Kaplan and Norton (2000) pointed to the more important position of non-financial or so-called "Leading indicators" in the BSC system, compared to the financial indicators they considered suitable for the former era of industrialization. They introduced a comprehensive view of the organization in the form of 4 consecutive perspectives (financial, customer, internal processes and learning and growth) and pointed out that measuring the company's performance using only financial indicators is insufficient due to the need to link indicators to the strategy and vision of the organization. These put the organization's strategy into the center of attention.

The second generation of BSC presented BSC as a system of strategy implementation. At this stage, relationships between indicators and targets have been formulated, as well as between targets and drivers (Kaplan and Norton, 1992, Olve et al., 1999). Later, in the development of BSC, there was a shift from simple links between perspectives to causal links between goals, indicators and

drivers, and a new generation of BSC has emerged. A strategic model of cause - effect interrelationships has emerged, too (Brewer, 2002). At the turn of the millennium, Kaplan and Norton (2001) began discussing the so-called strategically-oriented organization. They introduced the term strategic map, which over time has become perhaps the most important element of the BSC concept. Strategic map is a logical and comprehensive architecture for describing a strategy. It provides the basis for the design of the BSC, which is the cornerstone of the new "strategic management system" (Kaplan and Norton, 2001).

In the third generation, BSC began to be used as a management system that allowed organizations to clearly define their goals and strategies (Olson and Slater, 2002). It has been confirmed that one of the many advantages of BSC was its contribution to the strategic management and its connection to the operational management system, as well as to the specification of the company's strategy (Kaplan and Norton, 1992).

Fourth generation of BSC is the result of the cooperation of the consulting company Excitant with Kaplan and Norton, which was documented in the book "Strategy Mapping for Learning organizations". The essence of the fourth generation of BSC is that it does not support the copying of successful companies - best practice, but prefers thinking according to the thinking of successful managers - best thinking. Within this BSC structure, it is possible to define a specific vision, which describes the expectations of management with regard to the future development - the future is a tool for discussions of the company's management team. This BSC structure makes it possible to obtain information on the company's performance, both within the company and outside the company, as it also includes an external perspective, which has two components – the social and the environmental impact. However, it also continues to use those aspects of the original concept of BSC that are appropriate, useful and effective, but modifies what needs to be updated for the current market environment (Jones, 2010; Excitant, 2018).

3. Data and methodology

The input database of the empirical study was created from the data of 292 companies that do business in Slovakia in the field of heat production. The financial statements of the companies were provided by CRIF Slovensko (CRIF, 2016).

The heat economy of Slovakia is a network branch of local, at most regional importance. Therefore, the overall character and structure of heat supply companies, as well as the method of heat and hot water supply is determined by various factors, including in particular the climate and fragmentation of the territory, historical development, demographic conditions and territorial division, character of housing, commercial and industrial construction, economic activity or availability of fuel sources for heat production. These factors affect the performance of the analyzed companies from the outside. In addition to these factors, the performance of these companies is also affected by regulatory measures issued by state regulators. These external influences are difficult to manage, as regulatory measures often do not take into account the real situation of these companies, especially in relation to variable and fixed costs and regulated heat prices. Companies in this sector must pay attention to the protection of the environment, responsibly monitor environmental aspects throughout the production process and strive to continuously reduce the burden on the environment.

The input analysis of heat management companies focuses on the description of a selected group of financial indicators of companies. These financial indicators represent the input database for the selection of key financial performance indicators. The indicators, formulas for calculating them and mean values for the analyzed sample of 292 companies are given in Table 1.

Table 1: Input financial indicators and their mean values

Indicator	Indicators` description	Method of calculation	Mean
TL	Total liquidity	$short-term\ assets/short-term\ liabilities$	1.417
CR	Current ratio	$(current\ receivables+financial\ assets)/short-term\ liabilities$	1.349
ACP	Average collection period	$current\ receivables/sales \times 360$	155.88
IT	Inventory turnover	$inventory/sales \times 360$	27
CPP	Creditors payment period	$current\ liabilities/sales \times 360$	710.64
ROA	Return on assets	$EBIT/assets \times 100$	4.5
ROE	Return on equity	$EAT/equity \times 100$	15.4
ROS	Return on sales	$EAT/sales \times 100$	-12
ROC	Return on costs	$EAT/costs \times 100$	6.7
ER	Equity ratio	$equity/assets \times 100$	16
TDTA	Total debt to total assets	$debt/assets \times 100$	84
EDR	Equity to debt ratio	$equity/debt$	0.672
DER	Debt to equity ratio	$debt/equity$	1.48
ICR	Interest coverage ratio	$EBIT/interest\ expense$	2.530
DSCR	Debt-service coverage ratio	$interest\ expense/EBIT \times 100$	-75

Notes: EAT – Earnings after Taxes, EBIT - Earnings before Interest and Taxes; Source: authors

The average values of the indicators of 292 companies were compared with the mean values of the industry (CRIF, 2021) and the standardized form (see Figure 2).
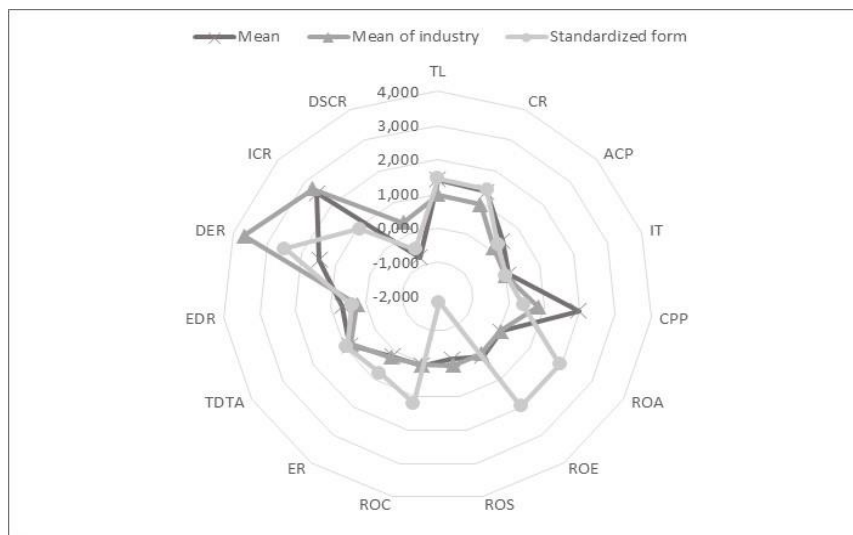
Figure 2: Comparison of the achieved results; Source: authors

Based on this comparison, it can be stated that the analyzed sample of companies achieves better values in the case of the indicators TL, CR, ROA, ROE, ROC, EDR and DER. Worse results are achieved by companies in the area of asset turnover, in the case of ACP, IT, CPP. The worse situation was recorded in comparison with the mean values of the industry, but also with the standardized form. It would be appropriate to reduce these indicators in order to increase the performance of companies. Therefore, these could be included in the Performance Measurement System. The ROA and ROE indicators reach a higher value compared to the industry, but lower compared to the standardized form. When evaluating the capital structure of a given sample of companies, it was found that the ER indicator underperforms - achieves worse values than the mean, but also the standardized form, while the TDTA indicator is worse than the mean of the

industry, but achieves better results compared to the standardized form. The ICR indicator also achieves better results than the standardized form.

The above analysis shows that the important indicators that need to be optimized to increase performance include indicators: ACP, IT, CPP, ROS, ER, TDTA, ICR, DSCR. The Logit model was applied to assess the significance of these indicators in the area of business performance evaluation.

The Logit model is a multidimensional statistical model that is used to predict the probability of inefficiency, performance, failure or financial health of a company, using the main economic and financial indicators as inputs. It was first used by Martin (1977), who applied logistic regression in the construction of an early warning system for banks. Few years later Ohlson (1980) used Logit model to forecast the financial situation of companies.

The Logit model captures the relationship between the dichotomous dependent variable Y and one or more independent variables X. The procedure for calculating the coefficients of this model compares the probability that the event occurs $L_{(1)}$ against the *probability* that the event does not occur $L_{(0)} = 1 - L_{(1)}$ using the odds ratio $L_{(1)}/L_{(0)}$. The formula for calculating the Logit model is as follows (Meloun et al., 2017):

$$ln\left(\frac{L_{(1)}}{L_{(0)}}\right) = b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_p x_p,$$

where x_i *are selected financial indicators,* b_i *are estimated parameters,* p *is the number of independent variables.*

4. Results and discussion

When selecting inputs to the Logit model, we applied correlation matrix. We used this method to eliminate strong correlations between the indicators entering the Logit model. The result of this procedure was a set of indicators entering the Logit model (see Table 2).

Table 2: Performance indicators confirmed by the Logit model

Effect	LOGIT Modeled Probability that Performance = yes					
	Estimate	**Standard error**	**Wald Stat**	**Lower CL 95,0%**	**Upper CL 95,0%**	**p-value**
Intercept	-4,66605	0,693799	45,23064	-6,02588	-3,30623	0,000000
CR	0,07724	0,064589	1,42992	-0,04936	0,20383	0,231777
ACP	-0,02927	0,092047	0,10113	-0,20968	0,15114	0,750473
IT	0,29095	0,448639	0,42058	-0,58837	1,17027	0,516649
CPP	0,00147	0,042651	0,00118	-0,08213	0,08506	0,972593
ROS	-0,07247	0,127324	0,32397	-0,32202	0,17708	0,569230
TDTA	4,67531	0,688949	46,05187	3,32500	6,02563	0,000000
ICR	0,09342	0,034789	7,21078	0,02523	0,16160	0,007247
ROA	11,57002	2,611556	19,62772	6,45147	16,68858	0,000009

Source: authors, processed in software Statistica

The results of the Logit model show that the statistically significant indicators from the above in relation to the performance of the company are the indicators: TDTA, ICR, ROA. These indicators are important indicators of the company's performance.

Based on the results of the Logit model, it is possible to determine significant financial performance indicators, which are listed in Table 3. This table summarizes performance indicators from all major areas of performance evaluation of a given sample of companies in the heat management sector.

Table 3: Performance indicators from all major areas of performance evaluation

Perspective	Goal	Measure
Top goal	*to increase company`s performance and value*	*EVA indicator*
Financial perspective	to increase *company`s* profitability	EAT/assets
	to reduce *company`s* debt	debt/assets
	to increase interest coverage ratio	EBIT/interest expense
Customer perspective	to retain current customers	number of customers
	to get new customers	number of new customers
	to create a positive awareness of the company producing thermal energy	number of satisfied customers
Perspective of internal processes	to ensure the renewal of production facilities	volume of emissions produced
	to ensure a reliable supply of heat to existing customers	volume of heat produced, number of consumption units
	to utilize capacity and prevent heat loss	actual consumption / capacity
Perspective of learning and growth	to increase employee loyalty	fluctuation coefficient
	to create a pleasant work environment	number of satisfied employees
	to increase employees' qualifications	number of qualified employees / total number of employees
Environmental perspective	to reduce the burden on the environment - the air	emission limits for pollutants – air (TZL, SO_2, CO_2, NO_x)
	to protect water	emission limits for pollutants – water (Fe, pH, t
		wastewater limits
	to reduce waste	quantity in tonnes
	to increase environmental awareness of employees	number of trained employees

(Environmental objectives and measures were processed based on the documents on social and environmental responsibility of the analyzed sample of businesses); Notes: EVA – Economic Value Added; Source: authors

5. Conclusion

Design and development of a quality system of performance measures is highly desirable in today's turbulent times. This system of measures have to take into account all the requirements of internal as well as the external environment. In addition to financial indicators, this system should include indicators for measuring satisfaction and performance in customer perspective, as well as indicators for measuring the performance of the company's processes. A very important component of this system are measures of employee satisfaction and performance. Recently, the original 4-component system of performance measures based on BSC has been supplemented by other perspectives, such as the perspective of social responsibility. In this perspective, there are measures that focus on responsibility towards employees, customers, society, but especially towards the environment. This need for social responsibility is nowadays most communicated in the public, but also in the business environment. Businesses supplement their performance measurement frameworks with environmental policy measures.

The analyzed industry belongs to this group of companies, while it pays increased attention to the environmental measures. These measures have the same importance in measuring business

performance as financial measures. It should be emphasized that shortcomings in compliance with environmental rules will be reflected in the financial results of companies.

Limitation of processing quality performance systems can be seen in goals, but especially measures of non-financial perspectives and their specifications. Therefore, financial perspective is the most sophisticated component of the Performance Measurement System. This is due to the fact, that these indicators have been applied for a long time and can be expressed and calculated exactly. Therefore, it is necessary to pay increased attention to the improvement of measures in non-financial perspectives of performance measurement.

The BSC system provides significant assistance in creating a quality system of performance measures. It creates a platform for the application of measures from various areas of measuring business performance. The contribution of this paper is that it outlines a framework of Performance Measurement System for analyzed sample, which could be beneficial for businesses in their effort to increase performance. Equally beneficial is the application of a more accurate statistical method in the selection of key performance indicators to the financial perspective of BSC.

To improve the selection of performance indicators, targets, benchmarks and actions, in the future we will focus on their more precise selection and design, especially from other perspectives outside the financial perspective.

6. Acknowledgement

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TRUST IN SMART ROBOTICS AND AUTONOMOUS SYSTEMS – RESILIENT TECHNOLOGY, ECONOMY AND SOCIETY

TRUSTWORTHY SMART AUTONOMOUS SYSTEMS-OF-SYSTEMS – RESILIENT TECHNOLOGY, ECONOMY AND SOCIETY

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Abstract

Smart and (partially) autonomous systems are today's drivers of innovation and economic respectively societal disruptive changes: in all industrial and social areas highly automated or autonomous intelligent systems are taking over tasks and services – and maybe, one day, control of our lives. This is a considerable risk to democracy, human independence and human rights, raising ethical questions. However, conventional technologies have also an impact, particularly on excessive exploitation of natural resources, climate change and inequality in global economy and society.

The concept of circular economy became a focus when thinking about a more sustainable future. We are now seeing many communities and businesses adopt novel approaches based on circularity. European policy has reacted to the challenges of climate change and environmental footprint reduction particularly in context of production, transport, farming and large urban agglomerations – smartness (intelligence) is not only addressing well-being, assisted living and comfort of citizens (keyword "Society 5.0"), but even more sustainability goals in the long term. The European Green Deal is a commitment to future generations, while the European Green Cities movement addresses many of the UN Sustainable Development Goals and manages a network of cities for collaboration and experience exchange by developing innovative projects.

1. Introduction – Smart and Autonomous Systems

Smart (intelligent) systems, forming together systems-of-systems with sometimes unexpected emergent properties through their interactions and impact on our lives and behaviours, are today's drivers of innovation and leading to disruptive changes in all industrial, economic and social areas. Therefore, our society is facing many challenges – upcoming crisis in many respects, e.g. the climate crisis, the Covid-19 (Corona) crises, and economic as well as social crisis impacts in the future. We have exploited our natural resources in a ruthless manner often just for short term profits and benefits of a few. This situation is encompassed by an enormous progress in technology, particularly in electronic systems and materials. Smart systems are already everywhere –but

integrated into "super-smart systems-of-systems" with advanced algorithms, artificial intelligence and "big data" in the background.

The impact of Smart Systems and Systems-of-Systems on technology evolution, society and economy is enormous, sharing positive as well as negative expectations as a basis for critical discussion. Particular focus is on the evolutionary development towards integrated large and complex system-of-systems cluster applications, e.g. Smart Cities, Smart Farming, holistic production and mobility solutions (e.g. beyond autonomous vehicles towards optimized shared multi-modal mobility and logistics solutions as a service) overcoming the boundaries of single isolated "systems of interest". The main questions are:

- how to develop intelligent, interconnected cyber-physical systems of systems, the underlying infrastructure (IoT, smart wireless connectivity, AI ecosystem), so that we can guarantee trustworthiness and high acceptance by the citizens,

- how can digital economy systems support a resilient, sustainable and ethically aligned, human-centered society,

- how can we, the people, manage the disruptive changes to be expected.

In a digitalized world, safety and security are well established properties, facilitated by standards, qualification/verification techniques and methods. Highly automated systems are challenging beyond the well-established techniques and methods – they have to react in a reasonable manner on unpredictable situations and environments, to take autonomous decisions based on high-level and (even) ethical principles, situation awareness, perception, scene understanding, Artificial Intelligence, Big data, IoT - these are just a few key words.

Even the attacks on human rights, freedom and independence are now much "smarter", and most of us are often not aware of the degree of surveillance and control, even in our democracies in the so-called "Western World".

This will impact considerably our lives and lifestyle, and, as a consequence, we will have to face the new challenges, opportunities and risks. Not to forget the economic risks – recent crisis like Covid-19 lock-downs have demonstrated even our economic vulnerability because of the dependency on worldwide functioning supply chains.

The technological basis is laid by IoT (human – smart devices interaction and communication) and IIoT (IoT in industrial context, machine-to-machine communication) as infrastructure (connectivity), and CPS (Cyber-physical Systems) as "things" or "devices". But smartness is more – it means intelligence, cognitive systems and technology, machine learning and artificial intelligence, security, big data and cloud connectivity, involving many domains of everyday life and digital transformation of our world.

With respect to safety, cybersecurity, privacy, and data sovereignty, the new "cognitive technologies" are a severe concern for specialists, politicians and citizens, and raise severe ethical and societal concerns, and dependency on these technologies in a networked world is an additional concern now.

For our future it is most important now to strive for a "resilient society" and a "sustainable economy", both relying on each other. Such a strategy will cope with the challenges particularly by the of the crises mentioned before – climate, pandemic and economic risks, stability of society and long-term survival and peace.

2. European Efforts towards Digitalization

The digital transformation of European business and society is a major goal of the EC. EC Growth, the DG (Directorate General) for Internal Market, Industry, Entrepreneurship and SMEs, considers digital transformation as a key element for European growth, because Europe can build on its strength in traditional sectors and can take up the potential and challenges of advanced digital technologies. Technologies considered in this context are IoT, big data, advanced manufacturing, robotics, 3D printing, blockchain technologies and artificial intelligence (see European Commission, 2018 - 2020).

The initiative "Digitizing European Industry" targets to meet Europe's needs to join forces under a common strategy that takes digitalization of the EU's economy forward in order to unlock the full potential of the 4th industrial revolution. The pillars of this initiative are (see Figure 1):

Figure 1: Pillars of the European Initiative "Digitizing European Industry"; (Source:

https://ec.europa.eu/digital-single-market/en/pillars-digitising-european-industry-initiative)

In the booklet "My agenda for Europe" of Ursula von der Leyen, the new President of the European Commission, is one chapter dedicated to "A Europe fit for the digital age". It focuses on AI, IoT, 5G, and ethical and human implications of these technologies, empowering people through education and skills, and on protecting ourselves with respect to the risks of these technologies.

Research is a key element to drive digitalization forward. On European level, organizations like AIOTI [AIOTI], the Alliance for Internet of Things Innovation, which takes care of the IoT aspects in 13 Working Groups, or the industrial associations ARTEMIS [ARTEMIS] (Advanced Research and Technology on Embedded Intelligent Systems), EPoSS [EPoSS] (European Technology Platform for Smart systems Integration) and AENEAS (Association for European Nano-Electronics Activities), which are the private partners in the ECSEL Joint Undertaking, a European PPP within Horizon 2020 (Public-Private Partnership) with an industry-oriented Research Program, and other PPPs, take care of further development of research, standardization and promotion of these topics, together with the European Commission and national funding authorities. China is already keeping up with Europe, US and Japan, e.g. with its AI initiative and strategy.

But it is not only economics and competitiveness of European industry – the recently announced "Green Deal" as basis and justification for the upcoming huge efforts are targeting at "Resilience" and "Sustainability" in all technology-driven areas, like manufacturing, mobility, public and industrial administration, particularly considering also societal and ethical aspects.

Additionally, DG Growth delivers an annual report on standardization, e.g. the "Rolling Plan on ICT Standardization", which includes most of the relevant areas in this paper's context and is a key pillar in Digitalization, and have started a Joint Initiative on Standardization (JIS) http://ec.europa.eu/growth/single-market/europeanstandards/notification-system_en, although they do primarily consider the European SDOs (Standardization Organizations, ESOs) CEN, CENELEC and ETSI. The same is done by the international standardization organizations ISO and IEC, particularly in their Joint Technical Committee JTC1 (Information Technology), which cover all these topics of "Joint interest", particularly IoT (SC41), AI (SC42) and Security (SC27) and Software and Systems engineering (SC7).

The straightforward goal of these efforts is to have advanced technologies in ICT end ECS (Electronic components and systems) the enable a sustainable and resilient society in the economic and human factors and well-being sense. As examples like the movement of "Resilient Cities" and "Sustainable Growth" show, these technologies are a chance to overcome current waste of resources and to optimize resource usage, recycling and reuse sustainable production not only in industry but also in agriculture (smart farming, in large cities even "vertical farming" in an until now unseen performance making large population agglomerates less vulnerable to supply risks in case of a crisis), mobility, work spaces and living spaces ("smart buildings", "smart homes"). "Business resilience" is also a key objective, e.g. the COVID-19 impact on global service delivery models, as several studies have described (SSON-Study "Reality Bites – Impact of COVID-19 on Global Service Delivery Models"").

In a publication "Why European companies need to complete the digital transformation to remain viable and competitive", this crisis is considered as a "turbo" to advance faster in our digitalization – to become more resilient and sustainable as economy and society.

The Corona-crisis is looked at as a "disruptive force and digitalization turbo" (citation):

"Breakthrough for digitalization", "How the virus makes digitalization move forward" or "Corona makes the Internet a matter of course" – this is how the headlines of articles describing the effects of the coronavirus on the digitalization of various areas of life are currently read.

On the other hand, human freedom, independence and privacy is for sure endangered, as well as too much dependency on technologies you have not nearby access to concerning maintenance and update.

Examples how AI can influence our job situation is demonstrated by measures of some large companies, and even public organizations, particularly by biased training datasets (taken from newsletters):

- Microsoft replaces journalists by AI systems (for MSN-website News)
- Public unemployment service uses AI algorithms to select clients: elder women skipped out of the search for jobs (without individual check of qualification)
- Racist decisions by AI systems (court, police, gender issues)

Therefore, we have to look not only at system properties like safety, security or privacy, but also on other aspects, how we can "TRUST" these technologies.

3. The UN Sustainability Goals and the European Green Deal

On a historic UN summit September 2015, the United Nations General Assembly set the "2030 Agenda for Sustainable Development", which came into force on 1 January 2016. The world leaders adopted the 17 Sustainable Development Goals (SDGs) . This is a commitment for the next

fifteen years, to fight hunger, disease, poverty, inequality, and climate change which are real problems that affect millions of people every day, ensuring (hopefully) that no one is left behind.

As easy as these issues are to identify, actually solving them requires a global effort, cooperation, and an understanding that everyone can play a part in moving us forward. These 17 GSDs (also called "Global Goals") are a collection of interconnected goals designed to give all of us on our planet a better future, with hundreds of targets and measurement indicators geared toward a date of 2030. The goals were created with businesses in mind, providing a path – what some people refer to as a "Pathway for Humanity" — for any business to harness their power by directing their efforts toward specific global objectives. The reference in the bibliography at the end of this article is downloadable for everybody – it is a booklet describing in a concise manner these 17 goals. More details with further links can be found on https://sdgs.un.org/goals .

The goals themselves to be simple and direct, but powerful, ranging from ending poverty to building sustainable cities. Technologies are key to realize the most important goals for a still growing world population under pressures like resource exploitation and climate change. An overview is provided in Figure 2. The Global Goals are:

SDG 1: No Poverty

SDG 2: Zero Hunger

SDG 3: Good Health and Well-being

SDG 4: Quality Education

SDG 5: Gender Equality

SDG 6: Clean Water and Sanitation

SDG 7: Affordable and Clean Energy

SDG 8: Decent Work and Economic Growth

SDG 9: Industry, Innovation & Infrastructure

SDG 10: Reduced Inequalities

SDG 11: Sustainable Cities and Communities

SDG 12: Responsible Consumption & Production

SDG 13: Climate Action

SDG 14: Life Below Water

SDG 15: Life on Land

SDG 16: Peace, Justice and Strong Institutions

SDG 17: Partnerships for the Goals

To monitor and track progress in achieving results towards the SDGS (Sustainable Development Goals), the UN has created a global initiative "Sustainable Development Solutions Network" (https://www.unsdsn.org/sdg-index-and-monitoring). The SDSN methodology (sound metrics, statistical methods, identification of gaps etc.) was audited by the European JRC (Joint Research Center) in July 2019, the results of which are available as a report (see References).

Several regions of the world have developed related reports, e.g. the *2020 Europe Sustainable Development Report* (ESDR 2020) builds on the methodology of the annual *Sustainable Development Report*, including SDG Index and Dashboards, issued by the SDSN and Bertelsmann Foundation.

The European Green Deal

The European Commission has particularly addressed the challenge of Climate Change and Climate Action. In „COM(2019) 640 final", a communication of the European Commission to the European institutions (European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions) on "The European Green Deal", the declared goal is a Europe "Striving to be the first climate-neutral continent". It is an ambitious commitment to future generations, identifying

"Climate change and environmental degradation as an existential threat to Europe and the world".

Figure 2: The UN 17 Sustainable Development Goals ("Global Goals"); (Source: http://greencities.eu/about)

To overcome these challenges, the **European Green Deal** will transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use
- no person and no place left behind

The European Green Deal has an action plan (https://eur-lex.europa.eu/legal-content/EN/TXT) to

- boost the efficient use of resources by moving to a clean, circular economy
- restore bio-diversity and cut pollution

The plan outlines investments needed and financing tools available. It explains how to ensure a just and inclusive transition.

The EU aims to be climate neutral in 2050. Reaching this target will require action by all sectors of our economy, including

- investing in environmentally-friendly technologies
- supporting industry to innovate
- rolling out cleaner, cheaper and healthier forms of private and public transport
- decarbonising the energy sector
- ensuring buildings are more energy efficient
- working with international partners to improve global environmental standards

The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy. This is called the Just Transition Mechanism. It will help mobilize at least €100 billion over the period 2021-2027 in the most affected regions. A most important part of this huge effort is dedicated to research towards "clean green technologies" to be developed and implemented throughout Europe, converting economy and society.

The European Green (Sustainable, Resilient, Circular) Cities Movement

Following the ideas and concepts of the UN Sustainable Development Goals and the European Green Deal particularly in context of urban agglomerations, where worldwide the large majority of people will live, the "European Green Cities" organization was founded in Europe.

European Green Cities is a non-profit organization, founded in 1988, that strive to help alleviate the climate crisis, by developing CO2-neutral cities and neighborhoods across Europe. The mission is to contribute to the development of green cities and buildings in a sustainable Europe, by supporting the projects with their know-how.

"European Green Cities" helps to alleviate the climate crisis by supporting municipalities and citizen-organizations to develop innovative projects within energy transition and mobility, facilitate stakeholder processes, carry out analysis, implementation of best practice, training in sustainable urban development and dissemination.

The organization initiates new project proposals and EU-applications, and help put the team of partners, cities, organizations, companies and consultants together.

European Green Cities also manages a network of cities to ensure collaboration and share knowledge across borders. Concrete examples and current projects can be found at http://greencities.eu/projects.

SDGs and holistic urban development

In European Green Cities we mainly support The UN Sustainable Development Goals no 3, 7, 9, 11, 13 and 17. The UN SDGs are interconnected, and thereby improving one of the goals often affect several of the others positively. But it is important to keep in mind that one battle at a time is more efficient, that trying to target everything at once, therefore we help cities create a baseline methodology, when they want to work with the SDG's proactively.

- Targeting the UN 17 Sustainable Development Goals
- Baseline development
- Long term planning
- Creating synergies through interdisciplinary knowledge

Mobility and inclusive environments

European Green Cities are supporting great mobility for all users - especially children and women. Providing space for user groups that often are dependent on walking or cycling, make the city accessible for everybody, and support the green transition towards a more CO2-neutral mobility system. Further they support fossil free car-use.

- Mobility plans
- Cycling analysis and strategic solutions
- Gender sensitive urban planning
- Solar powered E-mobility and charging infrastructure

Smart buildings and energy efficiency

European Green Cities have over the years contributed to making façade renovations to support lower energy consumption and better living environments. We work to improve the building stock of social housing by contributing with our proficient knowledge from a vast variety of renovation projects across Europe.

- Fjernvarme
- Knowledge on facade renovations and isolation
- Support better housing for
- Eliminating energy-poverty

Communication and stakeholder engagement

European Green Cities help stakeholders to include optimization and development of energy efficiency, energy production, mobility, health, education, fair democracy, recycling management, job creation, gender equality, smart grids, climate adaptation and biodiversity.

- Workshops and Community engagement
- Stakeholder processes
- Develop interdisciplinary understanding
- Webpage and newsletter design and management

EU Funding and project management

We support the cities, by offering cooperation in the first phases of project development, finding EU-funding and putting together a team, and eventually implementation, dissemination and project management.

- Fundraising
- EU-applications and processes
- Strong network of European cooperation partners
- Project management
- EU-policies and agendas

To ensure knowledge sharing across Europe, the organization also manages the non-profit **European Green Cities Network**. The network consists of municipalities, social housing organizations, institutions, companies and universities from more than 19 countries.

4. Trustworthiness of Smart Systems and Systems-of-Systems

Safety and security are well established properties, facilitated by standards, qualification/ verification techniques and methods. Highly automated systems are challenging beyond the well-established techniques and methods – they have to react in a reasonable manner on unpredictable situations and environments, to take autonomous decisions based on high-level and (even) ethical principles, situation awareness, perception, and scene understanding.

With respect to "Resilience" and "Sustainability", ISO/IEC JTC1 standardization sub-committees SC7, SC41 and SC42 join forces as enablers by creating the adapted system property "Trustworthiness", leading beyond just safety and (cyber-)security in the established definitions.

This is particularly of importance if we look at the requirements for a resilient, sustainable society and economy – which goes beyond the classical technical requirements.

Trust means, according to the Joint Technical Committee 1 on Information Technology of ISO and IEC <ISO/IEC 25010:2011(en)>:

- "… the degree to which a user or other stakeholder has confidence that a product or system will behave as intended" (*ISO/IEC 25010, Systems and software engineering),*

And Trustworthiness is

- "the ability to meet stakeholders' expectations in a verifiable way", which includes, e.g. reliability, availability, resilience, security, privacy, safety, accountability, transparency, integrity, authenticity, quality, usability, but also societal and ethical properties.

Resilience, in a technical sense (there are psychological definitions also), may be defined as:

- "… the ability to provide and maintain an acceptable level of service in the face of faults and challenges to normal operation. Threats and challenges for services can range from simple misconfiguration over large scale natural disasters to targeted attacks." (Wikipedia, networks)

The societal and political part of resilience and sustainability is defined by the public stakeholders' interests who provide the framework for a resilient and sustainable implementation ("Jurisdiction").

Trustworthy systems-of-systems should support a sustainable economy ("EC Green Deal", meeting the "Grand Challenges" of the "UN Sustainable Development Goals") for the benefit of all people and not of a few only, while preserving human rights and ethical principles as far as possible. The goal could be a "Society 5.0" as reported in last years already in this session, but under consideration of the potential risks and respecting fair reasonable regional habits and backgrounds.

They should make society resilient against upcoming challenges like climate change, food shortage, increasing population and, on the other hand, to support the inclusion of the growing number of elder people or people with special needs. Resilience of a society means also to cope with critical shorter-term challenges (e.g. the Corona virus crisis), by smart robotics, digitalization and technology support in our case.

5. Machine Ethics - Ethics Guidelines

The impending highly automated and autonomous systems enabled by artificial intelligence (AI) bring with them new challenges and risks. Placing too much trust in, or misusing, machines that make decisions is risky, and the legalities are complex in terms of liability and responsibility. Autonomous systems can be grouped into three broad categories: technical systems that make decisions in "no win" hazardous situations (vehicles in traffic, collaborating robots); decision support systems in governance applications (administration, government, court, staff acquisition, etc.), which may lead to unfair decisions for humans and society; and systems that are open to deliberate misuse by providing information that can't be proven to be true or fake, potentially influencing elections, public opinion or legal processes to an extent unknown before. These risks cannot be easily countered by conventional methods.

Of course, there have long been risks associated with technology, with the potential for the dissemination of misinformation, failing algorithms and deliberate deception, but until recently the methodology at least allowed analysis and assessment of the predictable and deterministic algorithms behind the technology. We are now facing a completely different challenge – the age of highly automated and autonomous systems, artificial intelligence (AI) and decision making,

whereby human decisions are made by machines through methods such as deep (machine) learning, which are neither "explainable", nor be based on fair, unbiased training sets.

Public acceptance of highly automated and autonomous systems relies on trust in these systems. This is not just a technical issue (which have been discussed in the chapters before), but also an ethical one, with technology having "big brother" potential and other possible problems as foreseen in science fiction, e.g., Isaac Asimov's "Three Laws of Robotics". Asimov's laws seem reasonable and complete, but although they were complemented by an overarching "Zeroth law" ("A robot may not, through inaction, allow humanity to come to harm"), it has been demonstrated (even by Asimov himself) that realistic situations may result in unresolvable conflicts for a robot just because of adhering to this law.

AI technology is being implemented in automated driving, collaborative robots in the workspace, assistive robotic systems, highly automated production, and in management and decision systems in the medical and public service areas, the military, and many other fields. The EC, the European Parliament, the UN, many informatics and computer associations, and standardisation groups, the German Ethics Commission for Automated Driving, NGOs, and others, have created guidelines or even certificates for trustworthiness of highly automated systems, AI-systems, cognitive decision systems, automated vehicles, robotic systems, ethically aligned design, and the like (see references). A new science of "robot psychology" has evolved, that studies the interrelationship of human-robot collaboration and human wellbeing.

It seems that the question "Is it possible to create practical laws of robotics which can guarantee a safe, conflict free and peaceful co-existence between robots and humans?" cannot be given a definitive answer that is valid in all foreseeable situations. Even in Asimov's stories, robots had to decide which type of risk of harm is acceptable (e.g. autonomous robotic surgeon).

These robotic laws were written in 1942, when robots were androids and just relatively simple "slaves" for humans, not the highly complex robots that are conceivable today. And what about a robot developed for an army? And who is defined as a "human being" (from history we know that sometimes a certain group of people is not considered as equally human, e.g. genocide)? For this, we have to look at the humans behind the AI and robots. And this only partially covers the aspects of "machine decision making" and "machine ethics", referred to in the abstract.

One initiative attempting to cover the principles for system designers and developers is the IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems (AI/AS) (April 2016, with a document 2019). It not only identifies and recommends ideas for standards projects focused on prioritizing ethical considerations in AI/AS (i.e., machine/computer decision making), but also proposes a certificate for "ethically aligned design". The basic concept states:

"Ultimately, our goal should be eudaimonia, a practice elucidated by Aristotle that defines human well-being, both at the individual and collective level, as the highest virtue for a society…. honouring holistic definitions of societal prosperity is essential versus pursuing one-dimensional goals of increased productivity or gross domestic product (GDP). Autonomous and intelligent systems should prioritize and have as their goal the explicit honouring of our inalienable fundamental rights and dignity as well as the increase of human flourishing and environmental sustainability. The goal of "The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems" is that Ethically Aligned Design will provide pragmatic and directional insights and recommendations, serving as a key reference for the work of technologists, educators and policymakers in the coming years."

Many standardization groups, the EC HLEG group document, and the German Ethics Commission on Automated and Connected Driving, provide a set of recommendations for decision making,

placing human rights, independence and wellbeing in the centre, independent of economic or demographic attributes, such as age and race. But within the Trustworthiness groups on ethics and governance in ISO/IEC JTC1 SC41 (IoT) and SC42 (AI), the international discussion revealed that even the definition of (individual) human rights differs among cultures and different legal systems.

6. Conclusions

The technologically oriented funding organizations and the EC have a very positive approach and high expectations concerning the benefits of digitisation of economy, industry and society. The "Green Deal" programme and the human implications of these technologies, empowering people through education and skills, and on protecting against the risks of these technologies, are targeting resilience and sustainability of society and economy. However, we should be aware that many of the achievements could be used against us as well (and some research projects consider this fact already) or lead to wrong decisions because of badly trained or biased AI systems.

The final question is: Will technologies of the fourth/fifth industrial revolution (e.g. IoT, Big Data, Artificial Intelligence, Connectivity, robots) enabling disruptive developments (evolutionary or revolutionary), lead to a resilient, sustainable and sharing society, to "well-being for all", if based on higher ethical values?

7. Acknowledgements

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STANDARDISATION, VERIFICATION AND VALIDATION OF AUTOMATED SYSTEMS' SAFETY AND SECURITY - A SURVEY IN VALU3S

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Keywords

Abstract

The paper summarizes the deliverable about the final standardisation survey in the European project Verification and Validation of Automated Systems' Safety and Security (VALU3S). The project aims to improve V&V for Safety Cybersecurity and Privacy (SCP) related requirements for automated systems. In the course of the standardization survey, the relevant standards were identified, and ongoing trends and developments in Safety and Cybersecurity standards were investigated. A trend towards more objective and framework-based requirements was detected. In addition, the topic of interaction between safety and security risks was identified as a still existing challenge. Overall, the challenge of standardization to keep up with the ongoing progress regarding methods and development paradigm was a topic. This is of particular importance, as standards are becoming increasingly important due to the growing trend towards more certification.

1. Introduction

Standardization is an essential part of research and development. Whether by introducing new standards or updating existing ones, standardization reflects the dissemination of research and development findings toward the agreed state of the art. Standards are also significant in the ongoing development of the research work. Since standards include the current state of the art, they also have inconsistencies and missing instructions. The development of standards is inspired by industry and society. Increased standardization activities are thus also an increasingly important indicator.

The objective of the European VALU3S (https://valu3s.eu) project is to develop, implement and assess state-of-the-art V&V (Verification and Validation) methods and resources to minimize times and costs for verification and validation of automated systems regarding SCP requirements. This will ensure that European manufacturers of automated systems maintain their competitive edge and continue to lead the world. A multi-domain framework is developed and tested in order to provide a consistent structure for the components and elements. This is required to handle the V&V process by defining and categorizing evaluation methods, tools, environments, and concepts required to verify and validate automated systems in accordance with SCP (Safety, Cybersecurity, Privacy) requirements.

In the standardization task in VALU3S, a survey was conducted in order to identify standards relevant for the work in the project. These standards were evaluated regarding approaches towards risk management, system development lifecycle, and protective (Safety & Security) Requirements Catalogue, Failure Detection & Diagnosis. These topics were identified as most relevant for the project work. The goal was to:

- evaluate state of the art in standardization;
- identify standardization trends in order to align project work; and
- point out gaps in the methods and approaches presented in standards.

This will be used as input for further project work and connect standardization with the ongoing project. The paper is structured as follows. We will at first give an overview of the motivation, e.g., why we foresee the need for improved approaches towards safe and secure systems and the need to have these improvements mirrored in standardization. Then we will give an overview of the standardization survey and evaluation conducted in VALU3S and finally discuss the results and next steps.

2. Motivation

Our society is increasingly controlled by Information and Communications Technology (ICT) systems. The agricultural domain moves towards an interconnected, highly sensorized, and automated environment (Gnauer et al., 2020) with decisions taken by expert systems, optimizing the production and nutritional value while minimizing resource usage and impact (Schmittner, Christl, et al., 2019). Transportation systems are moving from isolated transport elements towards an interconnected and interacting system, called Cooperative Intelligent Transport Systems (C-ITS), where sensors in mobile elements and the infrastructure perceive and optimize the whole transport situation (Schmittner, Chlup, et al., 2019), from automotive systems (Schmittner, Dobaj, Macher, & Brenner, 2020) to railways (Schmittner, Tummeltshammer, et al., 2019). Industrial systems are already heavily integrated into the ICT systems (Bicaku, Schmittner, Tauber, & Delsing, 2018), which lead to the trend of Industry4.0 (Popkova et al., 2019).

With this overall trend and the increasing importance of the ICT system, not only for comfort and efficiency but for the very existence of our society and our daily lives, there is an ongoing effort on the European level to ensure resilience and trust by defining rules and regulation on the utilized solutions. One expression of this development is the EU Cybersecurity Certification Framework (EU Commission, 2021). This enables the creation of tailored and risk-based EU certification schemes. One example of this global trend towards stricter certification for cybersecurity can be seen in the vehicle type approval, which requires proof of a cybersecurity management system and an argument for the cybersecurity of a vehicle type.

With this in mind, VALU3S investigates and enhances state-of-the-art V&V methods and even implements new methods to reduce the time and cost needed to conduct V&V of automated systems. Here an exchange with related standardization groups is ongoing. Without such initiatives, the new challenges of certification of cybersecurity of ICT-based systems in our daily lives would not be possible. Without the interaction with standardization, it would be impossible to achieve sufficient automation and efficiency, especially considering distributed development and relations between development, operation, maintenance, or updates.

3. Standardization Survey

The initial question was regarding standards that have the highest relevance for the project partner and project work. Here we collected feedback regarding:

- **Interest** in the standard, ranging from a standard is used to a standard, could be interesting for future work.

- **Observe** the development of the standard, indicating a higher relevance of the respective standard.

- **Develop** the standard, meaning the partner is actively involved in the ongoing development of the standard.

Considering the focus of VALU3S, the standards reported here were aimed at safety and security. The highest number of overall reports were received for:

- **IEC 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems**, (International Electrotechnical Commission, 2010) *Overarching*, Domain independent basic safety standard. During the risk analysis, security is partially considered; and also, there is an ongoing discussion about the importance of security throughout the maintenance process.

- **ISO 26262 Road vehicles — Functional safety**, (International Organization for Standardization, 2018) *Road vehicles*, In 2018, the ISO 26262 Edition two was released. The standard is primarily concerned with the functional safety of automotive systems. It could also be applicable for vehicles in the agricultural domain, and the connection with security (e.g., combining V&V) is included.

- **IEC 62443 Security for industrial automation and control systems**, (International Electrotechnical Commission, multiple) *Industrial, (Overarching*, A security standard for industrial networks has been established, emphasizing on component production, system development, and system/plant operation. There is an ongoing rework of some subparts and adoption in other domains like railways and energy.

- **ISO/SAE 21434 Road vehicles — Cybersecurity engineering**, (*ISO/SAE DIS 21434 - Road Vehicles – Cybersecurity engineering*, 2020) *Road vehicles*, ISO/SAE 21434 is a standard for automotive cybersecurity engineering that is still in progress. Similarly, the ISO 26262, the interface from security to safety, is defined.

From the topics defined in these standards, the following topics had the highest relevance:

- Risk assessment
- Systems development lifecycle
- Protective (Safety&Security) Requirements catalogue, failure detection & diagnosis

3.1. Risk Assessment

Risk assessment is a broad theme applied in many domains, from insurance to banking to engineering. Risk is generally characterized as a mixture between impact and probability (Matthew, 2010). Impact describes the effect level of a risk, which can be expressed quantitatively or qualitatively. Likelihood represents the possibility of happening. In general, probability descriptions may be classified as either quantitative or qualitative. If impact and likelihood are described quantitatively, risks can be determined. With a qualitative definition, approaches like risk

matrices are applied, where quantitative evaluations of impacts and likelihoods are mapped into a risk (according to a defined risk matrix for the specific analysis method).

Risk assessments are carried out on various levels of detail, from concept to system and even implementation. The majority of risk-based standards require an initial concept level to assess the overall necessity for risk management. If the initial risk assessment identifies a high risk, the subsequent measures must also be more rigorous. The SIL (Safety Integrity Level) and ASIL (Automotive Safety Integrity Level) metrics used in IEC 61508 and ISO 26262, respectively, are an example of this approach.

There is an ongoing trend towards describing a framework rather than a concrete method regarding methods and tools for risk assessments in standardization. An example of this can be seen in the changes from ISO 26262:2011 (International Organization for Standardization, 2011) (see Table 1) to ISO 26262:2018 (International Organization for Standardization, 2018) (see Table 2). This change was done because the informative note leads to the usage of only the mentioned methods. In summary, the majority of observed standards use a more framework/objective-based approach to risk assessment. This creates an opportunity, as new approaches and tools can be integrated more easily.

Table 1 System design analysis from ISO 26262-4:2011

Methods		ASIL			
		A	B	C	D
1	Deductive analysis[a]	o	+	++	++
2	Inductive analysis[b]	++	++	++	++
[a] Deductive analysis methods include FTA, reliability block diagrams, Ishikawa diagram.					
[b] Inductive analysis methods include FMEA, ETA, Markov modelling.					

Table 2 System design analysis from ISO 26262-4:2018

| Methods		ASIL			
		A	B	C	D
1	Deductive analysis	o	+	++	++
2	Inductive analysis	++	++	++	++

In addition, there is a gap between security and safety risk assessments. Security risk assessments are without a standardized risk rating scheme since tolerable and intolerable risks depend on organizational values. For instance, if an organization can tolerate a higher degree of risk, fewer security measures could be chosen than for an organization with less risk acceptance. For standards, where security for safety-critical systems is considered, which needs to transfer and exchange results. In most situations, tolerance for safety risks is determined by social factors rather than organizational factors.

3.2. Systems Development Lifecycle

Concerning the lifecycle (regardless of system, software, or hardware), it is difficult to define a reference model that is adaptable enough to newer approaches to system development while retaining a precise collection of activities and ensuring a review of such processes. Here, we see an improvement in adaptability to newer development lifecycles. In terms of the software part of ISO 26262, the 2011 edition did not mention agile development, which is changed in 2018. However,

both versions include a software reference process model based on the V-Model. ISO 26262-6:2011 contained the following requirement:
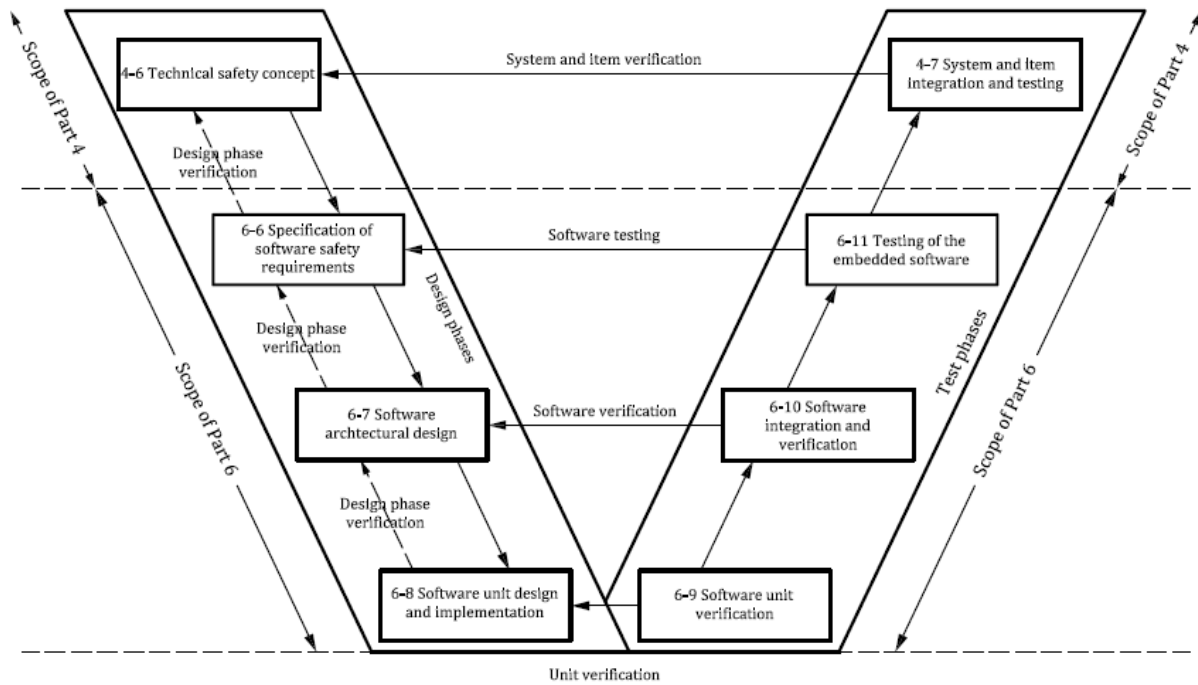
Figure 1 Reference phase model for the software development (From ISO 26262-6)

5.4.2 The tailoring of the lifecycle for product development at the software level shall be performed in accordance with ISO 26262-2:2011, 6.4.3.4, and based on the reference phase model given in Figure 1.

As a result, developing the software shall be based on the specified process model. This requirement was removed from ISO 26262:2018, and instead, the following note was applied to the figure:

NOTE 1 *Development approaches or methods from agile software development can also be suitable for the development of safety-related software, but if the safety activities are tailored in this manner, ISO 26262-2:2018 6.4.5 is considered. However, agile approaches and methods cannot be used to omit safety measures or ignore the fundamental documentation, process or safety integrity of product rigor required for the achievement of functional safety.*

The requirement 5.4.2 in the 2011 version of ISO 26262 restricted all phase models to phase models based on the given V-model. With the removal of the requirement and the addition of the note in 2018, it was accepted that the reference phase model (Figure 1) is adapted and tailored on follow a phase model based on agile approaches as long as sufficient rigor is followed. ISO 26262-2:2018 6.4.5 is the section of tailoring which describes how to adapt the given model. This is especially important since development, for example, for security, is often based on agile approaches to react to new security information.

There is a trend towards a more vital interaction from safety and security towards system engineering; on the other hand, less strict requirements concerning the applied lifecycle model. In particular, we believe this trend will continue with emerging safety-oriented agile and security-oriented DevOps approaches. This complicates the development of workflow management tools and necessitates further tool interaction, which is currently not supported.

3.3. Protective (Safety & Security) Requirements Catalogue, Failure Detection & Diagnosis

Standards attempt to remain technologically neutral, so no guidance on protective (safety & security) requirements is given. However, IEC 62443 includes Functional Security Requirements, which is a significant exception (FSR). In most circumstances, the assumption is that the lifetime of a standard is longer than the validity of guidance on protective (safety & security) requirements. One challenge of safety and security standardization is providing a strong framework for achieving safe and secure systems. This means it needs to be balanced with allowing technical progress and remaining at a level where the described content stays "state of the art" for an extended period.

4. Conclusion

We are currently seeing a significant movement in safety and security standards. This results from modern approaches to system architecture and new technologies that necessitate greater versatility and automation. Even with these advances in standardization, there are still gaps caused by:

- Risk management methods at various levels of safety and security, and transferability are not supported in multi-concern schemes. Besides that, risk assessment is mostly focused on qualitative methods, and modern approaches for quantitative assessment have not yet been adopted for standardization.

- In standardization, lifecycle approaches move from strict requirements to more flexible references. The challenge is to keep up with the continuing evolution toward more versatile lifecycles while maintaining robustness.

- Because of the different rates of technological evolution relative to standardization, it is challenging to incorporate protection, detection, and diagnosis requirements into standardization. Still, guidance in this direction is needed, and there are considerations about whether faster types of publication could be utilized for such topics. For example, for the ISO/SAE 21434, ISO and SAE create supporting documents as PAS (Publicly Available Specification), which gathers information faster and can be updated more frequently.

5. Acknowledgement

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BUILDING A KNOWLEDGE REPRESENTATION OF CYBERSECURITY VULNERABILITIES USING NATURAL LANGUAGE PROCESSING

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Keywords

Abstract

The rising amount of cybersecurity incidents puts our systems at risk. Cybersecurity experts can hardly keep up with the quantity of information they are confronted with. Consequently, joint approaches, referred to as threat intelligence have been developed to gather historic information and increase our systems resilience. However, not all the information presented is directly usable and requires manual interaction. To stay up to date with current developments in the threat landscape, it is essential to consider automation. Therefore, we propose a hybrid method capable of extracting relevant information from structured formats, as well as unstructured text and apply Natural Language Processing to entries of the National Vulnerability Database (NVD). Moreover, we discuss an ontology capable of representing the extracted data as a knowledge base. The ontology helps to performs a set of queries as well as logical and inference operations for in-depth cyber risk analysis.

1. Introduction

We consider cybersecurity as one of the essential parts of critical system development lifecycles. It is responsible for protecting assets from cyberattacks such as integrity violations, information disclosure, and other malicious activities. In the last few years, many cyberattack incidents have been reported, leading to anticipating global cybercrime damage reach six trillion dollars by 2021 (Frank Downs et al., 2020). The global COVID-19 pandemic is considered to increase such incidents because most workplaces are moved to remote work force infrastructure (SOBERS, 2021).

Therefore, to build up a secure system, we need to be avoided past, current, and future cyber incidents. Threat modeling could be an excellent approach for detecting the security threats and vulnerabilities in the system model (Abomhara et al., 2015). However, maintaining its threat database is challenging because the amount of known threats and security vulnerabilities rises daily. To keep up with the increasing number of threats, various approaches towards archiving and sharing of incident information, threats and attacker methodologies have been developed (Menges

& Pernul, 2018). This is conventionally referred to as threat intelligence. However, the integration of the contained information is still mainly managed manually and is consequently time-consuming and requires unreasonable effort by experts to extract information from unstructured text to feed the threat database with relevant cyberattack incidences.

Therefore, we introduce an approach based on Natural Language Processing (NLP) to extract data from threat intelligence sources with a focus on the NVD. The extracted data are described semantically in an ontology to express information in terms of well-defined vocabularies and to understand data and knowledge to cope with the meaning of the content for each cybersecurity vulnerability. The ontology provides data scalability for managing a wide range of security vulnerabilities with all relevant information. Consequently, this approach is designed to address the time and effort issues consumed by a security architect to collect a diverse set of security vulnerabilities. Vulnerabilities assist in determining the exact security threats in a system design.

2. Related Work

For the presented concept, we focus on data from the NVD which forms a layer above the Common Vulnerabilities and Exposures (CVE) and links it with additional information and a method capable of extracting information from plain text. Vadapalli et al. introduced an approach capable of extracting cybersecurity relevant information from unstructured text (Vadapalli et al., 2018). They rely on Natural Language Processing and the Stanford CoreNLP.

Moreover, Joshi et al. (Joshi et al., 2013) extract cybersecurity information from CVE vulnerability descriptions. Mulwad et al. (Mulwad et al., 2011) developed a system that allows a mapping from unstructured text to Resource Description Framework (RDF) and Web Ontology Language (OWL). Another approach utilizing the Stanford CoreNLP and mapping that information to the Unified Cybersecurity Ontology (Syed et al., 2016) was presented by in (Satyapanich et al., 2019). Some implementations towards information extraction from CVE/NVD data can be found online. However, they focus on different aspects. While one approach only considers information specific to linux kernels another one does not take attacker capabilities into account which might influence the way in which vulnerabilities are treated.

In addition, a systematic review of the existing ontological engineering research applied to security is discussed in (Blanco et al., 2008). Shaaban et al. (Shaaban et al., 2019) presented an ontology-based model for the cybersecurity verification and validation process for the automotive domain. It uses inference rules to assure that the applied security requirements for a vehicle are fulfilled. A method for security requirements engineering of security domain ontologies is presented in (Souag et al., 2013). Souag et al. (Souag et al., 2015) presented a general security ontology for requirements engineering. The authors implemented and developed an interactive environment for the ontology.

3. NLP Approach and Model Evaluation

The proposed method includes an automation action for extracting data from threat intelligence sources such as the NVD and then creates an ontology hierarchy containing a complete landscape of all information we consider relevant to a specific cybersecurity vulnerability. The extraction method is carried out using a hybrid method consisting of the direct extraction of structured attributes and NLP for analyzing unstructured text. The extracted data is collected to create a knowledge base of a security vulnerability. An illustration of this approach is displayed in Figure 1. The following sections provide a structured overview of the proposed approach.

3.1. The NVD as Threat Intelligence Resource

The NVD represents an established and freely accessible resource for vulnerability and exploit related information. It was developed by the National Institute of Standards and Technology (NIST). When considering that the NVD alone contains more than 164.000 entries, which are rapidly increasing, according to the NVD dashboard (NIST, 2021), it becomes apparent that its integration can leverage security within our systems. The NVD builds upon the CVE and augments its enumeration with additional properties. Consequently, existing CVE entries which are formulated as unstructured text become more elaborate and, therefore, more applicable to automated approaches. The NVD adds value by providing additional information and technologies in structured form. This includes the:
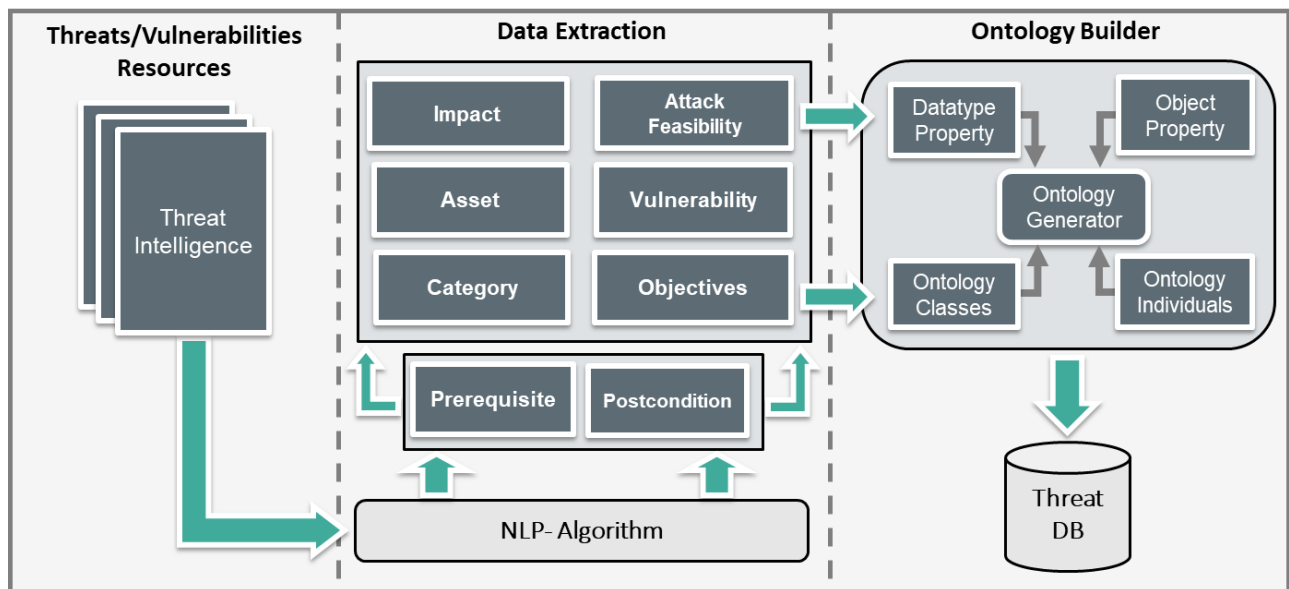
Figure 1 The structure of the NLP/Ontology approach for threat intelligence data extraction

- Common Platform Enumeration (CPE) - a standardized naming method for Information Technology (IT) products, could be used for describing a product. (Cheikes et al., 2011)

- Common Weakness Enumeration (CWE) - an enumeration for identifying generic weaknesses within technological systems. It also gives insight into mitigation and detection strategies. (MITRE, 2020)

- Common Vulnerabilities Scoring System (CVSS) - a framework for describing the severity of vulnerabilities by assigning a criticality score as well as for communicating the characteristics of a vulnerability. (FIRST, 2020)

All the technologies represent joint approaches to gather information inside one central resource. Moreover, the NVD forms a wrapper for these data sources and links them together. While the other technologies allow for an easy integration, the CVSS was considered to require additional transformation to conform to a rating value depicted in ISO/SAE 21434 (ISO/TC 22/SC 32, 2020). It considers measures for describing the effort and the difficulty required for a successful attack which is called exploitability. This exploitability can also be referred to as attack feasibility. Furthermore, the impact values may also be used to define the impact of a certain threat. However, the impact as well as the exploitability need to undergo transformation. Therefore, we created a representation based on the categories specified in ISO/SAE 21434 (ISO/TC 22/SC 32, 2020). The resulting Table 1 is shown below.

As displayed in Table 1, exploitability scores in the CVSS range from 0.0 to 3.9. We associated these value ranges with the values **Very Low**, **Low**, **Medium**, or **High**. To get a proper mapping of the CVSS, the two inner ranges are twice the size of the two outer ranges to present the larger inner ranges of the CVSS sufficiently. Table 1 also depicts the mapping of the impact score. Following the same principle as before the mapping is conducted on four ranges, while the maximum value for the impact is specified as 6.0.

By applying the mapping function, we can derive ISO/SAE 21434 based impact values, namely, **Negligible**, **Moderate**, **Major**, or **Severe**. Furthermore, it is possible to determine the security objectives and, therefore, the threatened assets of a component. The CVSS contains the Confidentiality, Integrity and Availability (CIA) attributes. Consequently, we can utilize this information to further categorize a threat.

Table 1 Exploitability and Impact Score mappings

(A) Likelihood Scoring

Exploitability Score	Attack Feasibility
0.0-0.65	Very Low
0.66-1.95	Low
1.96-3.25	Medium
3.26-3.9	High

(B) Impact Scoring

Impact Score	Impact
0.0-1.0	Negligible
1.1-3.0	Moderate
3.1-5.0	Major
5.1-6.0	Severe

So far, we discussed only the structured information contained within an NVD entry. While this is highly relevant to form a knowledge base capable of representing vulnerabilities and consequently, threats, we can retrieve even more information. By further analysing the description of a CVE/NVD entry it becomes feasible to extract attacker capabilities. Therefore, the following section discusses an information extraction method capable of classifying these attacker capabilities in the form of prerequisites and postconditions alongside an example. Furthermore, the mapping of the attributes contained within an NVD entry will be displayed.

3.2. **Data Extraction**

Attributes such as the product alongside its version, the generic weakness, as well as the impact and likelihood values enable the identification of vulnerable components and help classifying threats. Although they do not provide an insight into how a more advanced exploit might be conducted, the vulnerability description of many CVE/NVD entries contains prerequisites and postconditions. Firstly, prerequisites represent capabilities an attacker must possess or gain to conduct a successful exploit. Secondly, the postcondition depicts capabilities that are achieved by an adversary after conducting an attack. When considering an attack with multiple steps, the postcondition of one step may become the prerequisite for the subsequent attack step (Lallie et al., 2020), an adversary might enforce a buffer overflow (postcondition) which can then be used as a prerequisite to achieve remote code execution (postcondition). Table 2 displays the mapping of an NVD entry.

The proposed approach towards extracting information from the presented unstructured text is based on NLP or more precisely Named Entity Recognition (NER). An implementation was conducted using JAVA and Stanford NER (Manning et al., 2014) based on the Conditional Random Fields (CRF) algorithm (Finkel et al., 2005). It is a supervised machine learning approach which can assign a label to portions of text. By supplying an annotated training set, a learning algorithm can be applied, thus allowing for the identification of the named entities "prerequisite" and

"postcondition". For a proof of concept, we utilized data combined from both, the NVD and an exploit database from Packetstorm Security (Packetstorm, 2020) and annotated them with doccano (Nakayama et al., 2018). Moreover, 478 vulnerability descriptions were annotated and reviewed by experts at AIT. The outcome was randomized and split into distinct sets for training (70%) and testing (30%). The experiment was conducted 100 times to make it statistically relevant due to the rather small amount of training data. This resulted in a precision of 80.9% and a recall of 64.9% for the prerequisite as well as a precision of 66.5% and recall of 53.6% for the postcondition which we consider satisfactory results for a proof of concept.

An entity may be defined through simple wording. However, vulnerability descriptions come in various styles and formulations. Therefore, especially in terms of the CVE/NVD it is also necessary to consider a single word or a combination of words that might indicate a prerequisite or postcondition. E.g., "leads to...", "an attacker gains/achieves..." indicate postconditions, while words such as "an attacker who...", "requires..." or "must have..." depict a prerequisite.

Table 2 NVD contents and extracted data.

	NVD Entry	Extracted Data
Vulnerability	Out of bounds memory access in developer tools in Google Chrome prior to 84.0.4147.89 allowed an attacker who convinced a user to install a malicious extension to potentially exploit heap corruption via a crafted Chrome Extension.	**Prerequisite:** convinced a user to install a malicious extension. **Postcondition:** exploit heap corruption.
Asset	**CPE: "cpe:2.3:a:google:chrome:*:*:*:*:*:*:*" versionEndExcluding: "84.0.4147.89"**	Google Chrome before 84.0.4147.89
Weakness	CWE-119	CWE-119
Likelihood	exploitabilityScore":2.8"	Medium
Impact	impactScore":5.9"	Severe
Security Objectives	Integrity Impact: High Availability Impact: High Confidentiality Impact: High	Integrity Impact: High Availability Impact: High Confidentiality Impact: High

By applying NER to CVE/NVD descriptions, the process of manually scanning through text and identifying the prerequisites and postconditions can be automated. However, when relying on automated approaches there are always errors. A biased NER extractor or ambiguity in the text might yield insufficient results. Therefore, a training set of adequate size also regarding the many ways a vulnerability can be formulated is necessary.

3.3. Ontology Builder

The extracted data are defined in triples (i.e., subject, predicate, and object) format for building a knowledge representation of security vulnerabilities. The data is semantically described as classes, subclasses, individuals, datatypes properties, and object properties, which describe the semantics of the whole ontology structure. For example, as discussed in Table 2, there is a set of information related to the NVD that can be extracted. This information is used and defined in an ontology. The semantic representation of data helps establishing a cybersecurity threat database containing logical consistency in the ontology model for multiple entities that represent various security vulnerabilities.

3.3.1. The Ontology Classes, Subclasses, and Individuals

The ontology model consists of classes and subclasses describing the primary data representing critical details of vulnerabilities as ontology individuals, as depicted in Figure 2. This model

contains all data representing a critical clause from the primary vulnerability resources. The description of classes and related individuals are discussed as follows:

Product: Describes something of value for a stakeholder, which requires protection. Therefore, this class includes all affected products, according to vulnerabilities identified.

Risk: It represents a set of values that refer to multiple levels of severity according to existing security vulnerabilities. As discussed in Section 3.1, the CVSS is defined to estimate the risk value based on likelihood and impact.

Vulnerability: Each vulnerability has a collection of information, providing more details about the affected elements, cybersecurity properties violation, and more explanation about potential threats.
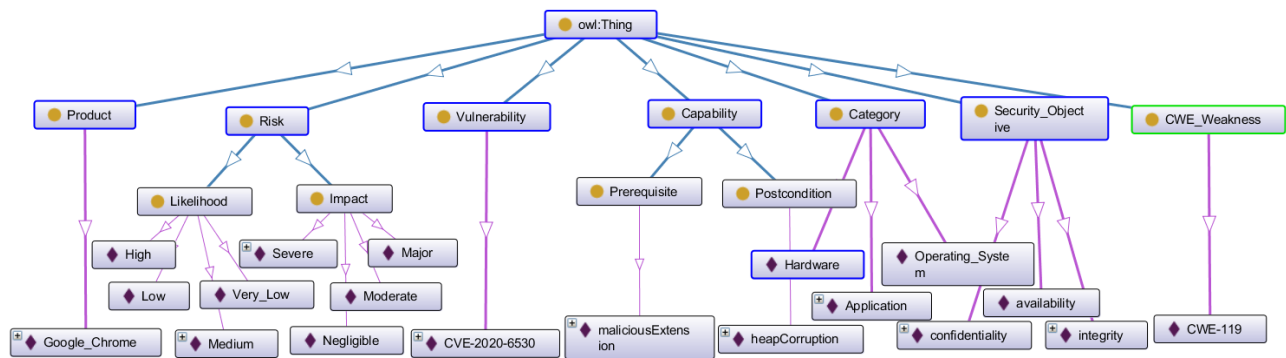

Figure 2 The structure of the ontology model

Capability: Attackers have capabilities in the form of the prerequisites and postconditions. As discussed previously in Section 3.2, these can be extracted from the CVE/NVD descriptions.

Category: Represents the primary classification of the affected asset. There are three possible categories of impacted assets: Application, Operating System (OS), or Hardware.

Security Objective: Holds the main security goals that need to be achieved. A vulnerability could affect any of these properties to achieve a malicious goal. This class contains these properties in the form of a CIA triad. Regarding the ontology model, we represent the violation of these properties through a vulnerability that affects a cybersecurity property of an asset.

CWE Weakness: Provides reference to security issues, mitigation, and detection strategies.

3.3.2. Ontology Properties

As discussed in (Hebeler et al., 2009), ontology object properties describe relationships among individuals and datatype properties describe links between individuals and their values. These properties are applied to define relationships among ontology individuals and add more description into individuals in the form of literal values. "**ID**" represents the ID of a vulnerability. "**Description**" contains all description content extracted by the original threat intelligence resource. "**Product**" indicates the name of an asset that is affected by a particular security vulnerability. "**Version**" expresses the product's version. Relationships between individuals are also described in the form of object properties. These properties express a semantic interaction for individuals with other ones in the ontology model. Cellfie (johardi, 2018), a Protégé (Stanford, 2020) plug-in, is used to import data from spreadsheets into OWL ontologies. A set of expressions are created to define relationships among multiple individuals in the ontology model according to proposed ontology structure, as illustrated in Figure 2. For example, **hasLikelihood** and **hasImpact** relationships are described to assign likelihood and impact values to specific security vulnerabilities. Besides that, each of these vulnerabilities violates a CIA cybersecurity property.

Therefore, the ontology is proposed to define a set of SPARQL (W3C, 2013) queries for retrieving threat data from our database and create Semantic Web Rule Language (SWRL) (Member, 2004) rules to infer cybersecurity property violations of assets in diverse system models, which we consider in our future plan.

4. Discussion

The ontology describes a full representation of vulnerabilities with all relevant information in terms of classes, subclasses, individuals, and properties. Moreover, it describes the consequences of a
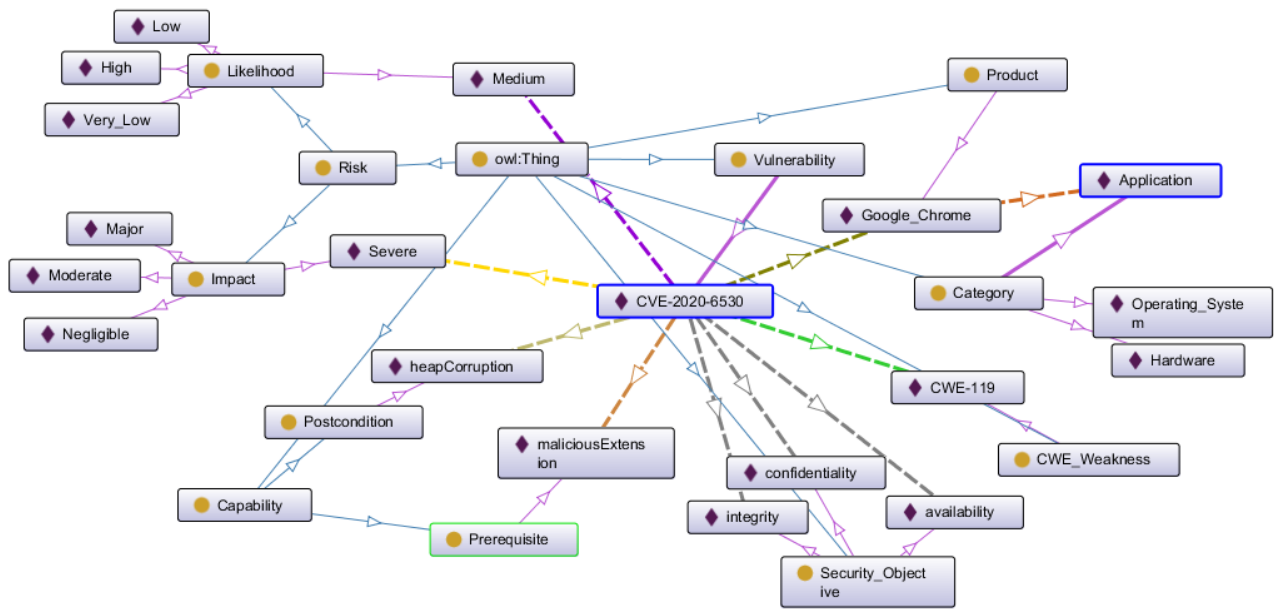

Figure 3 Relationships among multiple ontology individuals

vulnerability. For example, a CIA property could be violated by an existing security vulnerability, leading to an impact level on a particular system critical point. Figure 3 illustrates this scenario in an ontology representation, including the data described in Table 2.

The figure shows that vulnerability **CVE-2020-6530** violates **Confidentiality**, **Integrity**, and **Availability** of **Google Chrome** as **product** that is classified as an **Application**. The risk scores of this vulnerability are determined as **Severe** impact and **Medium** likelihood. In addition, the ontology explains that the prerequisite of this vulnerability could be defined as installing a **malicious extension**, that potentially leads to **heap corruption** as a postcondition. According to our approach, NLP helps to analyze and extract essential data about a vulnerability description. Then the extracted data are collected to create a complete knowledge representation of vulnerabilities and their impact against different system critical points. This approach is introduced to overcome time and effort challenges when collecting a diverse set of security vulnerabilities.

5. Conclusion and Future Work

This work introduced the first steps into an NLP approach to extract data from threat intelligence sources and then generate a semantic description of these data to express information in well-defined terms. This approach addresses the time and effort consumed by a security architect to collect distinct security vulnerabilities. In addition, the whole approach still in the research

investigation. In the security domain we need to be accurate when identifying threats. Any misclassification of the extracted data leave threat untreated. Trained models are never perfect and there will always be a certain error rate. Manual checking of the final results will most certainly be required. However, a semi-automated approach can speed up the process behind extracting the relevant information which is currently performed manually.

6. Acknowledgement

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COVID-19'S IMPACT ON ENTERPRISE SOFTWARE DEVELOPMENT

CASE STUDY ON COVID-19'S IMPACT ON ENTERPRISE SOFTWARE DEVELOPMENT

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COVID-19, Enterprise Software Development, Case Study, Agile, SAFe

Abstract

The COVID-19 outbreak created an unprecedented context for businesses all around the world. Companies had to face new challenges, resulting in issues related to productivity, duty arrangement, communications, home space negotiations, and their workers' wellbeing. There is not much empirical research on the behavioral, societal, and organizational aspects of COVID-19 and information systems. By analyzing the implemented COVID-19 mitigation strategy, deliverables throughput data, and internal recordings from planning meetings, this single case study aims to provide a detailed view on how the COVID-19 outbreak affected the selected enterprise software development company. The results are then discussed considering Obrenovic et al. Enterprise Effectiveness and Sustainability Model during Pandemic. As the results have not proved any negative impact of the COVID-19 outbreak on the enterprise software development deliverables in the examined company, the possible causes and contributing company attributes are discussed.

1. Introduction

The outbreak of the novel coronavirus SARs-CoV-2 causing the COVID-19 disease, epi-centered in Hubei Province of the People's Republic of China in 2019, has spread to many countries (Velavan & Meyer, 2020). It has put countries, organizations, and citizens in an unprecedented situation the modern digitalized economy has never faced before. Some organizations were not prepared for the sudden switch to remote work, so that they had to carry out changes to progress with digital transformation (Savić, 2020). COVID-19 has dramatically shifted affordances, thus requiring a new communication pattern in terms of frequency, length, and style (Waizenegger et al., 2020). Enterprises characterized by a networked structure, distributed workforce and leadership, flexible and straightforward guidelines, and less interdependence are more adaptable and can deal with disastrous situations more effectively (Obrenovic et al., 2020). One way organizations are increasing their flexibility and distributing the workforce and leadership is undergoing the so-called agile transformations (Fuchs & Hess, 2018). Agile is a set of iterative and incremental software engineering methods (Dikert et al., 2016) that becomes commonplace in many large organizations (Paasivaara, 2017), where agile practices have to be scaled (Paasivaara et al., 2012). Practitioners and consultants offer frameworks for large-scale agile approaches, such as the Scaled Agile Framework® (SAFe) (Fuchs & Hess, 2018). SAFe provides guidelines for achieving business agility by empowering people to make quick decisions and aligning the right people to do the right

work (Knaster & Leffingwell, 2020). Hence, the business agility should better position the enterprise to face the COVID-19 impact.

Every enterprise connected to the global economy had been somehow impacted by the COVID-19 situation. The question is, if the impact of COVID-19 has brought about negative results, decreases in productivity and deliverables. There is only little empirical research on the behavioral, societal, and organizational aspects of COVID-19 and information systems (Ågerfalk et al., 2020). Therefore, more studies are required to understand the way organizations dealt with the COVID-19 impact. This paper contributes to filling the gap by presenting the results from a single case study conducted in a multinational enterprise software development company. The aim is to provide insights into the real-life COVID-19 mitigation and COVID-19's impact. The company's internal documentation on COVID-19 mitigation strategy, data stored in the project management tool and internal recordings are used to examine the COVID-19's impact on running the company. The main contribution of the paper is threefold. First, it presents real-live COVID-19 outbreak mitigation strategy and data depicting the COVID-19 impact on enterprise software deliveries throughput. Second, study provides results from the analysis of internal recordings from planning meetings before and post COVID-19 outbreak, and the findings are discussed in the context of recent state of art. Third, presented findings based on Obrenovic et al. (2020) Enterprise Effectiveness and Sustainability Model during Pandemic can help enterprises better position themselves for further unprecedented situations.

2. Background

This section provides the theoretical background required to understand the context of the study. As the selected company follows the Scaled Agile Framework® (SAFe), SAFe is shortly introduced. Then, some studies focusing on COVID-19's impact on organizations and workers, and the Enterprise Effectiveness and Sustainability Model during Pandemic are described.

2.1. Scaled Agile Framework

Agile, characterized initially as incremental and iterative software development that ensures quick response to change, and is done by closely collaborating teams (Shammi et al., 2011), is spreading through organizations of various types and sizes. The need to scale agile practices goes beyond IT and impacts all corresponding organizational structures (Gerster et al., 2019). As an answer to the need for applying Agile at scale, various frameworks for scaling Agile emerged (Vaidya, 2014). According to the 14th State of Agile Survey (CollabNet VersionOne, 2020), the Scaled Agile Framework® (SAFe) is the most popular framework across large enterprises.

Scaled Agile Framework - SAFe (SAFe, 2020) provides prescriptive guidelines for implementing an enterprise-scale Lean-Agile development. SAFe highlights three levels (Layers) of organization: Team, Program, and Portfolio. For the Portfolio and Full SAFe configurations, the concept of Value Stream is added. The Value Stream is aimed at building and supporting a set of solutions, which are the product, services, or system delivered to the customer (SAFe, 2020). The Team level comprises the agile teams. At the Program level, the so-called Agile Release Trains are introduced to scale many teams and individuals (Putta et al., 2018). Agile Release Train is a long-lived team of agile teams (SAFe, 2020). In SAFe, Agile Release Trains work in 8 – 12 weeks long timeboxes called Program Increments (PI) to incrementally deliver value in the form of working, tested software and systems. Each PI begins with a PI planning event, during which teams estimate deliverables, highlight dependencies and identify risks. Teams are presented with Features, each representing a service that fulfills the stakeholder's need and is deliverable within one PI. Next, teams create User Stories representing a small pieces of desired functionality, to fulfill the benefit of the feature.

Stories are estimated in Story Points, relative numbers without connection to any specific unit of measure. Each story's size (effort) is estimated relative to the smallest story, which is assigned a size of "one". The bigger the size assigned, the higher the complexity of the story. One of the PI planning outcomes is PI Objectives describing what the team plans to accomplish during the PI. The objectives are presented and evaluated by the stakeholders.

To support organizations in managing their large-scale agile environments, software project management tools were designed, such as Rally (Broadcom Inc., 2020). Rally was listed as one of the leaders in the agile planning tools market in Gartner's magic quadrant (Mann et al., 2020). It was marked as providing the highest level of features for managing multiple agile projects for established and mature teams (Mihalache, 2017).

2.2. Covid-19 Impact

Waizenegger et al. (2020) state that COVID-19 provides a unique context that is significantly different from the pre-COVID-19 outbreak's specifics. Before COVID-19, workers had the autonomy to schedule their professional and domestic tasks flexibly. COVID-19 related changes connected with the enforced working from home have created various challenges resulting in issues related to productivity, duty arrangement, communications, home space negotiations, and wellbeing. To maintain "business as usual", knowledge workers need to adapt quickly to nonconductive working spaces and unfamiliar digital platforms (Waizenegger et al., 2020). Due to the lack of empirical research, Waizenegger et al. (2020) recommended the conduction of further research to answer research questions such as: "What policies have been initiated and implemented, and how do they support or hamper remote e-working in the post-COVID-19 era?" (Waizenegger et al., 2020) and "How has organizational culture shifted and transformed towards the perceptions of remote e-working and flexible working?" (Waizenegger et al., 2020)

Obrenovic et al. (2020) searched for the factors contributing to enterprise effectiveness and sustainability during the time of the pandemic. Their study concludes that companies with a distributed leadership and workforce are more likely to sustain business operations in times of COVID-19 and any future pandemic. Furthermore, they introduced Enterprise Effectiveness and Sustainability Model during Pandemic (Obrenovic et al., 2020) depicted in Figure 2.
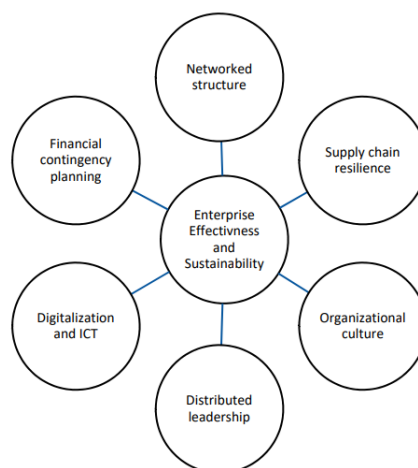
Figure 1 - Enterprise Effectiveness and Sustainability Model during Pandemic conceptual model (Obrenovic et al., 2020)

Obrenovic et al. (2020) described that: (1) organizations with a networked structure are more responsive, resilient in the face of adversity, and are more likely to achieve business sustainability;

(2) organizations with a shorter and more diversified supply chain are more likely to sustain their operations during the pandemic; (3) organizations nurturing the culture of flexibility, agility, and resilience find it easier to adapt to changes and reorganize their resources in times of crisis; (4) organizations fostering shared leadership and delegating authority to members of different organizational units allow for the facilitated gathering of intelligence from all functional domains and accounts for faster response to stressful events; (5) prosperous organizations leverage ICT and integrate Intranet, social media, and online communication platforms into their daily business routines, have a better emergency response since they can make use of technology-mediated knowledge, gather, process, and share information and coordinate collaboration in times of crisis; (6) enterprises with financial contingency plans sustain their business operations throughout the pandemic.

3. Research Method

In this section, the overview of the selected method and research steps is provided. Then, the context of the study is described. The case study was selected as a key research method. As Runeson & Höst (2008) state, case studies are used in order to investigate contemporary phenomena in their natural context and allow the researcher to obtain findings through the analysis in depth of typical or special cases and thus understand how the phenomena interact with the context. The conduction of the case study followed the process described by Runeson & Höst (2008) as depicted in Figure 1.
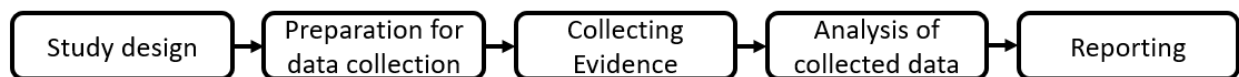

Figure 2 - Case study process (Runeson & Höst, 2008)

3.1. Study Design

The objectives of the case study were defined as follows:

- Objective 1 - Examine the COVID-19 outbreak mitigation strategy applied in a multinational enterprise software development company

- Objective 2 - Examine the impact of the COVID-19 outbreak and applied mitigation strategy on the throughput of development teams in a multinational enterprise software development company

- Objective 3 - Examine the impact of the COVID-19 outbreak and applied mitigation strategy on the work planning mechanisms in a multinational enterprise software development company

3.2. Preparation for Data Collection

With an intention to determine and uncover the impact of COVID-19 on the enterprise software development in the selected organization, the data for the period before the COVID-19 outbreak and post-outbreak were required. Hence, it was planned to gather data for the period from February 2019 to March 2021. This timeframe represents 13 months before the COVID-19 outbreak and 13 months post-outbreak. To meet Objective 1, the internal COVID-19 mitigation communication was used. To meet Objective 2, archival data were used, specifically data available in Rally, the

company's project management and tracking tool. To meet Objective 3, archival data were used, specifically recordings from the company's planning sessions.

3.3. Collecting Evidence

To collect data for the Objective 1, the authors obtained access to the intranet page summarizing all the corporate communication about COVID-19, mitigation strategy, and recommended tools. Next, for Objective 2, the authors obtained access to the project management tool Rally and generated reports for further data analysis using custom reporting templates. The results were downloaded and stored in *.xls files. Last, to fulfill Objective 3, the authors were granted access to the archive with the recordings of the company's records of quarterly planning meetings stored on the company's intranet. All the required data for the examined period were found and downloaded for further analysis.

3.4. Analysis of Collected Data

Obtained data were analyzed in detail, starting with the analysis of the company's COVID-19 mitigation intranet page. The synthesized insights were extracted into notes and then trimmed for further reporting. Next, custom reports were created using the inbuilt capabilities of the Rally tool. The extracted data were converted to excel and processed there to expand the analysis and reporting capabilities. Then, all gathered recordings from PI Planning team readouts were reviewed. During the review simple systematic annotation (open-coding) was used with intention to mark any COVID-19 related information, statements, risks, or other mentioned impact. The coding was done manually without usage of any data analysis software.

3.5. Reporting

The outcomes from previous steps were synthesized and summarized. The final reports from the study conduction are presented in Section 4. It was decided to present the data in the form of a combination of descriptive text and graphs.

3.6. Mapping to Enterprise Effectiveness and Sustainability Model During Pandemic

To understand the preparedness of the examined company for the COVID-19 outbreak and validate the existing research with the reported results, we mapped the current company settings to Obrenovic's et al. (2020) Enterprise Effectiveness and Sustainability Model during Pandemic. The results are provided in Section 5.

3.7. Case Study Context

The selected organization has been on the market since 1970's. After the acquisition in 2018, it became part of a multinational corporation with more than 20 000 employees. The organization examined in this study underwent the agile transformation in 2016, and since then, the Scaled Agile Framework has been followed. There are various SAFe configurations applied within the organization. The examined Value Stream uses the Portfolio SAFe (SAFe, 2020) configuration. The single-case study was conducted in a division that delivers mainframe software. The analyzed Value Stream specifically focuses on workload automation software, written mostly in low-level programming languages. For newer components, modern user interfaces, higher-level languages like C, Java, or JavaScript are used. The majority of products are represented by onpremise software sold to customers with license and support for a three-year period with renewal for another three years. The typical customer is a big multinational corporation from various sectors.

There are two Agile Release Trains, together containing 29 agile teams, in the examined Value Stream. The teams are working in sprints of 2 to 4 weeks within the three months Product Increments (PI). Every PI starts with a PI Planning event, which ends with the so-called "PI Readouts," where the teams present and commit to objectives for the upcoming PI, receive feedback, and accept from the stakeholders and leadership. During the PI Readouts, the teams use customized dashboards in the Rally tool, containing the overview of the objectives, features, risks, internal dependencies, and the draft of the plan for the upcoming iterations. The PI Readouts are done by every team and have a maximum of 15 minutes timebox per team. Aside from the objectives, teams also present identified risks and interdependencies with the other teams. PI Planning is done in person if the localization of the team members permits. Typically, the geographically collocated team members gather in one meeting room and connect with the other PI Planning participants via a video conferencing system. Leadership, teams, and even team members within one team are distributed mostly in the Czech Republic and the United States of America. The company culture fosters presence in the office, requiring that the in-house members meet face-to-face daily. Home offices are exceptional.

4. Results

In this section, the results from a single case study are presented. We provide three different perspectives. First, the insights into the COVID-19 outbreak mitigation strategy in the selected company are presented. Second, the results of the Rally tool data analysis are provided. Third, the PI Plannings recordings analysis results are described.

4.1. COVID-19 Mitigation

The first COVID-19 related communication was distributed on January 24, 2020. Travel restrictions to Wuhan, China were restricted, and all travelers were instructed to be more cautious. On January 28, 2020 employees were asked to follow hygiene recommendations, avoid contact with people having any COVID-19 symptoms, and if not feeling well, work from home. Since February 6, 2020, common office areas have received increased cleaning and disinfection. Starting February 13, 2020, all non-essential travel to China and other countries identified as high-risk were restricted. Since February 28 2020, all business trips to high-risk countries were suspended, and all employees were encouraged to avoid personal travels to these countries. Employees returning from high-risk countries were restricted from entering offices for 14 days upon the arrival. Local government actions and quarantines were announced to be respected. Employees' attendance at tradeshows or conferences was suspended. March 3, 2020, employees in high-risk countries requested to work from home, if possible. If office presence was needed, social distancing techniques had to be utilized to minimize interaction with other employees. No visitors were allowed, gyms and breakout rooms closed. All internal and external business trips were suspended. March 24, 2020, the company rearranged office work to follow all local orders by government authorities. The sites started to operate on split shifts, dividing employees into four groups shifting every week, resulting in 25% presence in the office. Starting April 7, 2020, facemasks were required while on-site worldwide. Since April, the mitigation has remained and differentiated by local authorities' orders and recommendations. i.e. in the Czech Republic, the offices remained closed when the government declared a state of emergency (March 12 – May 17, 2020, October 5 – February 14, 2021, February 15 – February 27, February 27 – April 11). Since July 6, 2020, the shift rotation was changed by dividing employees in two groups only, resulting in an expected 50% presence in the office. When finishing the case study, the suspension of travel, social and physical distancing measures, office rotations, compulsory wearing masks in the office, and reflecting local authorities' orders and recommendations were prevailing.

4.1.1. Mitigation Tools and Support

We reviewed the intranet page related to the corporate communication about COVID-19, and here we summarize our findings. The regular e-mail communications were sent weekly, informing employees about the updates in the mitigation strategy. Every employee had to pass a mandatory web-based training on the COVID-19 mitigation policy. The COVID-19 Intranet portal was created to summarize all available information on COVID-19 mitigation and specific information localized and tailored for all continents and states the company operates in. Employees were distributed Ergonomic Guide for Working From Home in PDF format, which contained best practices for setting up sufficient working space at home, building a home office daily schedule, recommendations for small physical exercises, and a detailed guide on properly setting up ergomical work seat in the home environment. Next, employees were provided a Remote Workforce Toolkit, a set of essential toolkits in situations where they had to work from home or remotely. It contained a VPN connection guide and troubleshooting; information on home network troubleshooting; information on using internal software tools; manuals, best practices, and tips for working with WebEx; and manuals, best practices, and tips for using collaboration tools. The company also opened a COVID-19 testing reimbursement program, which allowed every employee to have a COVID-19 laboraty test and claim its cost every two weeks. This program has later been accompanied by the distribution of self-testing kits to employees.

4.2. Development Teams Throughput

We have examined the impact of the COVID-19 outbreak and applied mitigation strategy on the throughput of development teams in a multinational enterprise software development company. A time period of 26 months was selected for analysis. The period covers 13 months before the COVID-19 outbreak (February 2019 – February 2020) and 13 months after the COVID-19 outbreak (March 2020 – March 2021). The throughput is represented by the number of completed Features and User Stories per month. A Feature represents a service that fulfills a stakeholder's need, and a User Story represents a small piece of the desired functionality to fulfill the benefit of the feature. In practice, it means that one Feature consists of multiple User Stories. The data originate from the Rally tool. Figure 3 represents the total number of Features completed in respective months. Figure 4 depicts a number of User Stories completed in respective months.
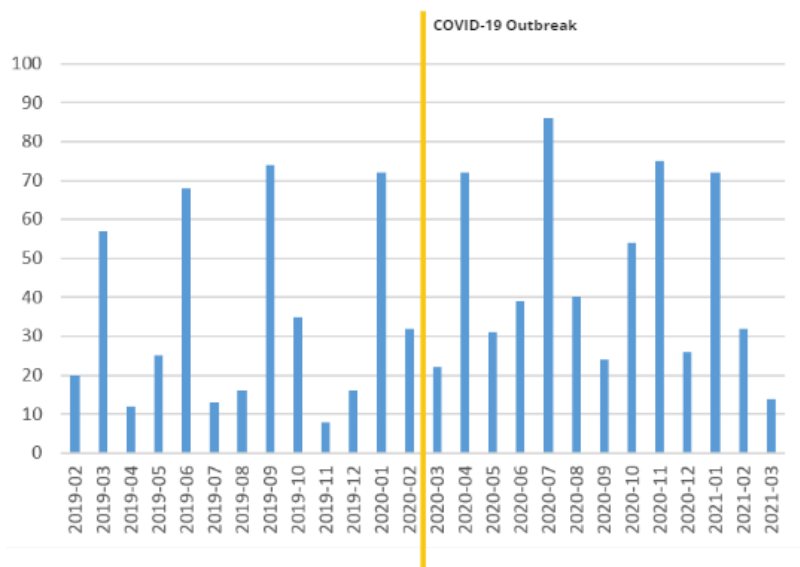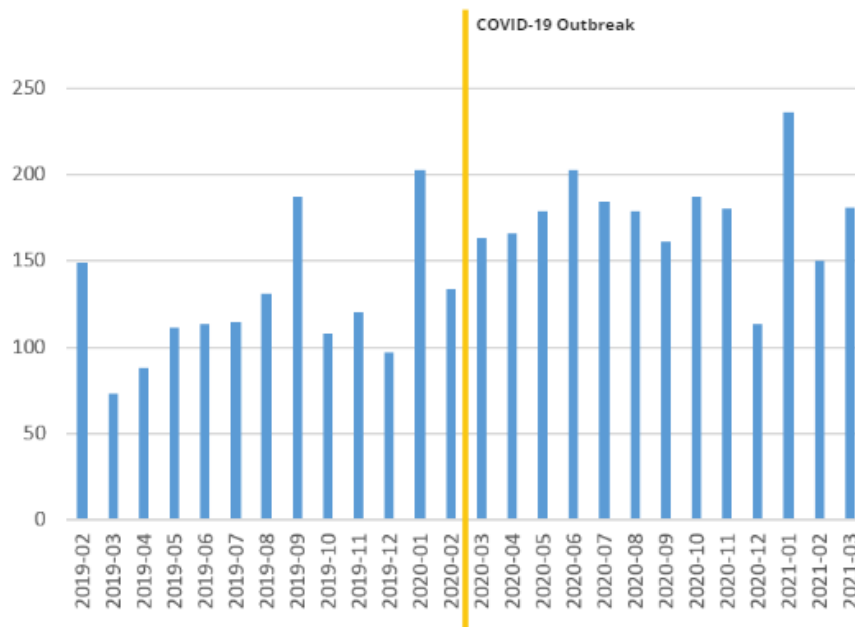

Figure 3 - Completed Features in period February 2019 - March 2021

Figure 4 - Completed User Stories in period February 2019 - March 2021

There is no visible downtrend in the deliverables. In fact, the throughput in absolute numbers has increased since the COVID-19 outbreak. When comparing the cumulative numbers, there were 448 Features completed in February 2019 – February 2020 and 587 in March 2020 – March 2021. It represents a 31% increase in Feature delivery throughput. A similar finding is visible with the stories, where 1629 User Stories were completed in February 2019 – February 2020 and 2282 in March 2020 – March 2021. It is a 40% increase in User Story delivery throughput in absolute numbers.

Next, we have included the complexity point of view to verify if the increase in delivery is not caused by delivering stories of lower complexity. The tool allowed to export only the statistics per quarters. Therefore we selected the time period April 2019 – March 2021. Figure 5 represents the total number of Story Points accepted in respective quarters.
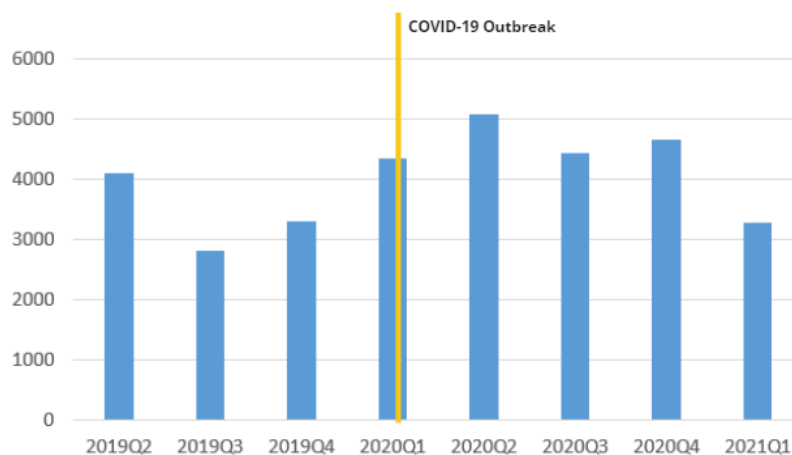
Figure 5 – Number of Story Points accepted per Product Increment 2019Q2 – 2021Q1

When comparing the cumulative numbers, there were 14543 Story Points accepted in the April 2019 – March 2020 period and 17468 Story Points accepted in the April 2020 – March 2021 period.

It is a 20% increase conforming with the uptrend visible in the delivery of Features and User Stories.

4.3. Video Analysis

During the video analysis, 34 recordings in total length of 54 hours and 52 minutes were reviewed. The recordings were captured during the nine PI Plannings that were held in the period from January 2019 to March 2021. All recordings were captured in video conference software tool WebEx. Our main intention was to identify any differences for the periods before and after March 2020. In the recordings from the period after March 2020, we specifically searched for COVID-19 related information, statements, risks, or other mentioned impact.

We have not identified any risks related to COVID-19 articulated by the teams during the PI Readouts. Similarly, there were no pivots identified in the presented objectives as a response to the COVID-19 outbreak, nor concerns related to a possible decrease in the team's throughput. The only change in the plans was postponing all announcements about the end of support for outdated versions of products not to aggravate the customers' situation by any enforced upgrades. Based on these findings, we concluded that COVID-19 had minimal impact, and the enterprise software development continued in the "business-as-usual" form.

The visible difference comparing the period before and post-March 2020 was that people in similar geolocations, even present in the same office, would not gather in shared rooms. Every single participant was connected to the PI Planning individually from theirs local PC. Unfortunately, the recordings covered only the readouts, not the planning process itself. Therefore, we could not evaluate the potential impact of the remote collaboration within every team, nor the tools they used, or challenges faced. However, the PI Planning readouts were not affected by the switch to full-remote at all. Similar tools as in the period before March 2020 were used, WebEx and Rally. Overall, there was no visible impact or significant difference in the PI Readouts content before and after the COVID-19 outbreak.

5. Discussion

The presented results showed no visible negative impact of the COVID-19 outbreak in the company's examined Value Stream focusing on enterprise software development. The unprecedented situation the modern digitalized economy has never faced before created by the COVID-19 outbreak (Savić, 2020) led to the implementation of various COVID-19 mitigations impacting productivity, duty arrangement, and communications (Waizenegger et al., 2020). In the examined company, the impacts of implemented COVID-19 mitigation strategy were mostly related to travel restrictions, social distancing, and rotation shifts. Before the COVID-19 outbreak, the company enforced presence in the office, and home offices were not commonly approved. The switch to full-remote collaboration introduced a new standard all employees had to adjust to. Surprisingly, based on the provided evidence, this had left no impact on the teams' throughput. In fact, the throughput in absolute numbers of delivered features and stories increased, and the teams completed 31% more features and 40% more stories during the 13 months post COVID-19 outbreak from March 2020 to March 2021, compared to 13 months period per COVID-19 outbreak. However, the incerase in amount of Story Points delivered was only 20%. The periods April 2019 to March 2020 and April 2020 to March 2021 were compared. Still, all metrics showed visible uptread. Thefore, we conclude there was no measurable negative impact on the throughput of the teams.

We did not discover any challenges or risks related to COVID-19 the teams would present during PI Planning Readouts. Furthermore, we have not identified any changes to the readouts process and content when comparing the pre and post COVID-19 outbreak periods. We have only identified the difference in how the employees gathered for PI Planning. People in similar geolocations, even present in the same office, did not gather in shared rooms. Every single participant was connected to the PI Planning individually from their local PC. However, the PI Planning readouts were not affected by the switch to full-remote at all. It was an unexpected finding that examined Value Stream continued in "business-as-usual "regime without obvious pivots or decreases in deliverables during the COVID-19 outbreak.

For the explanation of our findings we used the Effectiveness and Sustainability Model during Pandemic described by Obrenovic et al. (2020). Obrenovic et al. (2020) provided six propositions of an Effective and Sustainable company. Here, we provide the reflection of these propositions in the examined company.

"Proposition 1. Enterprises with a networked structure and high level of virtuality sustain their business operations in times of a pandemic." (Obrenovic et al., 2020). The examined company follows the Scaled Agile Framework (SAFe), which provides guidelines for achieving business agility (Knaster & Leffingwell, 2020). Additionally, it organizes various roles around Value Streams to deliver a set of solutions to the customer which results in the creation of a networked structure.

"Proposition 2. Enterprises with a shorter and more diversified supply chain sustain their business operations in times of a pandemic." (Obrenovic et al., 2020) The benefit of enterprises focused on software development is their relative independence of any supply chain to remain sustainable. They mostly use just internal resources to produce software products. Therefore, they are not impacted by any impediments in the deliveries of supplies.

"Proposition 3. Enterprises with an adaptive and flexible culture sustain their business operations in times of a pandemic." (Obrenovic et al., 2020) Agile, which has a response to change as one of its fundaments (Shammi et al., 2011), is nowadays not used only by small teams but scales to whole organizational structures. This is the case of examined organization. Therefore, the changes needed to happen in a short term to address specific needs or adhere to the updated business strategy can be done in relatively short terms with minimal impact on the throughput. The change is happening by nature in Agile, so that it is not visible in change of throughputs. The organizations adapt to turbulence in business environments without disturbing the throughput of deliverables.

"Proposition 4. Enterprises with distributed leadership and workforce sustain their business operations in times of a pandemic." (Obrenovic et al., 2020) The examined company had leadership and workforce distributed in the Czech Republic and the United States of America. When the COVID-19 started to rocket, measures were implied to avoid close contact of even collocated employees. The leadership was not distributed just geographically and physically, but also as per the role. SAFe empowers people to make quick decisions and align the right people to do the right work (Knaster & Leffingwell, 2020) that contributed to removing possible delays caused by full remote collaboration.

"Proposition 5. Enterprises with advanced digitalization and internet technology sustain their business operations in times of a pandemic." (Obrenovic et al., 2020) Due to the characteristics and distribution of teams, agile release trains, development silos, and even the leadership, the examined company employees were used to collaborate remotely even before the social distancing measures were implemented. It positioned the company well for the full remote working that followed after the COVID-19 outbreak.

"Proposition 6. Enterprises with a financial contingency plan sustain their business operations in times of a pandemic." (Obrenovic et al., 2020) The effects of the COVID-19 outbreak in the examined company are unlikely to be fully realized or reflected in results until future periods. That is given by the characteristics of the business and the usual 3year renewal contracts. However, the first year with the COVID-19 influencing businesses worldwide had left no visible impact on the deliverables. If this is going to change is currently unpredictable.

Our findings contribute to the verification of the Obrenovic et al. (2020) model. We see similarities in the propositions provided in the model and the examined company settings. The Agile transformation and SAFe implementation conducted in 2016 in the examined company contributed to the overall organizational preparedness for the mitigation of the COVID-19 outbreak. As the teams were used to collaboration in distributed environment before the COVID-19 outbreak and were used to leveraging technologies to ease the collaboration, the switch to full-remote with implied social distancing did not lead to a visible impact on the deliverable throughput or planning process. Additionally, as the company is not dependent on any external suppliers to deliver the products and has a model of 3year renewal contracts, the fluctuations in deliverables as a possible result of the COVID-19 outbreak were not observed. The company's fast response to the COVID-19 outbreak, regular updates, and implied restrictions seem to successfully protect the employees, leaving no impact on the throughputs caused by the reduced capacity of the teams. Similarly, neither the teams nor the leadership expressed any concerns about the COVID-19 outbreak impact in the examined video recordings.

Our paper provides a valuable contribution for both practice and research communities by uncovering the real-live COVID-19 outbreak mitigation strategy and an organization setting that contributed to the successful remission of the COVID-19 negative impact on the company's deliverables. Additionally, the paper advocates the reliability of the Obrenovic et al. Effectiveness and Sustainability Model during Pandemic (Obrenovic et al., 2020). Although more case studies are required to enable the generalization of findings on COVID-19's impact on enterprise software development, we believe that the information provided in this paper can help enterprises better prepare themselves for further unprecedented situations.

5.1. **Limitations of the Study**

The presented results were obtained in one Value Stream of a large multinational enterprise and, therefore, might be influenced by the local context. Achieving validity in a single case study is a known challenge, especially when compared to a research focused on large random samples. The advantage of large samples is breadth, whereas their problem is one of depth. For a case study, the situation is reverse (Flyvbjerg, 2006). Therefore, the case-study method in general can certainly contribute to the cumulative development of knowledge (Flyvbjerg, 2006).

Internal factors impacting the data, such as people gaining and

improving their skills, staff replacement, and changes in management positions, were not considered. It is possible that mentioned changes contributed to improvements in the throughput, as well as the overall mitigation.

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SUPPORT BUSINESS PROCESSES IDENTIFICATION AT THE ARCHITECTURAL LEVEL

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Support process, business architecture, business process identification

Abstract

A well-structured business process architecture is a requirement of every enterprise architecture. Business/enterprise architecture standards specify diagrams for mapping the business process architecture and what it should contain, but specific practices for how to identify business processes and the relationships between them are rare and highly dependent on individual analysts' experience and skills. We consider the least elaborated area to be the identification of supporting processes and their relationship to key end-to-end business processes. In this paper, we extend an already existing process modeling method for ArchiMate by proposing a procedure on how to identify supporting processes and what relationships between support and end-to-end processes to capture in a process model.

1. Introduction

A good enterprise architecture enables one to achieve the right balance between IT efficiency and business innovation (The Open Group, 2018) and well-structured business processes are an undividable part of any good enterprise architecture. A good business process architecture is also important for methodologies from the Corporate Performance Management (CPM) field, like the Activity Based Costing (ABC), so that they have firm foundations they can build on.

Mapping of business processes at the architectural level is a specific domain. Standards and frameworks like TOGAF and ArchiMate (The Open Group, 2018, 2019) have definitions of what a business process is, but how exactly identify a business process without mapping its detail, that is left to others to explore. Specificity of this area is the necessity to stay at the process level of detail. Diving deep into business processes' detail means using different tools and models that go beyond the standard tools for business architecture (The Open Group, 2019).

There is research, we review below, that tries to address business process identification at the architectural level. This research addresses the problem well for the core or end-to-end (E2E) processes, but the support processes are usually presented as a complement that will clear itself throughout the analysis.

TOGAF and ArchiMate specifications do not classify the business processes at all. They have a detailed definition of what a business process is, but they do not specify a procedure on how exactly one should proceed when trying to identify the business processes. There are other works that recognize the architecture level of detail of business process models too. Davis & Brabander (2007)

and Seidlmeier (2019) use the value chain diagram, Brocke & Rosemann (2015) propose the Business Process Architecture Framework and Weske (2019) proposes the Process landscape. In all these approaches we can find business process classifications (core or main processes, support processes, management processes), but the detailed procedure for the business process identification is not specified in any of them. Similarly, the LEAD methodology (Rosing et al., 2014) works with abstract process maps, which capture sequences of business processes, differentiates between process types (management, main, and supporting processes) and generally describes how to identify a business process, but it is still a general description and not a detailed procedure. Sharp & McDermott (2009) discuss the importance of process identification and provide a practical procedure on how to identify a business process in general, but its focus is on workflows, leaving the architecture process maps out of the scope. Dumas et al. (2018) differentiate, in accordance with Porter (1985), between core and support processes and extend this classification with management processes. Dumas et al. (2018) present a process landscape model that captures these three categories of processes and a procedure that describes how to identify the business processes. The procedure focuses on the end-to-end processes which represent the core processes but the guidance for identification of support and management processes is much less elaborated and stays on the level of general advice. The procedure is also reflected in the process landscape model, where the focus is on end-to-end processes including their relations. The management and support processes are just listed with no explicit relation to the other business processes. A process modeling method for ArchiMate introduced in (Svatoš, 2017) builds on the process map from MMABP (Řepa & Svatoš, 2021) which captures business functions, their core E2E processes, their support processes, and the relations between support processes and the E2E processes. The method specifies an eight-step procedure for business functions and business process identification and how to capture them in the process map including their relations. The method differentiates between E2E and support processes. E2E process identification procedure is detailed but the procedure for support process identification points out only the idea of E2E milestones without providing any further detail. Nevertheless, the research reviewed above shows that the support processes are an important part of any business process architecture. We consider the support processes equally important as the core E2E processes since without their support the E2E processes cannot achieve their goals. The lack of detailed procedure for their identification can be in practice substituted by an analyst's experience but for a new inexperienced analyst, such procedure is crucial. The goal of this paper is to specify a procedure to determine how to identify and capture support processes and their relationship to E2E processes in a structured way, not just intuitively. For this purpose, we use as the foundation the procedure specified in (Svatoš, 2017) and we extend its idea of E2E milestones that, from our point of view, seems to be the way how to structure goal-oriented work that the business processes do represent.

This paper is divided into four following sections. First, we specify the method used to follow up in the next section with an analysis of what kind of output a support process can support an E2E process with and, through the analysis of MMABP's process map, we identify possible ways of synchronization of the support for E2E processes provided by the support processes. In the third section, we propose a procedure for the identification of support processes and their capturing in a process map that extends (Svatoš, 2017). In the fourth section, we discuss the proposed extension and what benefits it brings compared to the original method.

2. Research Method

Based on the rules for a process map specified in the MMABP (Řepa & Svatoš, 2021) and the generally accepted definitions of a business process we use inductive reasoning to answer the following two research questions:

- Q1: What kind of inputs can the support processes provide to the E2E process?

- Q2: How is the provision of support by the support process coordinated with the E2E process?

By answering these two questions we obtain characteristics of support processes and their relationships with E2E processes that a process map should capture. Based on this analysis we extend the process modeling method for ArchiMate introduced in (Svatoš, 2017) building on its idea of E2E process milestones. We specify a step-by-step procedure for the identification of support processes and their capturing in a process map.

3. Relationship Between Support and E2E Business Processes

Since our goal is to extend the process modeling method for ArchiMate introduced in Svatoš (2017), we base our analysis on MMABP and its process map (Řepa & Svatoš, 2021). The process map is one of the four diagrams the MMABP works with and together with the class diagram they form a global view of the modeled business system. It is based on the TOGAF Event diagram and allows one to capture business functions and processes and relations among them. Svatoš (2017) differentiates between E2E business process and support business process roles and defines the E2E business process as a business process which is linked directly to a customer of enterprise functionality (business function), covering the whole business cycle from the expression of a customer's need to its satisfaction with the product or service. To be able to do that, the E2E processes have to coordinate their support processes which purpose is to support the achievement of E2E business processes goals with a particular product or service. This way a support process role is defined by the relation of the business processes to each other, and not by an explicit list of possible support processes (Porter, 1985) which, eventually, is anyway relative according to the process relation to other processes (Dumas et al., 2018, p. 50). The method in (Svatoš, 2017) suggests identifying the E2E processes first and then looking for E2E processes' milestones to be able to identify their support processes. It does not go any deeper and so it leaves the detail to individual skills and experience.

As far as the Q1 is concerned, the answer we can find in the definitions of a business process like "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer" (Hammer & Champy, 1993) or "a set of linked activities that take an input and transform it to create an output" (Johansson H. et al., 1993). As the relation of the E2E and support processes is set up, the definitions of a business process above suggest that the E2E process coordinates three types of support processes:

- support processes that provide the E2E process with necessary inputs for its execution

- support processes that provide the E2E process with the transformation of its inputs into the target outputs

- support processes that provide the E2E process with the delivery of the outputs to its customer.

We can find similar differentiation in the SCORE framework that differentiates between Source, Make and Deliver processes (Rummler & Ramias, 2015). An E2E process takes care of the coordination of these support processes and deals with the issues when any of its support processes fails or gets stuck and makes sure that the goal of the E2E process is achieved. E2E process focuses on the bigger picture in form of the complete business cycle i.e. from the expression of a process customer's need to its satisfaction with the product or service.

Since the support is provided by support business processes, question Q2 is, how they are initiated and how exactly their support is coordinated with the supported E2E process. The answer we can find in the process map the method proposed in (Svatoš, 2017) builds on. There are four different possible ways of synchronization for an E2E process and its support process in the process map:

- directly initiated and on completion synchronizing support process (Figure 1)
- not directly initiated and on completion synchronizing support process (Figure 2)
- directly initiated and not on completion synchronizing support process (Figure 3)
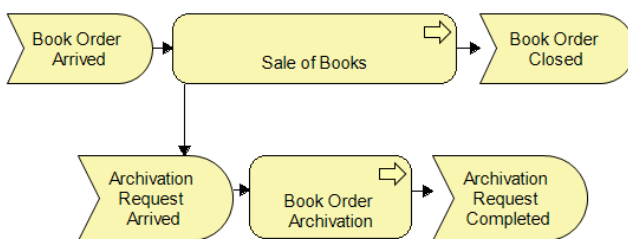- not directly initiated and not on completion synchronizing support process (Figure 4)

The main factors in this differentiation are differences in support process initiation and E2E process synchronization with support process completion.
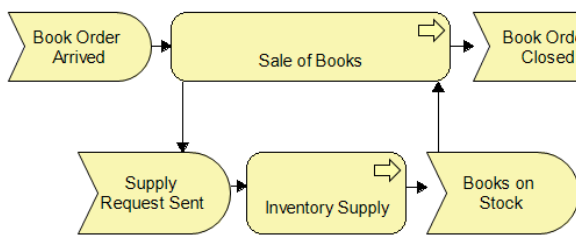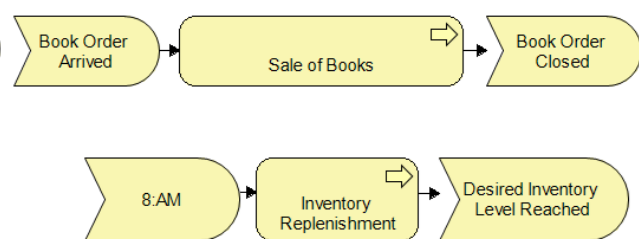

Figure 1: Directly initiated and on completion synchronizing support process
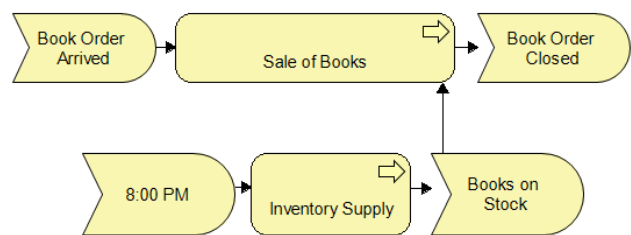
Figure 2: Not directly initiated and on completion synchronizing support process

Figure 3: Directly initiated and not on completion synchronizing support process

Figure 4: Not directly initiated and not on completion synchronizing support process

Directly initiated and on completion synchronizing support processes are the most straightforward ones. An E2E process initiates the execution of its support process and waits for its completion since without its output the E2E process execution cannot continue. This support process execution is optional for the E2E process. It is executed only in cases when the E2E process requires it. In Figure 1 the Sale of Books process decides to execute the Inventory Supply process when the ordered books are not in stock and waits for its completion so that it can deliver the books to the customer. If the ordered books are in stock already the Inventory Supply process is not executed at all.

Not directly initiated and on completion synchronizing support process is a process that usually represents "batch" driven support. The E2E process cannot directly execute the support process, it puts its order in a backlog of the support process and waits for the support process completion. The support process is executed according to some business rules based on time or ad-hoc conditions. The support process then takes its backlog and processes it. This way it usually supports more instances of the E2E process, which filled the backlog. When finished, the supported instances of the E2E process can continue their execution. In Figure 2 the instances of the Sale of Books process send their orders to the Inventory Supply process backlog and wait for its completion so that they

can deliver the books to their customers. When a deadline for orders is reached, the Inventory Supply process is executed. The reason for this setting may be so that the orders towards the supplier are not done on a per book basis, but in reasonable batches. When the support process is completed and so the "batch order" is processed, the individual instances of the supported E2E process can proceed to deliver the books to their customers.

Directly initiated and not on completion synchronizing support process is a process that is initiated by a particular E2E process, in required cases, but the E2E process does not wait for its completion since it is not relevant for the E2E process goal achievement. In Figure 3 the Sale of Books process executes the Order Archiving process, but it does not wait for its completion since it is not relevant for its goal achievement.

Not directly initiated and not on completion synchronizing support process is a process that usually represents continuous support that tries to keep the necessary inputs for the supported E2E processes available at the required level. Although the supported E2E process does not initiate this kind of support process directly nor it waits for its competition, the supported E2E process is dependent on the reliable performance of this support process. The procedures dealing with failures of cooperation of these two processes have to be captured in the supported E2E process detail. The process map abstracts form these internal dependencies since they require much more detailed analysis and therefore, they are subject to a different diagram – the detailed process diagram. In Figure 4 the Inventory Replenishment process supports the Sale of Books process by keeping regularly demanded books in stock in reasonable volume. The Sale of Books process does not initiate nor wait for its completion. They both run independently on each other even when there are missing books in stock the Sale of Books process needs for its completion. This would be likely solved as depicted in Figure 1. The Sale of Books process would also have access to the Inventory Supply process, through which it would directly order retrieval of the missing books. The Inventory Replenishment process may or may not react to this event by reconsidering the required volumes in stock depending on the "forecasting algorithm". This way, reaching one E2E process milestone would be supported by two different support processes.

4. Extending the Process Modeling Method for ArchiMate

The process modeling method for ArchiMate introduced in (Svatoš, 2017) suggests basing the support process identification on E2E process milestones which are essential for the delivery of service or product to the customer. No further detail is specified. This we find necessary to extend since finding milestones with the proper level of detail is not an easy task, and yet, it has a significant effect on the readability and usefulness of the process map. First, we clarify what a milestone is – what exactly an analyst should look for when analyzing the E2E process.

In the project management theory (Andersen, 2006), a milestone anticipates what the project is supposed to achieve at a pre-set date, and it should describe a desired state of affairs, the desired future situation. A milestone is a moment in time and should not be mixed with the delivery of so-called deliverables. They are sometimes evidence of the completion of a milestone but not necessarily (Asana, 2020). Milestones represent only essential points of the project. They represent control points that a project is moving in the right direction (Andersen, 2006) separating so the individual sequence of tasks performance of which is leading towards reaching the milestone. As noted above, a milestone also represents a deadline (pre-set-date) that can be missed, and also a place of possible decisions on what to do next (Asana, 2020).

In accordance with the above-summarized characteristic of a milestone, we define a milestone for a business process as: "Milestones are control points within a business process represented by states of affairs essential for the delivery of service or product to the business process's customer. For the

business process, these states of affairs represent sub-goals to reach and places of possible decisions what to do next."

Having the milestones defined we can start looking for them in an E2E business process. This way we decompose the E2E process goal into individual milestones, which the E2E process has to achieve to be able to reach its goal. The E2E process is in its nature coordinating process and so it will use the support processes to help it to reach its milestones.

The analysis done above shows us that there are three types of support processes according to what stage of the E2E process they support - completion of input delivery, input to output transformation, and output delivery. As we can differentiate three stages in E2E process performance, we can say that finishing a stage can be seen as reaching a basic milestone of the E2E process on its way to its goal. This is important to take into consideration when looking for the milestone since it helps an analyst to focus on the essential states of affairs the milestones should represent – the control points dividing the phasis of support of an E2E process.

The milestone identification is followed by the support process identification. As there are defined milestones according to the stages of support of an E2E process, one has to take into account, that the same milestone can be achieved by the performance of different support processes. The analysis done above shows us that there are four different ways of synchronizing of E2E process and its support processes possible. For each milestone, it is necessary to consider all these types of support so that all the support processes that support reaching the milestone are identified.

Taking the above into consideration, we suggest the following reformulation and extension of eighth step of the process modeling method for ArchiMate (Svatoš, 2017).

Identify support business processes for each E2E business process:

1. Look for milestones of the E2E process that represent the completion of input delivery, input to output transformation or output delivery. Keep in mind the proper level of detail - milestones are control points within a business process represented by states of affairs essential for the delivery of service or product to the business process's customer.

2. Analyze how the identified milestones can be achieved considering all the four possible ways of E2E process synchronization with its support processes in a process map. For each milestone consider what way it can be achieved and identify what support processes support that milestone with its output. Consider that one milestone can be supported by several support processes.

3. Identify the goal state of each identified support process.

4. Identify starting event(s) of each identified support process.

5. Capture the synchronizing relation in the process map whenever a support process is initiated by the E2E process or the E2E process synchronizes with the completion of its support process.

5. Discussion

The proposed procedure for support process identification builds on (Svatoš, 2017), which also provides a practical example and discussion of the benefits of the modeling procedure based on the MMABP's process map. In this paper, we propose an extension of this modeling method. The extension provides an analyst with a structured approach how to identify support processes of an E2E process. First, it adds a proper definition of what a milestone is so that even an inexperienced analyst knows what exactly one should look for when identifying the E2E milestones. The original

procedure has just built on the general meaning of a milestone and that left a space for speculation how detailed a milestone should be and that may lead to an inconsistent level of detail of the process map. Second, there are specified phases of support of an E2E process, which help one to focus on the individual parts of the support. The original method does not provide this structuring guidance and an inexperienced analyst may get confused by the numerous options one has when looking for all support processes of an E2E process. The proposed phases allow one to structure the analysis and not get overwhelmed by the available support processes. Third, there are specified four different possible ways of synchronization for an E2E process and its support process in the process map. This makes an analyst aware that the milestones can be reached in different ways and that even reaching one milestone can be supported by more than one support process. The original method worked explicitly only with one way of synchronization that was directly initiated and on completion synchronizing (Figure 1). This way the original method neglected the remaining three possible ways of synchronization for an E2E process and its support process and left their identification to an analyst's experience and expertise. Figures 2 – 4 represent the variants of support of Sale of Books process that extend the original example in (Svatoš, 2017) that would be otherwise neglected when proceeding only by the original modeling procedure.

6. Conclusions

Process maps are a standard part of business architecture standards and frameworks. These standards and frameworks usually have well-defined what such a process map consists of. What is less developed, are the procedures how to create such a process map, preventing an inexperienced analyst from diving into too high detail ruining so the consistency of the abstraction of the process map. In this paper, we have focused on the least elaborated part of the process mapping – identification of support processes and their relation to the ones they support.

We analyze the relationship between a core E2E process and its support processes finding that we can split the stages of support of an E2E process according to a functional view at the business processes and specify four different possible ways of synchronization for an E2E process and its support process in the process map. All this is done at the process level of detail. Based on the analysis, we have extended the existing method for process identification (Svatoš, 2017) so that it reflects the identified characteristics of support processes and their relation to E2E processes in the context of the MMABP's process map. The method keeps the business process abstraction consistent as the process map's level of detail is determined by the identified process goals. The main benefit is that the existing process modeling method, and also its extension, allow one to capture and structure business processes and their causal relations in a process map while staying at the abstract process level, not forcing an analyst to go deep into process detail, which is not subject to business architecture.

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BIG DATA PROJECT MANAGEMENT APPROACHES IN THE CZECH REPUBLIC

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Agile, Big Data, Czech Republic, Data Analytics, Data Mining, data volumes, project management, project success

Abstract

The amount of data grows exponentially every year and the information obtained from their analysis is an asset of every business. Therefore, more and more companies invest in Big Data implementation and use. However, the technology for processing this data is very complex and it is very difficult for companies to successfully master and operate it as to fully utilize its potential. Projects focused on this issue often end in failure. There are many critical factors affecting success of these projects. One of the most critical factors is appropriate project management. The paper aims to identify the approach which is most often used by companies in the Czech Republic to manage Big Data projects, as well as to assess how successful these projects are. The research is based on data from a research which included a questionnaire survey. The paper determines the most frequently used approach to Big Data project management in the Czech Republic, including the resulting success of such projects as perceived by respondents.

1. Introduction

The Big Data technology offers new and advanced options for obtaining, aggregating, storing, and analysing large volumes of diverse and differently structured data which are generated by modern tools with increasing intensity (Reinsel et al., 2018). Analysis of these data offers a comprehensive insight into the examined issue, because it also takes the data that could not be processed in this way previously into consideration and puts these two sets of data into mutual context (both from the aspect of lack of capacity, the unavailability of this data or the lack of available tools)(Manyika et al., 2020).

Companies are very interested in implementing Big Data technology, if they are not yet using it. Only 10.5% of queried companies worldwide are not considering investing into implementation of Big Data technologies (STATISTA, 2020).Interest in this technology also slowly grows in the Czech Republic, where, according to a 2020 survey, about 9.1% of all companies use Big Data technologies (CZSO, 2021a). In 2016, the figure was 8.5% (CZSO, 2016).

Despite great interest in this technology, its implementation by companies remains highly problematic. According to the most recent statement by Gartner, a high percentage of Big Data projects are not successful – the company's official sources give a 60% failure rate, unofficial

sources a failure rate of up to 85% (Gartner, 2016; Heudeker, 2017). This means that the success rate of Big Data projects is very low.

Many experts and researchers have focused on the issue of such high failure rate and have defined a lot of advice on how to improve the situation. So far, however, the success of these projects is very similar (see Figure 4, O'Neill, 2019).

This paper focuses on project management as one of the defined critical success factors of these projects (Gao et al., 2015, Yeoh & Popovič, 2016, Evers, 2014, Koronios et al., 2014, Saltz & Shamshurin, 2016; McAfee & Brynjolfsson, 2012; Gómez & Heeks, 2016; Wamba et al., 2020). The aim of this research is to identify the most used approaches to managing Big Data projects by companies in Czech Republic.

This study is a part of the authors long-term research focused on mapping and analysing critical success factors of Big Data projects.

The first part of the work is devoted to an introduction to the researched issues, the next part describes the procedure of data collection and research methodology. Finally, the results of the research, its limitations and further research are summarized.

2. State of the art

The term, Big Data, does not include only large volumes of data – it also includes data in different structures, in different formats, from different sources and with different processing rate requirements.

In general, Big Data can be described using the so-called V characteristics. The basic 3V characteristics consists of – Volume (meaning large volumes of data), Variety (meaning data in different structures) and Velocity (generation rate and the necessity to quickly process such data). This definition was first used by Douglas Laney, a Gartner data analyst, in his 2001 research work (Laney, 2001). Another V was later added for Business Intelligence – Value (data valuable for business). There are also other characteristics, such as Veracity (data from trusted sources), Viability (reflecting the actual state), Vulnerability etc. (Snow, 2012; IBM, 2012; Experian, 2017). The development of Big Data characteristics has been going on for a very long time; 42 have been defined so far (Shafer, 2017).

Big Data technologies are particularly suitable for large companies or companies focusing on processing of unstructured data (audiovisual recordings, etc.). According to data from the Czech Statistical Office for the Czech Republic, Big Data are most used by companies with more than 250 employees, most often in CZ-NACE 60 – Programming and Broadcasting (creation and broadcasting of radio, television and data programmes), as well as in CZ-NACE 53 – Postal and Courier Activities (transport, storage and collection of letter and parcel services) (CZSO, 2021a, 2021b).

In the Czech Republic, the main source for Big Data are positioning data (GPS), used for Postal and Courier Activities – logistics companies (CZ-NACE 53) together with companies in Land and Pipeline Transport (CZ-NACE 49), as well as data from customer databases (without further specification) and data from internet search engines aimed at identifying customer behaviour which were mostly used by companies from the ICT sector (CZ-NACE J), in particular in Programming and Broadcasting (CZ-NACE 60) and IT Activities (CZ-NACE 62-63) (CZSO, 2021a, 2021b). Another important source of data in the Czech Republic is the so-called Open Data (publicly available data).

For Big Data analysis, Czech companies most often use methods of image information analysis, predictive analysis, and web content analysis. Machine learning and computer natural language processing (NLP) are used the least (CZSO, 2021a).

According to a 2020 survey, the Czech Republic is below average (EU27) compared to other EU countries, see Figure 1. Data for this chart were drawn from Eurostat databases (Eurostat, 2021) and are for 2020.
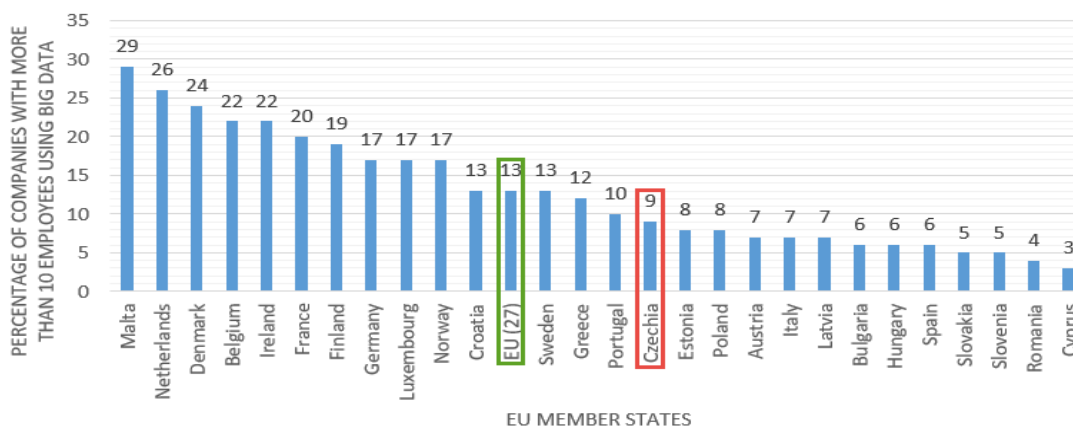
Figure 1: Comparison of EU member states in terms of the use of Big Data technologies. Source: Author's own elaboration of Eurostat data

2.1. Project Management

Project management is an integral part of each project. It is a process of coordinating individual activities in order to achieve the set goal in the specified quality, at the required time and using available financial resources. Approach to management must be selected on the basis of experience, specifics and requirements of the project. There are many approaches and frameworks which are aimed to define procedures, responsibilities and rules governing the project.

Basic project management methodologies are divided into agile and non-agile approaches.

An agile approach is referred to as a change-driven approach. It is the opposite of a traditional approach to management. This methodology assumes that project processes cannot be precisely defined in advance and only basic principles and planned practices can be described. The aim of the project is defined in advance, however, in the beginning, it cannot be clearly defined how to reach it. Thus, the contracting authority has a high degree of flexibility, and as it is a member of the project team, it can alter the terms of project assignment during the project. Delivery of solutions takes the form of partial iterations which can be further modified (Wysocki, 2014).

A non-agile or traditional management approach is used in a project in which it is possible to precisely, clearly, formally and directly plan all activities at the very beginning of the project and clearly define its goals, processes and all requirements. This type of management is very susceptible to any changes during the project (Bruckner, 2012).

Choosing the right management approach is a key factor for the success of the project. Approaches specific to development of software or for Data Mining, which is closely related to Big Data, are used to manage projects focusing on implementation and use of Big Data technologies.

According to literature review, suitable approaches for Big Data project management include Scrum, Kanban, eXtreme programming, AABA (Architecture-centric Agile Big data Analytics), DSDM (Dynamic systems development method) agile methodologies and KDD (Knowledge Discovery in Databases) and CRISP-DM (Cross Industry Standard Process for Data Mining) agile

methodologies, as well as non-agile versions of CRISP-DM, KDD and SEMMA (Sample, Explore, Modify, Model, and Assess) frameworks (Franková et al., 2016; Saltz & Shamshurin, 2019; Ponsard et al., 2017; Tsoy & Staples, 2020). Very often, the literature refers to combinations of methodologies, such as Scrum-Kanban (Scrumban), Lean-Kanban, Scrum-eXtreme programming and others (Baijens et al., 2020; Schmidt & Sun, 2016; Al-Mazrouai & Sudevan, 2020 etc.).

Choosing the right management method significantly increases the probability of project success - this is a key factor in the success of these projects (Gao et al., 2015, Yeoh & Popovič, 2016, etc.)

3. Data collection and methodology

The research aimed to identify approaches to Big Data project management which are used in the Czech Republic.

The research questions are:

- RQ1: Is the agile or the traditional approach to management of Big Data projects used most often in the Czech Republic?

- RQ2: Which project management frameworks are most often used for managing Big Data projects in the Czech Republic.

- RQ3: What is the success rate of Big Data projects in the Czech Republic?

Author used the quantitative research method through a questionnaire survey. 53 respondents who have experience with Big Data projects and are employed in a companies operating in the Czech market participated in the survey.

3.1. Data collection

The data from the questionnaire survey used in the research were obtained in the period from November 2020 to February 2021 through electronic and telephone surveys.

Based on a random selection, 75 respondents who are employed in Czech companies and work with Big Data were contacted, mostly via email. 53 of them have responded so far and the research still continues. The random selection was made using a random number generator program (Czech companies working with Big Data were numbered in the database).

The questionnaire survey contained 18 questions and was focused on the experience respondents had with Big Data projects, and specifically the success of such projects, project management, used technology and tools, respondents job title, team size, industry and more. The questions were determined on the basis of previous interviews with Big Data specialists. Respondents were asked mainly about their latest Big Data project and also had to confirm that it took place in Czech companies. Right from the start of the survey, respondents were asked to confirm that they have experience with Big Data projects; if they did not confirm this, their answers were not taken into account in the research results.

4. Results

This part of the paper addresses the results of the questionnaire survey. Descriptive statistics were used to summarize the research data. The results are plotted in pie or bar graphs.

One of the questions of the questionnaire survey was focused on the last Big Data project management of the respondents; their answers are displayed in Figure 2.
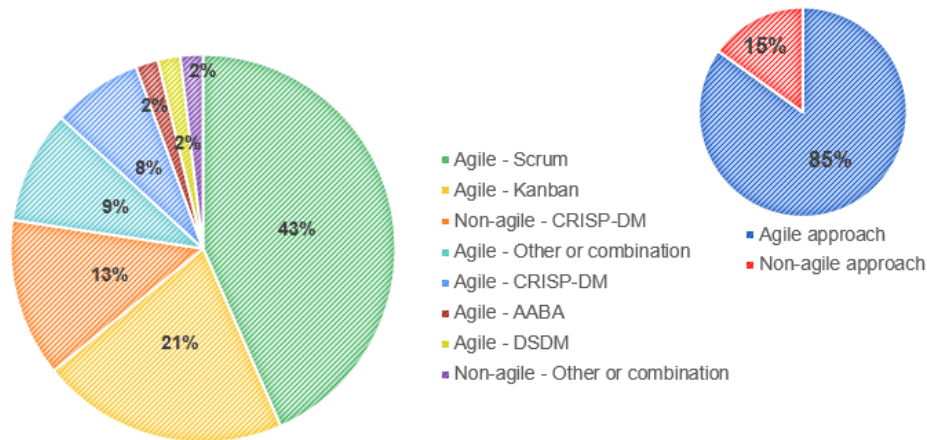
Figure 2: Approaches used to manage Big Data projects in the Czech Republic. Source: own research

According to the results of the survey, the agile approach to Big Data project management is most often used, preferred by 85% of respondents. The most commonly used framework is Scrum (43% of cases) and Kanban (21%). On the other hand, the least used framework is the agile method of DSDM, AABA and also the non-agile approach called Other or combination – representing a synthesis of several non-agile frameworks into a single one (e.g., SEMMA-CRISP-DM) or another specific and less frequently used framework.

The most used traditional approach to Big Data project management is CRISP-DM (13%), which, according to the survey, is most often used for Data Mining by Data Scientist respondents. This approach can also be applied in an agile version which is used by only 8% of respondents.

The dependence between the approach used to manage Big Data projects and their final success as perceived by the respondents is displayed in Figure 3.
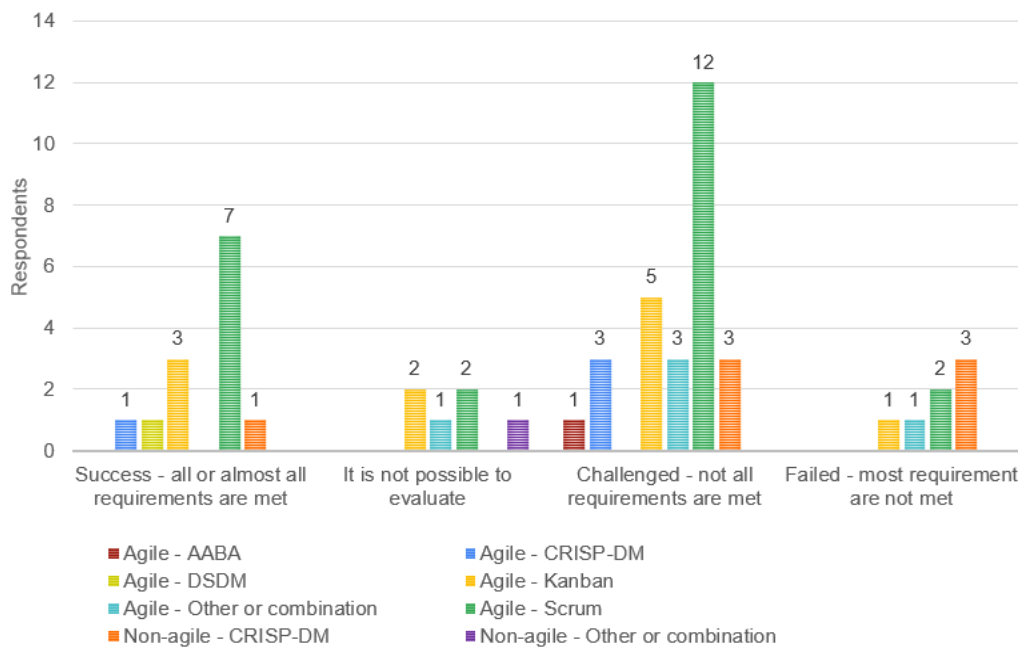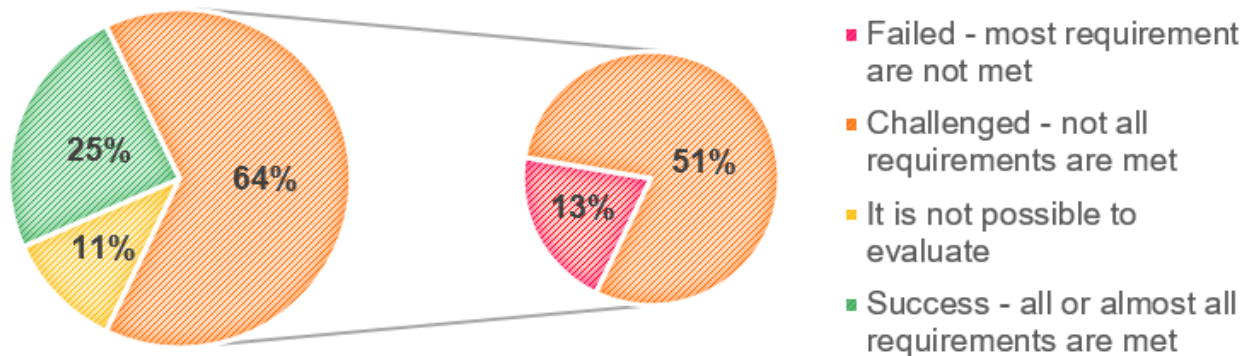

Figure 3: Success of Big Data projects depending on the management approach in the Czech Republic. Source: own research

According to the survey, it is clear that projects perceived as successful rather use agile management approaches – Scrum or Kanban, than the traditional ones. On the contrary, projects

perceived as unsuccessful were most often managed by the non-agile concept of the CRISP-DM framework.

The survey was also focused on the perceived success of the last completed Big Data project of the respondents which is displayed in Figure 4. The project was considered unsuccessful if it did not meet the requirements to an acceptable extent (Challenged) or to an unacceptable extent (Failed).

Figure 4: Success of Big Data projects in the Czech Republic. Source: own research

According to the survey, Big Data projects in the Czech Republic are perceived as successful in 25% and as unsuccessful in 64% of the cases. This result is very close to Gartner's claim (2017) that lists a 60% failure rate of Big Data projects.

5. Conclusions and future work

Respondents of quantitative survey in the Czech Republic most often use an agile management approach in Big Data projects, using the Scrum framework. Traditional management approaches are used only to a very limited extent, most often in the Big Data – data mining process, in which the CRISP-DM framework is applied. Furthermore, the perceived success of these projects was examined, which according to the survey is low and only 25% of projects are perceived by the respondents as successful. 51% of the Big Data project did not meet the requirements to an acceptable extent, 13% failed completely.

Another study focusing on the use of agile approaches to software development in the Czech Republic also states that Scrum is the most widely used (Dolezel et al., 2019). Is the Scrum management framework simply a trend in project management or is it actually the best approach to managing Big Data implementation and development? The author's research will further address this issue.

This research will continue. Within the research, a qualitative survey will also be conducted in the form of semi-structured interviews with Big Data project managers. The purpose will be to eliminate weaknesses caused by using a single research method and also to supplement other knowledge in this area.

6. Limitations

The number of potential respondents is very limited by the specific IT area – Big Data, which very few companies in the Czech Republic deal with so far, see Figure 1, and also by the reluctance of people to respond to this kind of surveys. The research is also limited by the complexity of

retrieving a representative sample of data with available data on companies that work with Big Data in the Czech Republic. Another limitation is that the respondents had different job classifications.

7. Acknowledgements

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COVID-19'S INFLUENCE ON LEARNING AND TEACHING

COVID-19 IN TEACHING AND LEARNING: EARLY FINDINGS FROM PUBLISHED STUDIES

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COVID-19, education, learning, online learning, literature review

Abstract

The paper provides a systematic literature review with regard to published research on teaching and learning in COVID-19. The purpose of the research was to provide a first overview of learning and teaching topics as well as to sketch already existing findings that might be useful to researchers as well as educators. The findings show that educators in many disciplines were keen to share their experiences in the crisis, publishing mostly case studies as well as studies on experiences of different stakeholders. The existing findings mark the great challenge that the sudden and unusual teaching mode caused to students as well as to teachers, often causing serious problems and anxiety. The teaching in COVID-19 is marked by the use of established technologies, its originality being focuses mainly on teaching design innovation.

1. Introduction

The COVID-19 worldwide pandemic that emerged in late 2019 and spread across the globe in Spring of 2020 represented more than just a dire health crisis: due to the nature of the disease, preventive measures in most countries were focused on limiting personal contact, thus quickly leading to closure of educational institutions. While schools remained opened somewhat longer, higher educational institutions were among the first closed, forcing students and teachers into a comparatively sudden virtual mode of teaching and learning. Other – non-educational – institutions followed. This led to a sudden surge in the use of different types of virtual interaction (e.g. online shopping, remote work, tele-medicine), all of which had existed before but had been used to a much lesser degree. This of course provided an interesting environment for research in information systems as well as related fields (Dwivedi et al., 2020). In education, it led to a sweep of publications related to this new "emergency online education" (Shim & Lee, 2020; Srivastava et al., 2021). Education professionals and researchers in the area of e-learning and education worldwide have carried out studies or simply wished to share their experience.

First publications on teaching and learning in the pandemic arrived as early as Summer 2020 in now virtually-held conferences, by the Autumn 2020, journal publications were also available. The research on the impact of the COVID-19 crisis will continue to appear probably for several years, as the forced experience could have a long-term impact on the way education is perceived and organized. Researchers interested in publishing in this area might need an overview of topics that have already been covered by the existing wave of publication. Educators can also benefit from the topics that have been moving their colleagues during the pandemic and insights into their

experiences and findings. This research paper will therefore address the following research questions:

- RQ1: What topics have been approached by researchers related to teaching and learning practices during the COVID-19 pandemic in 2020 and early 2021?

- RQ2: In what areas do early experiences and findings lie and what key points do they contain?

This paper presents a systematic literature review of a selection of early literature published on teaching and learning in the COVID-19. The study indents to sketch the directions of the research topics and findings; it is not its purpose to provide an exhaustive review as in the ongoing crisis as new literature is still being published. The process of the data collection and analysis is described in Section 2. Section 3 describes the target areas and research topics of the selected publications, which Section 4 sketches key findings. Finally, Section 5 not only summarises the paper conclusions, but also provides suggestions for further research.

2. Method

The study uses a systematic literature review to gather and analyse relevant publications in order to draw conclusions about topics that have been of interest to the scientific community in the area of teaching and learning during the challenging conditions of the pandemic. Figure 1 details the selection process of the analysed papers.
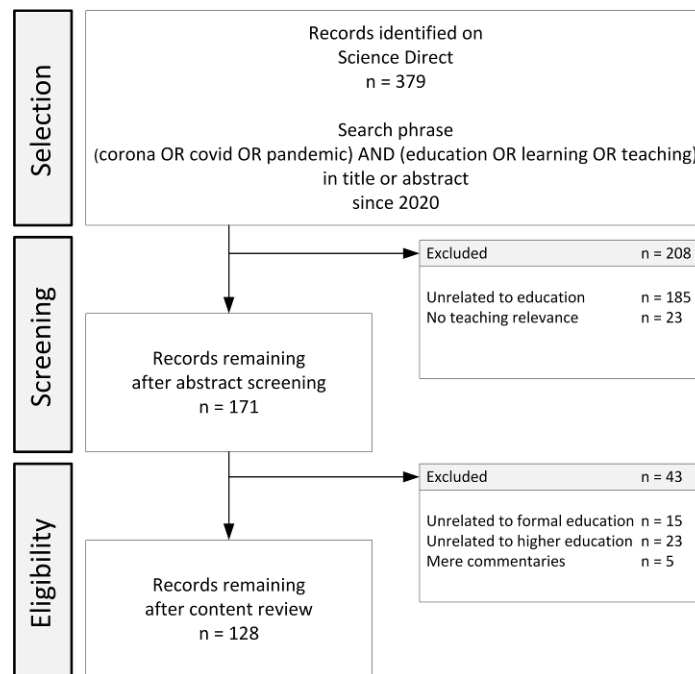
Figure 1 Data collection process in detail

The articles for the analysis were collected from the database ScienceDirect. ScienceDirect aggregates articles published by Elsevier across a number of disciplines including physical sciences and engineering, life sciences, health sciences, and social sciences and humanities. The platform was chosen due to its broad scope; it is expected as a mirror for publishing activities on different platforms. The search focused on journal papers, published between 2020 until May 2021 (when the collection was carried out), that included in their title or abstract keywords related to the COVID-19 crisis as well as the educational context (for exact search phrase, see Figure 1). The

paper abstracts were then screened regarding their relevance. A large number of papers had to be removed as they were concerned with different flavours of machine learning in connection to COVID. After the screening, the papers were categorised as to their target group and type of output, which meant that their content was more closely reviewed, leading to an exclusion of further papers because they were not directly related to the teaching/learning perspective (though they were concerned with education) or because they lacked research depth.

For the analysis in this paper, only studies from higher education were considered, hence excluding studies focusing on schools as well as discussions of educational landscape general or management of education. Besides providing a structured overview of the topics discussed in these papers, a summary of key findings (such as would be interested to educators) was created. This summary of findings in Section 4 was drawn mainly form papers with a general, discipline-independent focus in order to make it applicable to a broad academic audience.

3. Papers and topics

Of the selected 128 papers, 55 (42.97%) were published in 2020 and 73 (57.03%) were published in Spring 2021. The papers were categorised as to their target discipline, i.e. the discipline from which they drew study participants or related to in their study (see Table 1). Most of the journals were published in the areas of medicine, with focus on one of the many disciplines of this area. There were also many publications in nursing. Other areas did not have a pronounced number of publications, with a large number of studies being concerned with multiple target disciplines (e.g. across all disciplines on a particular institution) that were then categorised generally as "higher education". In most disciplines, the number of publications increased in 2021 in comparison to 2020; this comparison is allowable, since in both years, the publications only covered a proportion of the whole year (in 2020 Autumn, in 2021 Spring). By the end of 2021, of course, the publications can be expected to fully outstrip 2020.

Table 1 Identified target areas and their frequencies

| target discipline	in 2020	in 2021 (until 05/21)	total	relative change betw. years
medicine	35	32	67	-0.045
higher education	9	15	24	0.250
nursing	3	10	13	0.538
economics (incl. business administration)	1	4	5	0.600
pharmacy	1	2	3	0.333
languages	1	2	3	0.333
chemistry	0	2	2	1.000
engineering	0	2	2	1.000
health care	1	1	2	0.000
biology	1	0	1	-1.000
other (e.g. agriculture, aviation)	3	3	6	0.000

Furthermore, the papers were categorised as to their topics (see overview in Table 2). The categorisation focused on the intention and purpose of the papers (rather than formal criteria, e.g. methodology). The most common topic was the description of employed solutions and the discussion of their design, advantages, and disadvantage (case descriptions, 39 paper, 30.5%). While some papers intended to present successful designs as a solution blueprint, others simply shared the successes and challenges of their implementations of online learning. These papers employed different methods to collect data, such as surveys, interviews, design models, or even narrative approaches. Further common topic were studies of the experiences of the pandemic mode from the perspective of students, teachers, or both (altogether 36 papers, 28.13%). These mainly

employed surveys based on structured questionnaires to gather impressions of their target groups. A smaller number relied on qualitative instruments, such as diary studies and interviews.

Table 2 Identified topics and their frequencies

Topic	Description and notes	Frequency	Relative frequency
case description	descriptions of implemented solutions and designs	39	30.5%
experience - students	learning in the new mode (different areas measured)	23	18.0%
experience - teachers	teaching in the new mode (different areas measured)	11	8.59%
experience (students & teachers)	experience reports including students' and teachers' perspective	2	1.56%
impact	impact of the pandemic experience beyond the crisis	14	10.9%
experiential learning	mainly challenges form nursing and medical residents and fellows	9	7.03%
stress	stress and anxiety	6	4.69%
learning	impact on the learning output of students	6	4.69%
teaching in networks	sharing the teaching load in an interinstitutional teaching network	4	3.12%
readiness	preparedness of students and staff, incl. digital skills	3	2.34%
infrastructure	demands on and experience with institutional technical infrastructure	3	2.34%
overview	summative comparisons esp. btw. institutions	2	1.56%
other	e.g. technology acceptance, behaviour	6	4.69%

Case descriptions were prevalent in nearly all target disciplines, showing the great need to share the implementations and experiences on the one hand and the readiness to publish them on the other (see Figure 2). They were particularly common in medicine, but this target discipline was represented by a large number of publications overall. Students' experience reports were often drawn in studies across several disciplines, which was less the case for teachers' experiences.
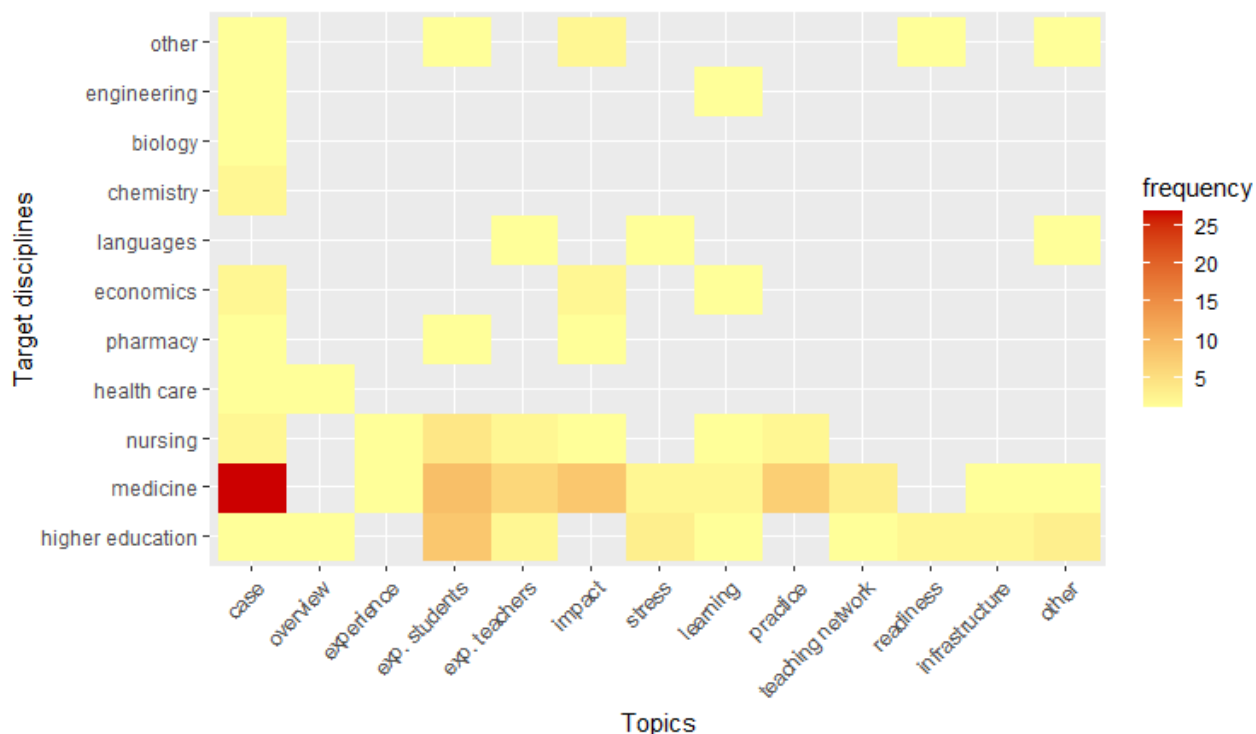
Figure 2 Distribution of topics by target discipline

A simple frequency analysis was also performed on the key words of the papers as well as on their abstracts (using text-mining methods). As is visible from the word clouds in Figure 3, terms

identifying the research as related to the COVID-19 crises (such as "covid-19", pandemic", and "coronavirus". While this is not surprising, it confirms that these papers were considered by their authors as being really specific to the special situation caused by the pandemic. Further visible is the crucial role that technology played as an educational enabler ("online", "virtual learning", "remote learning"). The high prevalence of medical papers is also visible in both word clouds as is the prevalence of surveys in the abstract word cloud as a method of inquiry.

Key words (word frequency > 2)

Abstract (word frequency > 5)

Figure 3 Word clouds of terms and phrases used as key-words and in abstracts

In the key-word word cloud, it is notable that the key words hardly overlapped. After cleaning the data, there were 353 unique key words of which only 67 occurred at least twice and only 16 the

occurred at least 5 times. On the one hand, this shows the breath of subtopics addressed by the papers, but on the other hand it also points to a lack of systematic key-word assignment.

4. Reported findings

The following is a summary of findings from selected categories with the aims to illustrate the lessons learned reported in the papers. These can be of interest for researchers who are choosing a research direction for their work as well as for educators looking for a quick overview of learnings from the crisis. In order to provide generic insights, mainly studies categorised as discipline-independent were chosen.

4.1. Readiness and influencing factors

A number of studies was concerned with students' readiness for the COVID-19 crisis as well as with factors that may have later influenced the students' performance in the virtual environment as well as their perception of the situation.

Of particular interest was the **infrastructural readiness** of the students, such as the availability of suitable technical equipment and sufficient technical connection. Especially students in developing countries were apparently not prepared for the lockdown (Dhahri et al., 2020). Besides technology, simply arranging a quiet working space was an issues for students learning from home, where the rest of the family was equally required to shelter due to lockdown rules (Kapasia et al., 2020). Lack of suitable infrastructure contributed to increased anxiety levels and acted as additional stressors (Dhahri et al., 2020).

Besides the existence of suitable infrastructure, students also required **digital skills** to participate fully in the new learning environment. While students are sometimes considered automatically "computer savvy" or "digital natives" (for critique and discussion see Helsper & Eynon, 2010), not all students were reported quite as ready to accept the challenge. Most notably younger (by age) and academically younger (by degree level) students report greater uncertainty regarding their digital skill and thus online learning readiness (Rafique et al., 2021; Tang et al., 2021). Rafique et al. (2021) found that female students' perception of their digital skills was significantly lower than for male students.

Besides digital skills, further abilities are needed in order to establish a **readiness for online learning**, a multi-dimensional skill-set that includes motivation and self-discipline, as well as ability to learn independently (Rafique et al., 2021). Similar to digital skills, students from higher-degree programmes (Tang et al., 2021) and older students (Rafique et al., 2021) appear to be much better able to deal with the challenges of online learning (without significant gender differences).

An interesting further skillset, specific to the pandemic, is suggested by Guo and Huang (2021): they point out that the crisis situation required **specific information-literacy skills**. They suggest that it was particularly necessary to be able to satisfy suddenly arising and pressing information needs through research, at the same time being able to identify reliable information sources. Particularly relevant were sources specifically related to the disease, including exact data on COVID-19 cases nationwide and worldwide. Furthermore, they point to the need to resist misinformation and false information.

4.2. Stress and anxiety

Not surprisingly, the sudden change of educational mode during the COVID-19 crisis has put many educational participants into difficult situations. Several studies in the review have examined the

effect of the COVID-19 crisis on stress-level, anxiety, and depression symptoms of staff and students.

During the pandemic, higher-education **students** have been experiencing a significant increase in in depressive symptoms, level of anxiety, and sleep disorders, according to a systematic literature review by Deng et al. (2021), although with different strength in different geographical regions. One reason for this difference could be technical infrastructure, lack of or problems with which acted as a palpable stressor (Dhahri et al., 2020) and which would hit students in less developed countries and regions harder, even excluding them from participating. Furthermore, undergraduate students seem to have suffered more that graduate students, with students in more advanced study-years of their undergraduate degree being hit harder (Deng et al., 2021). A reason for this could be an increase of students' self-doubt about own learning and especially examination performance (Dhahri et al., 2020) that would be a greater issue for students about to take their degree. As more advanced students were better able to cope with distance education (see discussion in Section 4.1), they would be less effected. Hasan & Bao (2020) describe the "fear of loosing an academic year" as a very specific stressor connected to own learning performance under these challenging circumstances. Female students were also more prone to suffer from anxiety during the COVID-19 educational situation as were students with financial problems or students living alone (Deng et al., 2021). In order to diminish the stress experiences by students, Srivastava et al. (2021) recommend focusing on created a connected and interactive learning environment, that provides social support and mentorship.

Teachers have also been a subject to additional stress factors during the COVID-19 crisis, notably high workload and anxiety about family health as well as loss of control over work, spill-over between work and home, stress of online teaching, irregular working hours, and financial worries (MacIntyre et al., 2020). MacIntyre et al. (2020) further examined the coping strategies of teachers, differentiating between "approach strategies" (active approaches towards chance and acceptance of a problem) and "avoidant strategies" (dysfunctional strategies tending towards denial or distraction). Among the teachers in their survey, approach strategies such as acceptance, planning, or reframing were more common and they correlated with positive psychological outcomes (e.g. well-being or personal growth).

The psychological response of teachers who applied avoidant strategies such as denial or behavioural disengagement tended towards negative outcomes (e.g. anger, anxiety, or sadness).

4.3. **Student experience**

A large number of studies have collected and analysed students experiences during the unusual learning settings in context of the pandemic, focusing on different facets of students' perception. Quantitative surveys were the most commonly used instrument, though interviews or diary studies were also employed to gain greater depth.

Some of the experiences in the pandemic were positive. Students of all levels who participated in a study by Tuma et al. (2021) reported feeling confident working in a virtual mode, attending as many or more lectures than they would in a presence more and were generally satisfied with their learning progress. Students form other studies also named perceived advantages of virtual learning; these included a comfortable learning environment as well as an overall convenience allowing for better attendance, smoothness of interaction between participants as well as a feeling of safety in face of the disease (Hussein et al., 2020; Shim & Lee, 2020).

Other studies report negative experiences and perceived disadvantages. Technical challenges, mainly related to inadequate technical equipment, problems with internet connections were reported in several studies (Hussein et al., 2020; Kapasia et al., 2020; Shim & Lee, 2020). Coupled with

difficulties with creating a suitable learning environment at home (Kapasia et al., 2020) and problems with concentration (Hussein et al., 2020; Shim & Lee, 2020), these could be a source of considerable frustration and anxiety. The lack of bilateral communication and hence perceived loss of support from instructors were also named (Hussein et al., 2020; Shim & Lee, 2020). Kapasia et al. (2020) point out that the negative factors often hit students vulnerable sectors of society hardest.

Some studies were concerned with factors that could mitigate the negative aspects. Rahiem (2021) studied sources of students' motivation for sustained learning and found that these were largely internal, with extrinsic motivation having little effect. The study describes three main motivation sources: (1) personal (e.g. curiosity, taking up challenges, self-determination), (2) social (deriving motivation through interaction with others), and (3) environmental (though positively manipulating the environment such as creating a suitable learning space, listening to music or self-limiting use of mobile phones). To support students, Buttler et al. (2021) suggest a caring and supportive interaction with instructors with demonstrated empathy besides a suitable quality of learning materials and suitable, not too stressful exam formats and schedules.

4.4. **Teaching experience**

Teacher experiences, too, were studies during the COVID-19 crisis, describing their perception as well as response to the situation.

Without question, the sudden shift placed a considerable strain on the instructors (Moser et al., 2021), though most worked towards complying with the required teaching mode. According to Oyediran et al. (2020), instructors with higher educational attainment and more teaching experience were better equipped to deal with the situation. Prior experience with online teaching also made the shift easier (Moser et al., 2021). When digital skills were a concern, these could have been bridged by online training, which appears to be suitable to quickly raise the level of online teaching skills (Swaminathan et al., 2021). Many teachers (though not all), engaged in active strategies for implementing a suitable teaching design to reach their learning goals (Daumiller et al., 2021; Moser et al., 2021). Christopher et al. (2020) especially point to instructors' efforts to "humanise" the virtual or remote learning environment by creating a caring spaces and nurturing "communitas" (a caring community) among teachers and students.

4.5. **Cases**

Case studies were the most common type of paper. The case papers typically provided a description of an implemented setting (sometimes merely experiential, sometimes formative as a best-practice suggestion) and a documentation of its advantages, disadvantages, and perceptions by different stakeholder groups (sometimes purely narrative, often based on systematic data collection and analysis). The concrete implementation reported in the case studies throughout the COVID-19 pandemic would require a deeper study than offered by this paper. However, their overall contributions are mainly centred around these common points:

- **Rapidity of implementation** (e.g. Chiou, 2020). The authors tend to point out the quickness and cheapness of the implementation they suggest and describe as this was of essence during the sudden change.

- **Use of established learning technologies** (Chiou, 2020; e.g. Mishra et al., 2020). In most case studies, there is hardly any originality in the applied technologies, all of which are well established in e-learning (e.g. Learning Mangement Systems, video conferencing, established SNS such as Facebook, established messenger such as WhatsApp, existing data sources such as YouTube). The use of such technologies was closely connected to the need

for a rapid solution as well as limitations of previous experience, neither of which allowed for a more innovative solution.

- **Innovation of course design.** While technologies may not be very original, the designs were a subject to considerable innovation from the point of view of the educators and their institutions. Enabling ongoing education meant the implementation of unusual teaching formats, such as new forms of presentation (Chang et al., 2021), teaching process innovation (Qiu et al., 2020), providing new digital learning material (McRoy et al., 2020), or even using the pandemic itself to teach some topics (Zhang & Ramse, 2021).

The reported findings from the descriptions of the outputs were comparable to the findings collected in dedicated experience studies (see Sections 4.3 and 4.4).

5. Conclusions

The purpose of this study was to provide a fist overview of the publishing activities related to teaching and learning changes caused by the COVID-19 crisis. To this purpose a systematic literature review was performed, covering published journal articles from 2020 until May 2021. The findings show that educators and researchers in nearly all disciplines were keen to explore and share the effects of the COVID-19 on the teaching and learning practice. Large portions of the sample were concerned with presenting concrete case studies as well as reporting the experience of concerned stakeholders, esp. students and instructors. The findings from the studies show that the sudden change of the teaching mode represented a considerable challenge to all stakeholders, partially causing serious problems (down to full exclusion from participation) and anxiety to students and teachers. Nevertheless, students and teachers met the challenges often using creative and active strategies to continue teaching and learning, though the actual impact on learning is yet unknown. The applied solutions used for teaching do not show a high-level of innovation with regard to technical solution, but are rather driven by innovation in teaching setting while using established technologies.

From point of view of e-learning research, the findings reported are not original, often describing concepts and points that already exist. Their value lies in the breath of application, providing a good foundation for meta-research. Researchers interested in sharing their experiences should carry out a good literature review in their discipline and focus on enriching existing findings.

The findings of the study are meant to give a first sketch both of research directions as well as current findings. For this reason, the data collection was limited and was necessarily further hampered by the fact that the crisis is not yet over and further publications must be expected. In order to get a deeper view, it would be necessary to repeat the literature review after the pandemic limitations have ended (also allowing extra time for publication processes). Then, it would be necessary to include further publishing platforms in order to indeed include all existing publications. Including conferences would also be of interested, as many e-learning conferences collected research explicitly related to the COVID-19 crisis. Furthermore, a more comprehensive review should be carried out in a team of researchers as the classification offers different facets that are not sufficiently answered by a single researcher.

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ON THE ISSUE OF MODELLING EDUCATIONAL PROCESSES

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Keywords

Education, modeling of the educational process, integral quality criterion

Abstract

The authors synthesized a mathematical model of the educational process. In the synthesis of this model, the integral criterion of the quality of education was used. The above-mentioned quality criterion is formed on the basis of the classical approach, referred to as "iterative learning". The set of characteristics is determined on the basis of the theory of fuzzy sets. The integration of several approaches to the synthesis of the mathematical model allowed the authors to significantly increase the level of modeling efficiency and objectivity in assessing the quality of education.

1. Introduction

As a rule, the essence of the Fourth Industrial Revolution is interpreted as a transition to the automated production of a huge range of goods, the management of which is implemented using

intelligent systems, as well as the design and creation of a global industrial network of things and services. Thus, the fourth industrial revolution is an unprecedented reorganization of production and its entire management system, which is being carried out in most economically developed and developing countries at an incredible pace at the moment. It is very likely that one of the consequences of the quadruple industrial revolution will be a significant decrease in the demand in the labor market for specialists whose labor functions can be successfully performed by various machines and robots controlled using modern intelligent systems. Consequently, the education systems of all countries of the world must adjust the goals and ways of achieving them, adapting to the new conditions. And, in turn, the study, development and justification of innovative approaches to assessing the quality of the performance of activities in the field of education and the effectiveness of the functioning of educational institutions, as well as relevant management tools and tools – an urgent task.

2. Purpose and methodology of the study

The purpose of this work is to form a set of adequate indicators of the effectiveness of educational process control based on mathematical models synthesized by the authors. The methodology of the study is the analysis and processing of a set of statistics on the implementation of a set of processes implemented in the field of education, as well as the modeling of such processes and forecasting of scenarios of events in the short and long term.

3. Aspects of the implementation of modeling processes in the field of education

Aspects of implementation of process modeling in the field of education. At one time, in publications (Yablochnikov, 2018, 2019), the authors proposed a mathematical model of the educational process, an attempt to modernize which was made in this article. The analysis of the existing methods and methods (Novikov, 1998; Hull, 1950; Deich, 1970; Bond, 2001; Roberts, 1976; Ryzhkova, 2015; Johns, 1971; Antomonov, 1974; Mitsel, 2010; Bolshakov, 2012) of determining the level of quality of education, implemented by the authors in works, makes it possible to conclude that excessive attention is paid to the set of indicators used for the above-mentioned purposes having an economic essence. focus. At the same time, indicators indicating the ability of graduates of higher education to adapt to dynamic changes in socio-economic conditions, including labor market requirements, are either ignored or they are not given decent attention. At the same time, in our opinion, adaptability is one of the most important indicators of the quality of education in the modern world of high rapidly developing technologies, in the conditions of universal digitalization and the Industrial Revolution 4.0. The above-mentioned drawback in the system of comprehensive assessment of the quality of educational services and the management of the field of education as a whole can be overcome by focusing on the evaluation by participants in educational processes of the final results of this activity. in particular, by processing the results of the implementation of the questionnaire of university graduates.

Here and everywhere, the success of learning the content of an educational program will be understood as the value $\xi(t) = \mu \cdot \eta(t)$ (Osovsky, 2002, p. 285) in which $\eta = \eta(t)$ satisfies equations (1) or (2), and the value μ is determined separately for each linguistic variable that determines the levels and aspects of assessing the quality of education:

$$\dot{\eta} = \lambda \eta (1 - \eta), \qquad (1)$$

$$\dot{\eta} = \lambda (1 - \eta), \qquad (2)$$

where $\eta = \eta(t)$ - part of the total educational program successfully mastered by the student expressed in academic hours (or in loans), λ is the intensity of training.

In this article, we will determine the value based on a comprehensive multi-criteria approach to assessing the quality of education. In particular, this approach assumes use as "internal" estimates of quality (assessment of quality of realization of pedagogical processes by teachers of some university, representatives of his administration, etc.), and "external estimates". For example, by "external" assessments we will mean: assessments of the level of quality of educational services provided by the university, displayed in various international and national ratings, as well as resulting from monitoring by third-party organizations; Assessment of the quality of education in terms of employers and the labour market. A similar assessment is formed when a university graduate is hired by establishing his initial level of pay. This may be the average salary of a graduate of a certain university in a certain region of the country or world. The relative number of unemployed graduates with an appropriate level of education is also such an estimate. The determination of the satisfaction of university graduates with the quality of their education can adequately perform similar evaluation functions.

In publications (Yablochnikov, 2018, 2019), the authors carefully considered aspects of the synthesis of belonging functions for fuzzy sets A_i, contributing to the formation of criteria for the quality of education, taking into account the opinion of the totality of employers, as well as for fuzzy sets B_j ("internal" assessments), C_k ("external assessments"), D_l (assessments of the satisfaction of university graduates with the quality of education).

So, in particular A_i, we define five sets for: $- A_1$ "high level of education according to employers", $- A_2$ "level of education according to employers above the average", $- A_3$ "average level of education according to employers", $- A_4$ "level of education according to employers below the average", $- A_5$ "low level of education according to employers". To build the "normalized" functions of belonging $\mu_{A_i}(x_1)$, two criteria were chosen: the average salary of university graduates and the relative number of university graduates who could not find a vacant job.

In accordance with the above criteria, at the first stage, belonging functions were synthesized $\mu_{A_{ij}}(x_{1j})$, where $i = \overline{1,5}$, $j = \overline{1,2}$. Here, for example, A_{31} – "the average level of education according to the criterion of wages", A_{12} – "the high level of education according to the criterion of unemployment". Then the functions

$$\mu_{A_i}(x_1) = \min\left\{\mu_{A_{i1}}(x_{11}), \mu_{A_{i2}}(x_{12})\right\}, \quad x_1 = \text{colon}(x_{11}, x_{12}).$$

It should be noted that the synthesis of $\mu_{A_{ij}}(x_{1j})$ and all other "normalized" functions of belonging is implemented in accordance with an algorithm similar to the algorithm of synthesis of

functions $\mu_{A_i}(x) = \exp\left(-\dfrac{(x-i)^2}{2\sigma_i^2}\right)$, described in sufficient detail in works (Yablochnikov, 2018).

The parameters of membership functions are determined on the basis of expert assessments using the tools of the SPSS software product "Nonlinear regression". The type of belonging functions may differ from the functions of terms of a linguistic variable discussed in works (Yablochnikov, 2018, 2019), but the general mechanism of their synthesis Ω remains the same.

Then the general level of quality of education, taking into account all the listed criteria, can be determined by producing fuzzy sets $F_s = A_i \times B_j \times C_k \times D_l$ with the corresponding belonging function, calculated using the T-norm

$$\tilde{\mu}_{F_i}(x) = \min\left\{\tilde{\mu}_{A_i}(x_1), \tilde{\mu}_{B_i}(x_2), \tilde{\mu}_{C_i}(x_3), \tilde{\mu}_{D_{l_i}}(x_4)\right\}, \quad \text{where} \quad i = 1,2,3,4,5, \quad l_1 = 1, \quad l_2 = 1,$$

$l_3 = 2$, $l_4 = 3$, $l_5 = 3$, $x = \text{colon}(x_1, x_2, x_3, x_4)$.

Instead of T-norm (3), you can use T-norm

$$\mu_{F_i}(x) = \mu_{A_i}(x_1) \cdot \mu_{B_i}(x_2) \cdot \mu_{C_i}(x_3) \cdot \mu_{D_{l_i}}(x_4), \tag{3}$$

and instead of "normalized" functions $\tilde{\mu}_{A_{ik}}(x)$, the values of "subnormal" functions of belonging can be used $\mu_{A_{ik}}(x)$:

$$\mu_{A_{ik}}(x) = \tilde{\mu}_{A_{ik}}(x) \Bigg/ \left(\sum_{j=1}^{5} \tilde{\mu}_{A_{jk}}(x)\right).$$

To do this, we define vectors $\xi = \text{colon}(\xi_1, \xi_2, \xi_3, \xi_4, \xi_5)$ that characterize the possibility of a university graduate belonging to the terms of a linguistic variable Ω - "level of quality of education" (from "high," to "above average", "middle", "below average" and "low").

It seems to us that the process of determining these characteristics based on the T-norm (3) and the "subnormal" functions of belonging is more resistant to various random effects and more adequate to realize the assessment of the quality of education. If it is necessary to evaluate the quality to the end of an unimplemented educational program, then this can be quite successfully implemented using a value $\eta(t)$ that, in fact, characterizes the share of the total program mastered by the student.

Thus, the mathematical model of the educational process proposed by us not only takes into account the multicriteriality of the approach to determining the quality of the received education, but also determines the algorithm for calculating the numerical value of a certain integral indicator, which allows you to practically evaluate the quality of education. However, the implementation of such models and calculations in practice requires considerable effort and time, as well as the presence of specific knowledge in the field of mathematics. To unify the mechanisms proposed above for assessing the quality of education, at least general approaches to the synthesis of belonging functions should be developed, the values of these functions should be tabulated, and one of the T-norms should be selected. Therefore, instead of complex mathematical calculations based on the theory of fuzzy sets, we suggest using simple indexes that adequately reflect the methodology of all the above reasoning and are determined in the least cost.

As was shown in the works (Yablochnikov, 2018, 2019), the most valuable in the totality of competences formed by university graduates due to the development of a certain educational program is their ability to adapt to changes in social, economic, technological and other conditions for the implementation of professional activities. Therefore, in our opinion, it makes sense to form a fairly simple generalized criterion for the level of adaptability of a university graduate, thereby supplementing the existing set of educational indices and indicators of various ratings. As such a criterion, we have previously proposed to use the formation antichrusticity index.

From the entire hierarchy of the antichrusticity index in this article, we will analyze only the so-called university antichrusticity index. To determine its numerical values, as well as to further take

into account the opinion of employers, we proposed to slightly modernize it. Namely, instead of the relative number of university graduates who could not find a job in the specialty, use the data obtained as a result of the questionnaire of employers by one of the leading information agencies, for example, Forbes (Kazmina, 2020):

$$IAU = \gamma_1 \cdot \frac{r_3}{r_2} + \gamma_2 \cdot R_1 + \gamma_3 \cdot R_2 + \gamma_4 \cdot U$$

(4)

In this formula, all indicators (except) characterize the quality of educational activity of a certain university, for which they determine, namely: r_3 – average monthly income of its graduate, U – a generalized indicator of satisfaction with the quality of higher education (determined on the basis of questionnaire data), R_1 – place of the university in the QS World University Rankings, R_2 – place of the university in the ranking of "100 best Russian universities according to Forbes", – γ_i weight factors, r_2 – average monthly income of the country's population (or region). At the same time, 1 point was awarded for the first place in the ranking. Further, the numerical value of this indicator decreased by 0.01 points for each subsequent place (second, third, etc.). The numerical values of the coefficients in formula (4) were determined by experts: $\gamma_1 \approx 0.15, \gamma_2 \approx 2.57, \gamma_3 \approx 0.55, \gamma_4 \approx 0.1$.

Table 2 shows the values of the first component of the vector ξ_1 and index ξ of ten Russian universities. In all calculations here, instead of the relative number of graduates who did not find a job in the specialty, we used the rating "100 best Russian universities according to Forbes" (Kazmina, 2020), and the average salaries of university graduates are taken from (SuperJob, 2020). Vector component values ξ were calculated based on T-norm (3) and "subnormal" membership functions, and averages were used to characterize the surveys.

Table 1. Comparative values of indicators characterizing the level of education quality

University	The first component of the vector ξ	IAU
MIPT	0.1960905	3.717855
MSU	0.176764178	3.681687
HSE	0.079668438	3.615699
MSTU	0.06291557	3.571349
MFI	0.052458706	3.546538
ITMO	0.044682011	3.534589
SPbSU	0.012552617	3.410868
MISIS	0.008950938	3.343177
NNIGU	0.008184187	3.337389
MPEI	0	3.279292

The determination coefficient between the values ξ and the first component of the vector turned out to be 0.8084 (the level of statistical significance of the presence of linear correlation was 0.0004). Therefore, the values of the indicators calculated on the basis of the application of the mathematical model we have proposed and the values of the anti-fraud index of universities are agreed.

4. Conclusions.

We synthesized a mathematical model of the educational process. This model uses an integral criterion for the quality of education, for the formation of which both the classical approach of

"iterative learning" (Novikov, 1998) and the definition of a set of indicators based on the theory of fuzzy sets are used. This integration of the two approaches allowed the authors to significantly increase the objectivity of the traditional criteria for assessing the quality of education and, having summarized them, to develop a kind of integrated system of assessments. In addition, in such an integral assessment of the quality of education, we were able to adequately take into account the results of the questionnaire of university graduates and their personal assessment of the quality of education received as a result of education on the corresponding educational program.

On the basis of the synthesized mathematical model, we proposed a new fairly simple indicator of the quality of education - the index of the antichrusticity of education. The formation antichrusticity index has a high degree of consistency with the above mathematical model. It allows you to take into account the degree of satisfaction with your education of university graduates. In our opinion, the numerical values of the antichrusticity index characterize not only the individual components of the collection of competencies of a graduate of a higher educational institution (for example, adaptability), but also the quality of education (or the quality of the provision of educational services) in general.

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TEACHING AT TERTIARY LEVEL IN THE TIME OF COVID-19 - AN EXPERIENCE REPORT

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Keywords

Abstract

Teaching under COVID-19 conditions is even more challenging than before. Students have a strong wish to finish their studies in time, regardless of the uneasy circumstances. This contribution describes the actions that had been done within a study program at the bachelor's degree to deal with the changed conditions under the current pandemic. Since the theme of the study program is in the field of information technology, a benefit is students' and teachers' affinity to digitization. The retention of the timetable originally designed for face-to-face lectures has proved successful, even during phases of pure distance teaching. Synchronous (dislocated but simultaneous) forms of teaching were used for the vast majority of lectures. Because of low acceptance by students, asynchronous forms were used only sparingly. Various scenarios for conducting exams were also devised. Some conversions caused by the pandemic will be maintained in the post-COVID-19 era. In this respect, the pandemic has accelerated the digitization of teaching,

1. Introduction

1.1. Goal

Teaching is a challenging task: In a way, lecturers need to *sell* their message (Eng, 2017), which means they must consider the situation of students in terms of pre-knowledge, capabilities, and also the time students can invest into the study. Otherwise, the teacher would not succeed. This became even more important during the current COVID-19 pandemic. With only very little time for preparation, the teaching/learning situation had to adapt to the new situation which strictly forbids students to stick together in the classroom.

This paper documents how teaching changed in a particular bachelor's degree study program at the author's institution (SE, 2021). It shows the influence of the COVID-19 pandemic on the way we teach, how we do individual consultant meetings, and how we grade students. Since the theme of the study program is in the field of information technology, one of our benefits is the student's and teacher's affinity to digitization - the introduction of new tools is quite easy here. Therefore, it might be of interest for others to see what we have done and how it performed. Also, we expect that even after this pandemic, things will not be as before. Some hurdles on the way to a more digitized world have already been taken and it would make no sense to ignore the gained experiences and potential of new tools for future use after the pandemic.

1.2. Methods Used

Most of the changes made are simply a necessity. The only alternative to distance learning was to give up and resume the study program after the end of the pandemic. In the beginning, it seemed to be an option to postpone lessons and give them in the summer. But after a few months, it turned out that this exceptional situation will stay for a much longer period. MED (2020) documents the public opinion at this time about the pandemic's duration.

The effect of the changes was *measured* mainly from the feedback students gave. Besides the traditional feedback from students during lessons or immediately after lessons, our quality assurance system provides several feedbacks loops whose contents have to be documented:

- *Meetings during the semester:* In the mid of semesters the head of the study program meets with a delegation from students' class. They walk through all the subjects from this semester in addition to the students' situation in general. Its purpose is to get an understanding of how the students experience their study and to be able to react in case of problems.

- *Evaluation at the end of the semester:* Students are invited to evaluate every subject at the end of a semester. This is written feedback and it is anonymous. Students fill in an electronic form. This form covers the content and difficulty of the subject together with the performance of the teacher. Another topic here is the evaluation of the whole study program - which is a valuable source for our purpose too.

Another source is averaged grades, but so far there are only two to three semesters under COVID-19 conditions that seem to be unsound for a profound comparison.

1.3. Related Work

Extensive literature exists on teaching under COVID-19 conditions. For example, Mahmood (2021) describes appropriate and practical strategies for online teaching in higher education. She does not consider asynchronous forms of learning. Pokhrel et al. (2021) provide a report on the impact of the COVID-19 pandemic on online teaching and learning of various papers on the status of 2020. Sintema, E. J. (2020) discusses the impact of COVID-19 on teaching in STEM subjects in Zambia. His findings are based on interviews with heads of departments at a public secondary school Results of this study revealed that there is likely to be a drop in the pass percentage of secondary school students caused by COVID-19.

Iglesias-Pradas et al. (2021) analyze the spontaneous movement toward distance learning forced by the pandemic. They examine study programs at the School of Telecommunication Engineering (Universidad Politécnica de Madrid). Interestingly, their results show an increase in students' academic performance in distance learning.

1.4. Baseline Situation

The focus of the study program is on information technology, specifically, computer science. Students learn how to build software; hence they are well experienced how to handle a computer. They own a reasonably good computer and have an internet connection of good quality. Similar holds for the teaching staff.

For many years this study program is offered in two types: Traditional full-time and part-time. Especially for the part-timers, some screencasts exist that cover teaching content to be taught in asynchronous mode. At the beginning of the pandemic, these screencasts seemed to be a proper alternative to a conventional classroom, even for the group of full-time students.

1.5. History-So Far

This is a brief retrospective view of how COVID-19 influenced teaching in our study program.

At the beginning of the year 2020, the virus seemed to be far away, and that its influence on the western world would, but be similar to other viruses like Ebola. But at the end of February things changed.

First, we only avoided handshakes, then we kept some physical distance in meetings. Teaching was not touched by this at all until the middle of March.

Our enrolment process defines application interviews with the applicants. On the 9th of March, it was the last time we did them in face-to-face meetings.

On the 10th of March at 15:30 we were informed by our headquarters that we may not do any more contact lessons from the 11th of March on. This resulted in some very turbulent days. The author had to do some lessons the next day. After some thought, he decided to use discord for online teaching. To the students, these first days must have looked like chaos, since different teachers selected different systems for their lessons, like Zoom, and MS Teams. Helmold (2021, Chapter 14.2) gives a survey of such tools. This immediate transition to distance learning was necessary, but it was very unplanned because there was absolutely no time for coordination. Things became even worse: We had to do these lessons from our now empty classrooms. We walked around with laptops, headsets, and other stuff looking for an empty room that was reasonably equipped. It turned out that progress in lessons was not the same as in traditional presence situations - the tools we used were not proper, and also the students were not prepared for the switch to distance learning. So, we choose a combination of virtual meetings with class, screencasts, and reading courses. In some cases, the virtual meetings were only used for Q&A sessions about the content of the asynchronous learning material. The idea was to reduce the time students and teachers have to stay in front of a computer, and with a headset on for their lessons. This was not honored by at least a substantial mass of students as some of them were not willing to spend time for their studies outside of the planned timetable. The general idea of asynchronous teaching was not appreciated by some of the students.

On the 13th of March, this was a Friday, our headquarters announced, that the whole teaching staff must switch to home office starting from the upcoming Sunday. All planned exams had to be canceled. We were encouraged to carry any equipment with us which might be needed for homeschooling like computers, monitors, and headsets.

Fortunately, on the next business day, it was Monday, 16th March, our IT services came up with a well-prepared technical solution for synchronous distance teaching using MS Teams. This was a great simplification: One single tool for teaching, no need for the students to switch software between lessons within the same day. Teachers can share know-how and ideas on how to use this software. At the moment of this writing (June 2021), we still use MS Teams and there is no intention to replace it.

This setup did not change during the remaining part of the summer semester. Concerning teaching, everything was done in distance learning from the home office on both sides, students and teachers. Also, the exams at the end of the semester were held with MS Teams. For some of the exams, we used the *exam object* in Moodle but supervised the students with MS Teams.

Only the degree exams (bachelors and masters) were realized in face-to-face meetings.

At the time we started the winter semester, which was mid of September for part-timers to begin of October for full-time students, the campus was open for both students and teachers. We came up with a new idea: a hybrid teaching model (Martyn, 2003; EDIN, 2020). Lessons were held on-

campus but streamed with MS Teams too. This seemed to be a proper solution, but remote participants complained about low sound quality due to improper microphone equipment, and also low image quality when teachers used the traditional blackboard. Another problem was that more and more students stayed at home - teachers did their lessons in almost empty classrooms.

The active virus cases increased during the following weeks. Therefore, at the beginning of November 2020, we had once again switch to a full-distance learning mode combined with home office. This included the exams too. Until now, nothing has changed.

To conclude this section: Except for a few weeks, students and teachers stayed at home for more than a year now. This is quite an issue for the fresher's class since they did not have much time to stick together traditionally at the beginning of their study.

2. Lessons Learned

The pandemic surprised us, most of us did not expect it to reach Europe at all. Therefore, we were not prepared for it. What can we learn from this development in concern for the way we learn and teach? Here we present some of the lessons we learned from it:

2.1. Need for Good Technical Equipment

This is essential for a move to distance learning. But the list of items needed is not a very long one. On the teacher's side a reasonably good laptop computer, ideally with drawing functions to replace a blackboard plus a suitable software to annotate documents in general and slides, in particular, do the job. Both students and teachers need a webcam, a headset or similar, and a moderate-rated internet connection. Fortunately, our teaching staff was already very well equipped at the beginning of the pandemic. There was only some lack of webcams, which we compensated with the built-in cameras from the laptop computers. Very important is a dedicated room without distraction, but with comfortable office furniture due to the long time periods, one has to stay there. The requirements for students are lower: tablet functionality is not necessary, and a webcam is only required for exams. The camera of a smartphone is sufficient as a minimum requirement here. However, distance learning creates new problems for students, especially concerning the setup of special software. With face-to-face teaching, fixing incorrectly installed or configured software can be done quickly and easily on-site in individual cases. In distance mode, detailed instructions for setting up the required software help. FAQs on the most common problems are also useful and should be maintained on an ongoing basis. Furthermore, additional consulting appointments were introduced. These were again carried out online. Their goal was to solve individual setup problems. The function *Share content* of MS Teams was helpful here so that the teacher can view the screen of students.

2.2. Strictly Stick to the Planned Timetable

At the beginning of the distance learning period, we expected to do some changes to the timetable. Reasons for this were (a) to do laboratory lessons only once at the same time for otherwise partitioned groups of students, and (b) to consider the lack of traveling from home to the classrooms which would allow a more flexible timetable. This turned out to be a not-so-good idea. First, if one lecturer would do this, our very tight and well-planned timetable would immediately fall apart because it would influence a lot of other lessons from other lecturers. Second, it would be much harder, to return from distance learning mode back to traditional presence learning mode.

2.3. Do not Overestimate the Power of Digitized Learning Scenarios

Over the last few years, the author prepared essential parts of his teaching content as screencasts. They were designed to be used in the part-time study program because there the timetable does not include enough room for all the lessons. Therefore, some of the content has to be taught in asynchronous distance mode for the part-timers. During the summer semester of the year 2020, the author invested substantial effort to create even more screencasts. The idea was, to increase the asynchronous teaching and to enable the students more self-determined learning in respect of time. As has been mentioned above, at least our students expect teaching to be implemented mainly in scenarios close to traditional classrooms. In the next semester, the winter semester 2020, the author reduced the use of screencasts to the pre-pandemic level for part-time students. For full-time students, those screencasts are viewed as background material only.

2.4. Meetings with Students Outside of Lessons

Sometimes, students ask for individual consulting in their affairs. Usually, our teaching staff does not offer traditional consultation hours, we use email to arrange personalized meetings. A lot of such questions from students can be completely handled by using emails. If this is not adequate, we now arrange meetings in MS Teams, which turned out to be quite efficient - there is no need for the students to travel.

2.5. Exams

Exams happen sparsely during the semester but occur mainly at the end of it. How to handle them in distance mode? We were permitted to meet with only a few students in person at a time and with some security restrictions like minimum distance, protective masks, disinfection, tracking. But the risk of infection with COVID-19 impeded this type for exams in most cases. Once again, we had to find individual solutions:

- *Oral exams* work fine in distance mode but only for a small number of students. Student's use of illegal aids could easily be discovered. But the whole class is blocked for other types of exams at the duration of such oral exams. This can last for some days which is not acceptable for the final exams at the end of the semester. In periods of hard lock-down, we even did the final bachelor's and master's exams in distance mode. This is better than deferring these exams to a later date.

- *Written exams on paper:* Here the class meets for the exam in a *meeting* in MS Teams. Students write the exam on paper and submit scans from the sheets of paper by email or upload them to the e-learning platform (Moodle in our case). We usually divide a class into several *meetings* and assign an individual supervisor to each meeting. The option of *open-book exams* (Johanns et al., 2017) was discussed briefly but not considered to be sensible in most of our cases. Written exams on paper have a reasonable effort. We use this type usually for exams in programming. A never-ending point of discussion here is the degree of supervision during the exam. A minimum requirement is a surveillance with audio and video. Even after more than a year of distance learning we still have not formed a unified list of requirements that the students accept.

- *Written exams within the e-learning platform* avoid the need for paper, they are done online, together with the necessary supervision--as has been described above. Some of these exams contain questions with textual answers, but others use questions of type multiple-choice only. This works in combination with an amount of pressure of time to avoid illegal communication between students during the exam.

Grades improved slightly under COVID-19: weighted by ECTS points, the average in winter semester 2020/2021 was 2.12 (1 best grade, 5 failed), while in winter semester 2019/2020 it was 2.24. However, the courses were rated as slightly more difficult by the students: On a scale of -2 (much too easy) to +2 (much too difficult), the mean value for the winter semester 2021/2020 was 0.27, while in the winter semester 2019/2020 this value was 0.12.
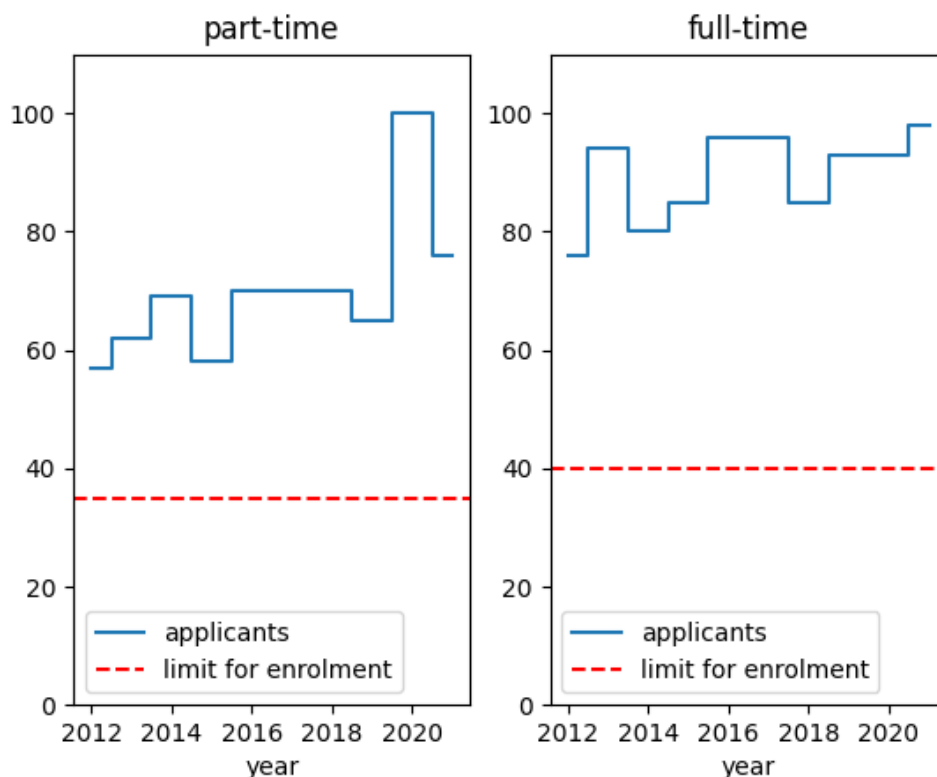

Figure 1: Number of applicants per year, separated by part-time and full-time study type.

2.6. Applicants

Our number of fresher's students per year is limited. Consequently, we need to select our new students from the applicants which leads to a laborious process including interviews with every applicant. It is important to have enough applicants per year. If the number of applicants is above the limit, we can select. This is the reason why we carefully observe the number of applicants per year. A drop in these figures would cause us to invest more effort in marketing.

As can be seen from Figure 1, in the year 2020 we had a rise of applicants in the part-time study program, while in the full-time program the number of applicants stayed stable. The dotted line gives the maximum number of fresh students per year. The reason for the markable increase for the part-time program is unknown to us. It might depend on COVID-19: Some working people might have had the idea that in a period of shutdown and unemployment a part-time study would suit. However, there are virtually no unemployed people among the applicants for the part-time study program. At the time of this writing, it turns out that the rise in the number of applicants was a one-time peak. For the year 2021, we expect to end with applicants numbered similar to the years before 2020. Currently, the data for 2021 given in Figure 1 is only an estimate based on current applications, as applications are accepted until the end of August.

The increased number of applicants in 2020 has reinforced an effect that has been going on for several years: fewer and fewer applicants to this study program have prior knowledge of information technology. This has an impact on the number of dropouts. Table 1 shows the current

dropout rate, separated by the year of entry of the students. The younger two classes already have more dropouts than the graduating class.

Table 1: Dropout rate per class in the part-time study program

Class (year of entry)	Dropout rate
2020	28 %
2019	32 %
2018	21 %

3. Conclusion - Expected Impact on Post-COVID-19 Era

The ideas presented above enabled us to uphold the study program under the conditions of the pandemic. Up to now, students did not have any delays in the progress of their studies.

No question, when the current pandemic is over, some things we introduced will remain and will sustainably change the way we learn and teach. Even after the first semester under COVID-19 conditions, our part-time students demanded a prolongation of distance learning at least for some parts of the semester. The reason for this is obvious: They want to avoid the travel from their working place or their home to our institution. In the age of information society and digitization, it seems anachronistic to stick with classical presence learning only. In this way, the pandemic has accelerated the trend to use distance learning methods.

Another thing is exams: At the moment, we do not see a good alternative to classic exams. The only exception is oral exams.

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VIRTUAL COLLABORATIVE LEARNING DURING COVID19 – LESSONS LEARNED IN PRACTICE

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Abstract

Teaching and learning have changed significantly due to the impact of the COVID19 pandemic, even for modules that were already delivered primarily digitally before the pandemic. Students have minimal social interaction in the context of higher education and face additional challenges outside of the university. This leads to a lack of engagement and also higher drop-out rates. Above all, the lower level of communication with instructors and the course offerings created during the rush into e-learning in early 2020 are intensively discussed as reasons. These effects were also felt in the hybrid modules based on the Virtual Collaborative Learning (VCL) framework. The following field report takes up the lessons learned just before and during the COVID19 pandemic and reflects on them within the scope of the four design dimensions of VCL: professional pedagogical support, technical platform, authentic task design, and learning analytics support. Particularly during the summer semester of 2020, we could observe a certain decrease in student engagement. Thus, adjustments were made to each design dimension during the pandemic that, in combination, showed an improvement in student engagement. In particular, good timing in communication and constant accessibility of supervisors are perceived as helpful. But also optimal conditions of the technical platform concerning tools, usability, and usefulness as well as the anchoring of social interactions in the instructional design were seen as conducive to engagement. Finally, Learning Analytics offers another perspective that leads to social interaction. Nevertheless, rapid iterative adaptation is associated with high effort for teachers, which needs to be reduced through the ongoing improvement of the four design dimensions.

1. Introduction

Learning and teaching have changed rapidly with the emergence of the COVID19 pandemic, but the change is far from complete. The rush into e-learning has made completing a semester a real challenge for students and teachers. In particular, international exchange and student mobility are affected, as well as social life, and thus teaching, and learning in presence is simply not possible for many students due to public restrictions and health necessary measures. These constraints make it uncertain whether the online services that universities are currently creating and expanding have the potential to re-engage students and keep the university as an institution or shift it further into the private education and education provider sectors (Banki, 2021; Barnes, 2020). For example, in a survey conducted by British Columbia University, 69% of students indicated that they were negatively impacted in their engagement with the module due to the remote teaching caused by the

pandemic. The main reason given was the loss of regular communication with lecturers (Banki, 2021). This was also perceived within the scope of the Virtual Collaborative Learning (VCL) modules who transfer learning in small groups into the virtual space (Jödicke, Bukvova & Schoop, 2014). VCL is a constructivist teaching arrangement based on the situational and problem-based learning approach, that uses authentic case studies (Schoop et al., 2021; Kopp, Hasenbein & Mandl 2012). This paper reflects on the adjustments of the four design dimensions just before and during the COVID19 pandemic and their impact on teaching and learning. The focus of the reflection is an inter-institutional bachelor module, a local master module and an international master module. All of them are based on the VCL framework and were held in the winter semester 2020/2021 or summer semesters 2020 and 2021.

2. The VCL Framework

VCL arrangements are based on four design dimensions for quality assurance. These are: "professionalized pedagogical support" provided by specially qualified e-tutors; "realistic cases and work tasks" to achieve maximum interaction among team members; a "technical platform" that provides the necessary functionality for collaborative work; and "learning analytics & information visualization". Intensively considering these design dimensions allows the development of clearly focused design measures to facilitate collaborative learning processes (Schoop, Clauss & Safavi, 2020).

Professionalized pedagogical support concepts

In VCL scenarios, learning processes are continuously supported by intragroup e-tutors, which are part of the group's communication processes but do not directly contribute to the development of results. Rather, they accompany the learning and collaboration processes of the groups and fulfill the following sub-tasks: By answering questions and providing *professional support* on tasks and content, the e-tutors help to reduce ambiguities and misunderstandings. They also provide recommendations for complementary scientific literature and materials as well as advice on suitable work techniques and methods. On request, they provide explanations of the tasks and support the students by providing feedback on the group-internal work processes and the quality of the assignment being processed. To promote ICT and collaboration competences as a central learning outcome, e-tutors provide *individual personal and group support* on the organization of learning activities by giving formative feedback on collaborative processes. To reduce negative group dynamic effects, e-tutors engage in preventive conflict management. They focus on the early identification of learning problems of the individual and the group. For working together virtually on a collaboration platform, the *technical support* is crucial. e-tutors support the selection of suitable tools and provide recommendations. They are also available to help with technical difficulties and should be familiar with typical problems. *Support in the assessment of performance*: As the e-tutors are directly integrated into groups, they have a comprehensive insight into intra-group performance, which they document in special observation sheets. These can then be used by the responsible teachers to deepen the formative assessment of individual and group performance. The organizational effort in virtual group learning settings is high. For lowering these efforts, e-tutors monitor all relevant submissions and deadlines and provide *organizational support*. Furthermore, they are the only contact person for the group for organizational questions. This allows to collect and cluster questions before forwarding them to the responsible teachers or domain experts. The preliminary coordination is done on the internal e-tutor channel, which helps to avoid redundant questions and to forward only complex questions to the teachers. The common contact person also prevents ambiguities resulting from different teachers being contacted by the learning teams, especially in international settings with mixed students from different institutions.

This broad spectrum of tasks and competencies calls for the comprehensive professional qualification of the e-tutors. This is provided in a specially developed, one-semester qualification module for master's students, which is designed as a blended learning arrangement with a subsequent practical phase based on a complex case study (Jödicke et al., 2012).

Realistic cases and work tasks

In VCL arrangements as a formal learning setting, participants have to complete assignments. These assignments are designed according to the approach of constructivism and problem-based and case-based learning (Schoop et al., 2021; Kopp, Hasenbein & Mandl 2012). Realistic case studies situated in fictional companies dealing with current economic trends such as digitalization or climate change are used. These should contain career-oriented knowledge and thus have a close connection to the students' future work tasks. Therefore, instead of factual knowledge, they primarily address conceptual knowledge, which is about open solutions that need to be developed through discussion and exchange. Thus, it is essential for the design of the tasks that they require multi-perspective input for the solution, which allows the learners to learn from each other. This requires active communication. The participants should distribute and solve the tasks as self-organized as possible. It changes the importance of the learning staff who step back from their traditional teacher-centric leadership role by acting as student-focused learning facilitators (Tawileh, Bukvova, & Schoop, 2013).

Technical platform

The systematic selection of the work platform is crucial to ensure that interactive, case-based learning in cross-location, mixed small groups in virtual space runs seamlessly and that the participants have flexibility in terms of temporal (synchronous, asynchronous) and local (mobile, stationary) access. Consequently, a powerful collaboration platform is required as a basis. This platform needs to provide suitable function modules for the communication and coordination of group work as well as for the execution of individual work assignments. To establish the reference to realistic application scenarios, the Microsoft 365 application - MS Teams, which is widely used in companies, is currently used as a collaborative working platform within our VCL projects (Schoop, Clauss & Safavi, 2020).

Learning analytics & information visualization

Social learning analytics (SLA) are focused on the semi-automated analysis of social behavior within virtual groups and recurring patterns of interaction that characterize effective learning and collaboration processes (Shum & Ferguson, 2012). SLA aim to improve learning and support processes by systematically measuring learners' data output and traces. Each activity of learners on the platform can be analyzed and mapped in dashboards by monitoring their data traces using SLA tools specifically designed for VCL support. Furthermore, the data is also used for chatbots, which are active conversational agents providing relevant information in dialog form. This allows that data traces related to user activities can be pre-aggregated and visualized for e-tutors and administrators to facilitate formative evaluation. In this way, the daily, time-consuming learning process support provided by e-tutors can be reduced in terms of resources and a higher level of support can be designed to more clearly and objectively justified decisions for specific didactic interventions. This data-driven information supports two sides (Schoop et al., 2021):

- The e-tutors can be alerted to unwanted developments in the project management, but also to poor interaction in the groups, which could hinder the achievement of the collaborative learning objectives.

- Individual learning groups can be shown the progress of their performance over time or their position in relation to the other groups.

3. VCLs held during COVID19

Basics of Community Management: The course is designed as a hybrid flipped classroom scenario and does not require a cooperating institution. It is focused on advanced diploma students and master's students from the fields of study: Business Administration, Economics, Business Education, Business Information Systems and Business Engineering. Since 2017, the learning objectives of the module are focused on the acquisition of theoretical and methodological knowledge as well as the development of the vocational action competencies acquired through the collaborative and practical application of various previously gained skills in a realistic scenario. The module's general learning objectives are, that students know and understand the process of interaction and group work processes in virtual communities. They are able to support individual and cooperative virtual learning and working processes in formal and informal communities, encouraging people to continue active participation, and recognizing as well as resolving conflict situations within communities. Furthermore, they are able to assess the performance of community members on the basis of predefined observation criteria and, if necessary, derive intervention measures from this. Our e-tutors as professionalized support in VCL programs are qualified in this module.

In the preparation phase, the participants learn theoretical content by using e-lectures and test their acquired knowledge with additional online self-tests. In the subsequent VCL project, participants work collaboratively for four weeks on a realistic problem in a fictitious international company that wants to build a company-wide knowledge and learning community. Afterwards, the participants deepen their knowledge in joint workshops on the basis of the experience gained from the virtual teamwork. In the winter semester 2020/2021, 32 students took part in the module. They were divided into eight groups during the VCL phase. No students dropped out.

Collaboration in the virtual Classroom: Within the scope of the before explained VCL framework the storyline was recently developed in spring 2020. It deals with a fictitious multinational gas and oil company with core business in the Middle East that has hired a small team of specialists from Iran and Germany to develop project ideas for a green and sustainable transformation of a holding company. The international master module has been held during the summer semesters 2020 and 2021 as a pure online event which offers a basis for a comparison during the evolvement of the COVID19 pandemic. The module begins with a virtual kickoff event via MS Teams, followed by a three-week virtual phase with three tasks, each lasting one week. Afterwards, the groups go through the second virtual phase according to the same scheme as the first one and present their final results in another synchronous online event. After the end of the joint work, the students are given the task to individually reflect on their group work. Within this module, the internationally mixed teams of 5 to 6 members have to assign the roles project manager, project reporter, researcher, and industrial expert. Only the role of the industrial expert has been changed from 2020 (directly participating as team member) to 2021(giving advice to the groups only from an external perspective). The module grants 5 ECTS at TUD and equal recognition at Shiraz University (Clauss, Altmann & Schoop, 2020). It is attended by students from TU Dresden and Shiraz University. The number of participants varied between 40 and 50 students in the two semesters. In 2020, at the beginning of the COVID19 pandemic, there was a significantly higher drop-out rate among German students. From the beginning of the course to the deadline for enrollment for the exam, 11 students dropped out of the course, which was often attributed to a heavier workload in the first pandemic semester. Besides the TU Dresden and Shiraz University students, also 9 (in 2020) or 13 (in 2021) industrial experts from the Iranian processing and mining industries (summer 2020), or electrical engineering branch (2021) have participated in addition.

Case-based Learning in the Virtual Classroom: The inter-institutional bachelor's module is a collaboration between TU Dresden and HTW Dresden (University of Applied Sciences). The participants were part of a project team of the fictive company Dresden NRG and had as their overall goal the development of a platform business model for electro mobility in Dresden. Each team consisted of equal numbers of students from both institutions. Due to COVID19, the module was held completely digitally and was divided into a total of 9 task packages. The participants solved the assignments in the virtual phases, taking into account the roles (project manager, project reporter, researcher) they had assigned themselves within the group. In addition to the kickoff event, the module was complemented by 3 other synchronous events. An interim and final presentation of the results as well as a final workshop in which the groups were given a transfer task to test their self-developed platform business model on the basis of a customer journey from the customer's point of view. The tasks in the 3 virtual phases began with a newly introduced "familiarization week" in which the participants did not yet have to complete any grade-relevant tasks, but were supposed to get to know their new learning platform and their new team members. In the next step the groups had to develop a joint group work contract and the create a common ontology as well as a PESTLE analysis on e-mobility in Dresden. This was followed by the interim presentation via MS Teams where the first results were commented on by a virtual jury consisting of three professors and a Ph.D. student. In the second virtual phase, the potential of the business idea has been examined according to the business model canvas. Further tasks concerned the legal form and remuneration models, the results were presented in a second synchronous, video-conference based workshop. Followed by 2 final collaborative team tasks on the topic of motivation & revenue theories and collective bargaining agreements as well as other framework conditions of the business idea, the groups solved the transfer task in the beforementioned final workshop (Schoop et al., 2021). The module grants 5 ECTS. In winter semester 2020/2021, 35 students from each institution attended the module. The students were divided into a total of 12 groups with 5 to 6 members and supervised by 4 experienced e-tutors, with each e-tutor supervising 3 groups. During this module, no dropouts were registered.

4. COVID19 and the influence on learning and teaching - Lessons learned in practice

Technical Platform: The need for a change of the technical platform, away from the open-source solution Elgg was initially derived as the most urgent need for action from the perspective of the students in an investigation of the international VCL module developed in 2019 (Altmann & Clauss, 2020). The change to MS Teams was perceived by teachers and students as a significant improvement in communication and collaboration, not least because of the unification of all tools necessary for virtual collaboration in the platform. This allows a better comprehensive support, guidance, and fairer grading, as all student activities are visible to the instructors. The entry for students and teachers is low-threshold because in the working environment of MS Teams many already known tools from the Microsoft office range are offered and supported by tutorials of the manufacturer. Besides practical experience with an authentic environment which with some degree of certainty they might meet later after graduation in business, the use of MS Teams offers students a good basis for collaboration and, due to the low entry barriers, allows them to focus on solving content-related rather than technical problems right from the start.

Realistic task design in combination with multiple teaching methods, tools, and means of communication broadens the spectrum of interaction and increases motivation in the VCL modules, which was reflected, for example, in the above-average commitment of the students in the processing of the tasks of the case studies. It also helps to implement the tools to be used in the instructional design of the tasks. Furthermore, a virtual meeting with the e-tutor in the first week of

the collaboration, which is anchored in the assignment, has proven useful to clarify initial questions and minimize uncertainties. Therefore, in the second virtual Corona semester (winter 2020/2021), a virtual orientation week was anchored in the instructional design, before the case-based collaborative learning started. The students did not yet receive any content related assignments but the task of familiarizing themselves with the learning platform, holding a first orientation team meeting and get acquainted with their e-tutor. This orientation week extends the case study by one week, but provides space for students to meet. Furthermore, the instructional design should be very clearly formulated, as there are fewer situations for informal exchange with the instructors in a purely online event. Thus, the hurdle to start communication in the virtual space is higher than in the analog classroom. In addition, to ensure a fair group structure, dropouts should also receive special consideration. While it is difficult to avoid that students leave the course shortly after it has started, the overall course design and a time schedule taking into account the period of official examination enrollment should ensure that the groups are no longer endangered by early dropouts. This can be achieved, for example, by an early exam enrollment in combination with the aforementioned familiarization week, so that the groups already know each other at the beginning of the grade-relevant work. The course instructor can compensate dropouts by timely merging the students left over to new teams, thus avoiding lasting capacity problems which would lead to disadvantages in team performance and assessment.

Professional pedagogical support should offer quick responses to requests as this was perceived as beneficial by teachers as well as learners. Students see the timing in answering their questions as an important factor to be met. But also in the case of several tutors in one course, as it is given in the VCL, quick response and continuous availability of the supervisor are seen as important prerequisites for the quality of their pedagogical support in the virtual collaborative setting. Furthermore, the majority of the e-tutors would like to have a regular consultation with the course supervisor to discuss the tasks of the next virtual work phases and thus ensure a more consistent quality of support and feedback by the e-tutors. This has been realized for the first time in the module Collaboration in the Virtual Classroom 2021 and reduced the individual coordination between e-tutors and course supervisor significantly, especially in the first virtual phase where groups and e-tutors have a higher amount of questions and feedback demand. This can be addressed by using a scaffolding approach with a high intensity of feedback at the beginning and stepwise reduction. By using a combination of formative and summative assessment, students show good acceptance of the assessment and allow differences to be captured, even within a group, so that free riders may well receive a lower grade than their group members. The feeling that effort is worthwhile and missing engagement is also perceived has a positive effect on the group atmosphere.

Learning analytics support has provided significant improvement in student and instructor perceptions, particularly through the recently implemented chatbot. The chatbot displays quantitative data on learner performance and group activity and provides indicators for the e-tutors to support their decisions on how and when to intervene as well as informing the students about their performance and by this triggering self-reflection. This gives students another perspective in the virtual environment about how their group performs compared to the others at this moment. Furthermore, e-tutors can support their groups in a goal-oriented manner and identify upcoming problems in group work at an early stage and accordingly intervene timely if necessary. For example, the social loafing effect may be diminished as participants become aware that their missing effort is being noticed. In a survey on the most helpful feedback of the module case-based learning in the virtual classroom, almost a quarter of the students (16) stated that they found the chatbot to be the most valuable feedback (n=69).

In addition to the previously explained positive effects of the design, it is also necessary to illuminate the downsides. The sophisticated course and case design, platform preparation and

intensive support of comparably high numbers of mixed learner groups demand a high level of extraordinary effort to be made by the teaching staff and also by the participating students, based mainly on personal commitment and intrinsic motivation. Intensified by the additional effects of the pandemic, the course supervisors needed significantly more time for the adaptation of the design dimensions and the tutoring of the students, compared with traditional module setups. Particularly at the beginning of the pandemic in the summer semester of 2020, the additional workload on students was also shown in high drop-out rates, even in the middle of the semester. In the winter semester of 2021, due to our adaptations, this problem did not occur. The module was followed by the students with a high level of engagement as well as a positive teaching evaluation. Especially the intensification of the feedback measures through three-dimensional feedback which was given through a content-related consultation hour, formative feedback through e-tutors, and learning analytics, paid well off.

5. Conclusion

In summary, the VCL framework has proven its worth in the COVID19 pandemic and current adaptations have contributed to better student engagement primarily by creating social interaction that is not only moderated by e-tutors, but also partially already embedded in the instructional design. Furthermore, the learning platform used should offer a good selection of user-friendly tools with a low entry threshold. For pedagogical support in the virtual space, timing, availability and mandatory feedback should be taken into account. New research should focus on the integration of virtual and analog learning with a view to a new, hybrid and adaptive configuration of the module, depending on the situation, so that a positive learning experience can be created for students on all channels. More flexible models also allow students to work independently of location and time, which makes it easier for students to cope with unexpected situations (like the pandemic effects), such as having to do the student job from home or losing the student job and experience financial setbacks, as well as living with parents to save on rent, being prevented from mobility, etc. Thus, equal opportunities can be balanced.

The iterative and regular research and expansion of the framework have contributed to this and can therefore be seen as a success factor. In future studies, the reduction of the workload in the supervision while maintaining the quality of learning progress, as well as the potential for scaling up participants through technical support and learning analytics should be examined more closely to support the ongoing VCL enhancement. Here, the interlock of qualitative feedback and learning analytics could offer a perspective that further blurs the boundaries between digital and analog.

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A COMPARISON OF STUDENTS CHEATING IN COMPUTER FACE-TO-FACE AND ONLINE EXAMINATION

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Keywords

Examination, online education, cheating, clustering, k-means, BigML

Abstract

Since the invention of computer technologies, they started to emerge in education environment as well. At first, they served only as supplementary tools for students and teachers to improve quality, but due to the COVID-19 situation, there was a need for a fast transition from face-to-face approach to full online mode. One of the most delicate aspects of this change is grading students based on computer online examinations. Due to the nature of this approach and the sense of safety it can lure students to cheat. In our research we observed two mandatory courses at IT faculty with final computer exams, which were originally taken on classroom computers with proctors but after pandemic situation began, they moved to online environment. We created a dataset containing data from two semesters of face-to-face computer examination and two semesters of online computer examination. Face-to-face and online exams had exactly same structure and subset of questions. We used statistical approach and anomaly detection clustering technique k-means to provide results. While statistical approach is suitable for small amount of data, clustering prevails in case of large datasets. Observed results were rather unexpected, because we found more potential cheaters in face-to-face examinations than in online environment. We justify that by students being more careful and afraid of being tagged as potential cheaters in online environment. In the future we would like to provide more complex analysis if we implement detailed logging into university examination system.

1. Introduction

In last decades, information and communication technologies developed enormously and had crucial impact on most aspects of human life, including education environment. Usage of information technologies for educational purposes grew rapidly in last couple years, even before pandemic situation. It includes not only online study material, recorded videos or student's collaboration in virtual environment, but also grading students based on results from exams made on computers.

Today's world developed very differently than we assumed couple years ago. COVID-19 has changed our lives in most aspects and defined new ways of living we never imagined before from the grounds. It has changed the meaning of the word "normal" and our attitude to everything around. Nevertheless, life is still going on and everything and everyone needed to adapt. In some

fields it accelerated natural progress and innovation, in some fields it forced a fast change or a transition to different system, which has not been needed before. Education environment is a prime example of that. There have been drastic changes in a way how university education works. Ratio of online education features to face-to-face ones has been steadily increasing over last decade. However, with pandemic situation the need for a transition to online world raised dramatically. Most universities run into various issues during this transition, but usually they overcame them successfully. Priorities have been set and universities focused on transitioning lectures and training courses to online environment first. It was followed by online consultations, student's online collaboration, online libraries and also an ability to solve administrative applications.

By the end of the first semester and the beginning of the examination period during pandemic situation the need for transitioning originally face-to-face exams to online exams gained its priority. In case that traditional exams were already computed based, most universities did not change anything and just use same exams in online environment to give students final grades. That leads to a possible way to cheat because the way how exams work did not change. Most of the original computer exams were created with a focus to remember something. These exams were proctored, and classroom computers had internet disabled and were monitored with supervisor. It worked quite well. However, when students started to do the same exams at home, online, there was usually no proctor, or even if there was, it is very different to in-person examination. Answers for most questions can be easily found on the internet or copied from classmates. Another possible issue is the fact that exams do not change enough with every semester and students can copy or remember questions and share them with their younger schoolmates (Lancaster, 2021).

According to Watson's research among couple hundreds university students 32,1% of them admitted cheating in face-to-face courses, while 32,7% admitted cheating in online courses (Watson, 2010).

2. Related work

There were many other researchers dealing with computer exams cheating, even before pandemic situation. Number of researchers drastically increased when online education including online examination outclassed traditional face-to-face environment.

Bawarith and his coworkers investigated ways how students cheat in computer exams and explored cheating detection options in online exams, through continuous authentication and online proctors. In addition, they have implemented an E-exam management system, which is used to detect and prevent the cheating in online exams. They discovered and described four most common ways to cheat, in both face-to-face and online environment. Using prewritten cheating sheets usually in small font, using prewritten cheating sheet hidden in the book or below the desk, using devices to communicate question number or correct answer by text messaging via cell phones and using headset with recording abilities and hide earphone behind long hair (Bawarith, 2017).

Fask presented a paper that utilizes an experimental design to assess the difference in student performance between students taking a traditional, proctored exam and those taking an online, unproctored exam. This difference in performance is examined in a manner which considers both the effect of the different physical test environments and the possible effect of a difference in the opportunity for students to cheat. He discovered that student who took online exam achieved score about 10% higher than those who took face-to-face examination (Fask, 2014).

Bilen focused on online cheating amid COVID-19, and he suggests that unlike the face-to-face examination, cheating should be expected in the online examination, with the reason being very

intuitive: the instructor can observe cheating evidence in the face-to-face examination, but there is only indirect cheating evidence in the online examination. Therefore, cheating is a part of the student equilibrium strategy in the online examination. Using a simple way to detect cheating - timestamps from the students' Access Logs - they identify cases where students were able to type in their answers under thirty seconds per question. They found that the solution keys for the exam were distributed online, and these students typed in the correct as well as incorrect answers using the solution keys they had at hand (Bilen, 2021).

Clark focused on the prevention of online cheating. He found that contract cheating was occurring in online chemistry exams and suggested watermarking exam materials to make them more difficult to share with contract cheating providers. He also recommended the use of unique data sets for individual students to work on. This means that if questions are placed on a visible file sharing site, the student with that data set allocated to them can be traced. (Clark, 2021).

Nizam and his coworkers focused on preventing helping students each other during online examination. They proposed a novel scheme for online exams during social distancing, where each student gets different question at a time and each of these question needs different time to answer. If an exam is designed this way, student's ability to help to each other is greatly reduced. This approach is successful in smaller courses but not very suitable for larger scale, because the difficulty of the preparation raises with number of students taking same exam (Nizam, 2020).

3. University computer examination

For our research purposes we obtained data from two mandatory IT courses at Faculty of Informatics and Statistics at Prague University of Economics and Business. Due to the non-disclosure agreement, we call them Course A and Course B. Prague University of Economics and Business transitioned to online environment as well as any other university in the world. We obtained data from two semesters before pandemic situation, specifically from summer semester 2018/2019 and winter semester 2019/2020 where computer exams were taken in-person in classrooms at university with proctors involved. Other two semesters of data from summer semester 2019/2020 and winter semester 2020/2021 were created during pandemic situation when exams were taken online and without any proctors. Face-to-face and online exams had exactly same structure and subset of questions.

University exams dataset contains basic information values, such as ID of the course, semester, type and name of the exam or maximum points and time for specific exam. However, it contains other values important in our research, specifically *Achieved Points* and *Time Spent* in the exam. We also calculated three other artificial values and called them *Effectivity*, *Successfulness* and combination of both, *Effectivity of Successfulness.*

Effectivity is a value how much was a student effective. It resonates with achieved points per minute of an exam. Student who achieved 10 points in 1 minute is as effective as student who achieved 100 points in 10 minutes.

Successfulness is a calculated normalization value where 100 represents maximum number of points and 0 represent worst possible result.

Effectivity of Successfulness is a calculated value and combination of previous two values. It represents successfulness measured by time spent in the exam. It shows how many points can student reach in lowest time possible. The higher this value gets the better.
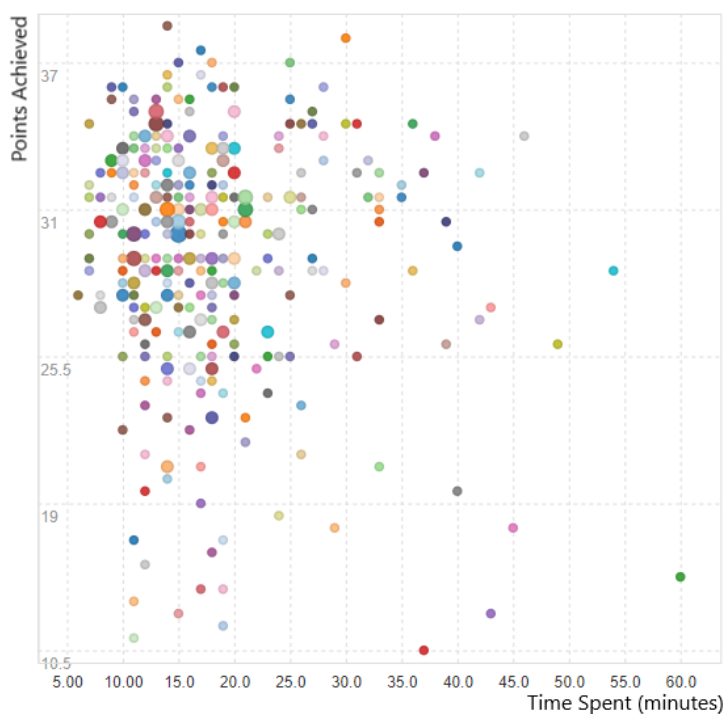
$$Effectivity\ of\ Successfulness = \frac{Successfulness}{Time\ Spent}$$

Course A had 337 students in pre-pandemic period. It had 294 students in pandemic period. Time limit for this exam was set to 60 minutes and maximum score was 40 points.
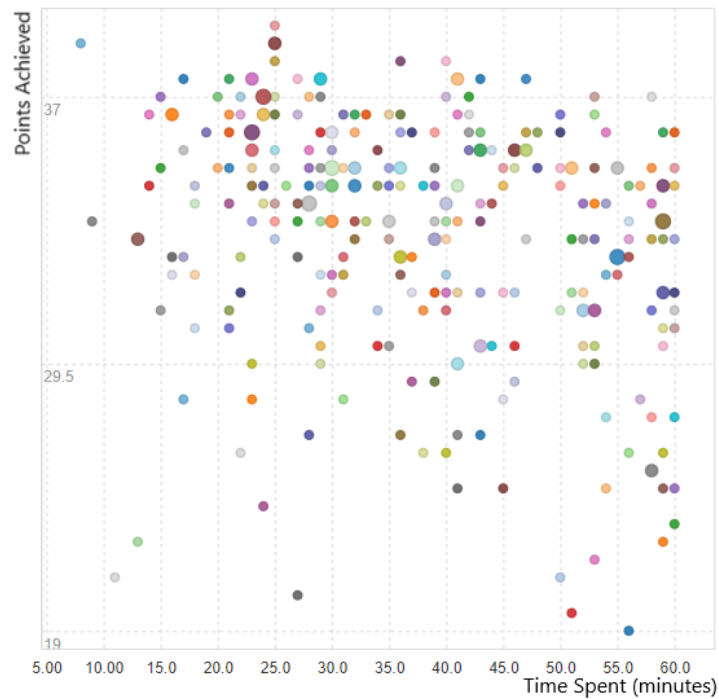
Table 1 - Course A

	Face-to-Face	Online
Number of students	337	294
Average achieved points	29,08	33,16
Median achieved points	30	34
Average time spent	18,17	37,80
Median time spent	16	37
Average Effectivity	1,92	1,04
Average Effectivity of Successfulness	4,78	2,60

Changes from face-to-face to online computer exams in course A showed an increase in all parameters we observed. Average achieved points raised by 14,03%, median by 13,33%. Time spent on the exam raised much higher, average time spent raised by 108,03%, median by 131,25%. Results of students in Course A in face-to-face examination can be observed in Figure 1, while results from online examination can be seen in Figure 2.

Figure 1 - Course A face-to-face

Figure 2 - Course A online

Course B had 291 students in pre-pandemic period. It had 304 students in pandemic period. Time limit for this exam was set to 60 minutes and maximum score was 30 points.

Table 2 - Course B

	Face-to-Face	Online
Number of students	291	304
Average achieved points	19,65	21,50
Median achieved points	19,91	22,07
Average time spent	30,69	45,56
Median time spent	30	44
Average Effectivity	0,74	0,49
Average Effectivity of Successfulness	2,45	1,63

Changes from face-to-face to online computer exams in course B showed an increase in all parameters we observed. Average achieved points raised by 9,41%, median by 10,84%. Time spent on the exam raised higher, average time spent increased by 48,45%, median by 46,66%. Results of students in Course B in face-to-face examination can be observed in Figure 3, while results from online examination can be seen in Figure 4.
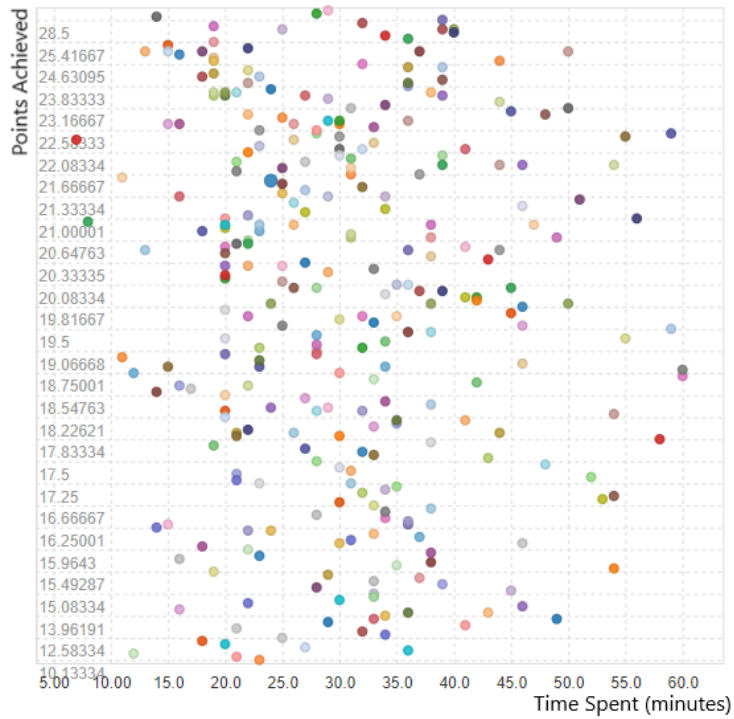
Figure 3 - Course B face-to-face
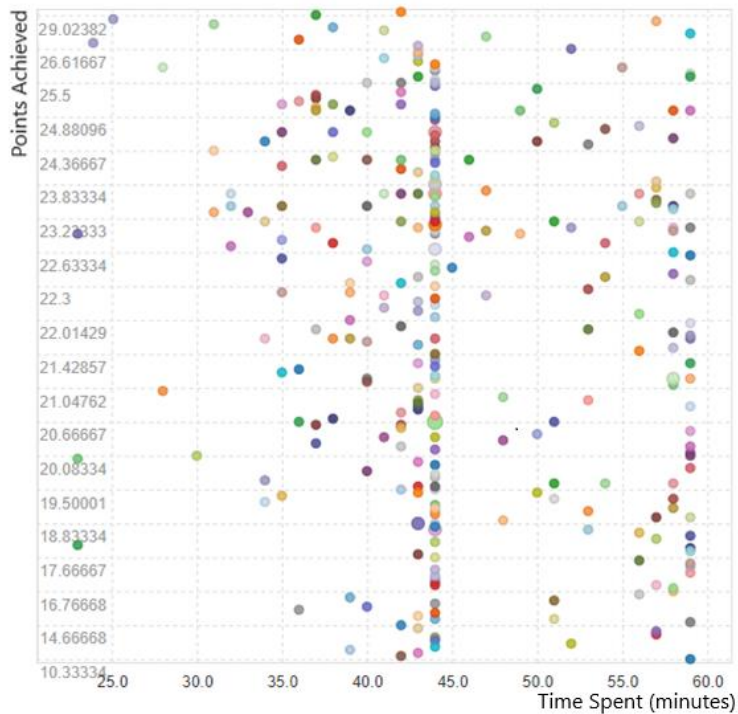
Figure 4 - Course B online

In our research we tried to focus primarily on students who finished exams surprisingly quickly with very good or even excellent results. We considered these students as potential cheaters. Due to the structure and information contained in dataset we created it appeared as the most certain approach.

Based on our previous research focused on recent anomaly detection approaches (Svarc, 2019), we used clustering technique, specifically k-means algorithm. There were clusters created based on *Time Spent*, *Successfulness* and *Effectivity of Successfulness* parameters. We used scaling parameter for *Time Spent* value because it's not accurate enough – it is rounded to minutes. *Effectivity of Successfulness* was important for a classification algorithm to detect anomalies. K value was set to 21 in all cases – both courses in pre-pandemic and pandemic period. We experimented with different values of K and based on Elbow Method we determined optimal value of K. We used BigML platform to perform anomaly detection.

4. Conclusion and future work

Observed results were rather unexpected regarding the fact that face-to-face and online exams had same structure and subset of questions. We defined a potential cheater as someone who has effectivity of successfulness higher than double of average value. In course A we observed twelve potential cheaters in face-to-face academic year and thirteen potential cheaters in online academic year. In course B we observed eleven potential cheaters in face-to-face academic year and two potential cheaters in online academic year. We justify these results by the fact that students in online environment were more afraid and scared of implementation of some kind of anti-cheating detection system and in the light of this feeling they completed online exams more slowly and carefully in order to avoid detection by such a system. In our research we conclude that paradoxically cheating was detected more in face-to-face exams rather than online exams. To reduce possibility of cheating in online environment we propose to enhance exams by changing them each semester significantly, shortening time to complete and making answers not easily searched on the internet or copied from classmates.

Clustering technique k-means showed promising results, but it was limited by small dataset containing only final computer exams of two courses at one faculty in two academic years – four semesters. In case of such relatively small amount of data benefit of clustering techniques over statistical ones could be questioned. However, if this algorithm runs on much bigger dataset, for example all online exams at whole university it would prevail statistical techniques by large margin. It could serve as a very valuable tool for teachers to detect potential cheaters.

For more precise and accurate analysis we would need more complex dataset. Current dataset contains timestamp of the beginning and the end of specific exam. We presume that if it contained detailed timestamp for each question answered, we could find many more potential cheaters. Main flaw of the existing dataset is that it does not detect students who complete all questions very quickly, but then wait for a long period until the end of the time limit and submit it in last minute. In the future, we would like to implement timestamps for each answered question which would lead to detection of such cases.

5. Acknowledgment

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DISTANCE LEARNING DURING COVID - 19 PANDEMIC: STUDENTS' PERSPECTIVES

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Abstract

Traditional distance learning/education has been studied for decades, however, emergency remote teaching/ learning during pandemic or distance learning during coronavirus crisis requires careful analysis from teachers' and students' perspectives. The primary research with cross-country comparative analysis and multivariate technique aimed to identify the University students' learning experience during the Covid-19 pandemic: challengers students face this period, the perceptions of the convenience of emergency distance learning, and the motivation to distance learning in future education. It was conducted among the Czech and Russian students in December 2020 (total: 250 students of 5 universities). The study confirmed that students face several technical and non-technical problems. About 26 % of all respondents feel not comfortable, notifying that the overall complexity of their study with the transition to emergency remote education increased. More than 63% of respondents state that they easily adapted to the conditions of distance learning during the pandemic. In general, students are satisfied with online/distance learning when: the teacher is adaptable to a new practice of e-teaching, good in digital skills and creativity to keep students engaged, and when the students are informed about education changes in time. Almost 60% of students would prefer blended learning, combining face-to-face and online education after the pandemic, and in the future of higher education. The findings of the research are of benefit to higher education policymakers and all educational actors: University managers, teachers, students.

1. Introduction

The term Distance learning (DL) first has been mentioned in the late 19th as a simple correspondence education. With the advent of internet technology and digital transformation, the concept of distance learning has evolved rapidly, reflecting and embracing the complex changing learning environment. Last decades numerous studies have been carried out, focusing on DL definition and characteristics, comparing the distance and classical forms of education, finding the tools for measuring the effectiveness of both forms of education, discussion the future of higher education (Clark, 1993; Gunawardena & Zittle, 1997; Kaplan & Haenlein, 2016). Without validating the significance of DL different meanings, for the purpose of this article we chose to use thoroughly definition of distance learning, presented by Berg and Symonson (2020). Distance

learning, also called distance education, e-learning, and online learning, is a form of education in which the main elements include the physical separation of teachers and students during instruction, and the use of various technologies to facilitate student-teacher and student-student communication.

Institutions and students embrace DL due to it accessibility, flexibility, safe-pace learning, other benefits. However, the providing of online activities has particular challenges, such as: difficulty of encouraging participation (Gibson et al., 2001); anxiety of students and difficulty of creating successful critical/analytical dialogue (Hughes & Daykin, 2002). From students perspective this form of study requires the students the higher level of self-discipline, avoiding the planned procrastination and "student syndrome". The University students are differ to some extent in their learning style: somebody prefer learning visually, others – via and with sound; often it is the learning styles combination. Motivation is one of the most important factor for effective learning.) Studying alone can be time-consuming and consequently requires heightened levels of motivation (Croft et al., 2015). Personal interaction is matter a lot for students, therefore the risk of feeling isolated' is a real challenge for them, and may reflected in decreasing the level of motivation.

The future of distance education will be directed by learning processes occurring in informal, as well as non-formal and formal learning environments. Blended learning approach, as a flexible combination of classroom teaching-learning practice (ace-to-face) and e-learning helps ensure the students'engagement, and take into account the individual leaning style (O'Byrne & Pytash, 2015; Sayhili, 2018). Presently the Universities all over the world experienced the significant challengers, caused by Covid-19, transforming the model of distance concept and the future of higher education.

2. Distance learning during Covid-19 pandemic: problem design

COVID-19 has affected many areas of our lives, including University education which is accompanied by the closure of university campuses around the world, and rapid migration most of educational processes: teaching, learning, and assessment into online domains. Distance education became a necessity and mandatory. Some studies ((Marinoni et al., 2020; Govindarajan et al., 2020) refer to this new system as "emergency online education", and global experimentation of remote/distance teaching and learning during the pandemic crisis. Why the term "emergency remote teaching", or "emergency remote learning"? Simply remote learning is a temporary move the process of teaching and learning performed at a distance. Although distance learning/ distance education should not cause any major problems for teachers and learners, the emergency distance learning/education do due to its origin. Distance learning, being mostly planned and instructional delivery process, usually providing on the basis of accredited programs, shifts to the alternate delivery model due to crisis circumstances. It involves the use of fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format, once the crisis or emergency has abated (Hodge et al., 2020).

From the start of the pandemic crisis in March 2020, many higher educational actors struggle with challenges. There are two groups of concern. The first group is the University and faculty concern about digital methodology adaptation, teaching outcomes, the certain reduction in the number of foreign students. All of a sudden Universities have to go through the "childhood disease" of the operative transition to distance learning; to keep up with the program both teachers and students have to rapidly adopt new technologies and their possibilities. To construct a well-designed online learning experience, universities have to develop digital learning methodologies and provide digital learning contexts, tools, and support systems (Krishnamurthy, 2020). The second group is the students' concern about distance learning during the coronavirus pandemic. Since the beginning of the pandemic quarantine, students have faced a lack of ability to determine if they want to take

online courses, or not? instead, everyone had to. During typical times, students may visit the library, attend tutoring sessions, and go to places with a good internet connection speed. They can also go to sport, unlike during COVID-19 students had to stay at home, where the space and possibilities for study and go to the sport are limited. The results of a survey conducted by the Institute of Sociology of the Academy of Sciences of the Czech Republic in May 2020 map how the closure of universities in the first wave of the epidemic affected the psyche of students. Distance learning increases stress in college students, deepens their propensity for depression and loneliness (ASCR, 2020).

Hastily tailored courses, technical problems, prolonged social distancing, the inability to attend classes in person to master the subject in deep discussions with the teacher and classmates might have an influence on education quality, decreasing the students' motivation in distance education. Recent research, studying the impact of remote education on student learning through the perspective of teachers in eight countries had made the conclusion that „learning loss is global and significant": teachers see the students' disengagement and learning loss, and many students struggle with issues such as learning challenges, isolation, or a lack of resourcing (Chen et al. 2021).

Being the second authors'study raising the problem of the impact of digitalization and coronavirus challenges on the younger generation (Svecova et al. 2020), this study presents a modern contribution to the field of knowledge on higher education by focusing on student perceptions and student's learning motivation during the two waves of the pandemic. We wanted to know:1)What are the difficulties the students faced in connection with the transition to emergency distance learning? 2)What is the students' motivation to distance learning, and what benefits DL brings? 3) How relationships and interactions with teachers are seen? 4) Whether students want to keep distance learning in the future? The answers to these questions help to determine the students' perceptions of DL, its methods, and quality, applying in the universities of different countries.

3. Methodology and Data Collection

Based on the ideas presented above, someone might ask why the authors didn't name the study as, for example, "emergency distance learning in Covid-19", or "remote learning"? By designing the research framework and constructing the survey which is mainly based on the questionnaire method of data collection, we tried to better reach our target audience with the questionaries' clarity and brevity. The target group is full-time University students, bachelor programs, humanitarian and economic faculties, the majority fall into the 19 – 24 age group. Despite the majority of the surveyed respondents before the pandemic experienced mostly face-to-face learning, students have the idea: "what is distance learning?" and this term is easily understandable and recognizable for them. We developed the theoretical framework of distance learning; we also wanted to know the students perceptions of online/distance learning during current emergency online education, and of the future University education.

The primary research with cross-country comparative analysis and multivariate technique conducted among Czech and Russian students (total: 250 students of 5 universities). The data has been collected from November 2020 to mid - December 2020. We called the group of 125 bachelor program students from Czech state universities (Masaryk Institute of Advanced Studies Czech Technical University in Prague and the Institute of Economics and Management (School of Business) of the University of Chemistry and Technology in Prague was called to fill out an online Questionnaire in Google Form. 90 students responded so the rate of return was 84%. About 160 bachelor program students mostly from economic and humanitarian faculties of Russian universities (Perm National Research Technical University, Perm State University, and Voronezh State University) participated from the Russian side. The Questionnaire consisted of 25 questions, 9

of them were multiple-choice. Some of the single-choice questions were designed as a Linkert scale. The majority of the questions were close-ended or semi-closed. There were 4 open-ended, long-form questions offering the respondents the ability to elaborate on their thoughts. The questionnaire was divided into several thematic areas: problems and difficulties the students faced with the transition to DL; the benefits of DL and the level of convenience, and the student's motivation to study in distance mode; preferred platforms and technologies; the quality of distance education; students' readiness to DL and their attitudes to distance education in the future. The questionnaire also included a group of questions devoted to the psychological problems of students due to the separation and a certain degree of isolation during the pandemic. The results from primary research are presented below.

4. Results

4.1. Distance learning in the time of Covid-19. General Overview

The vast majority (78,5%) of all respondents accepted the transition to accepted the emergency transition to distance/online learning(study remotely) with understanding as the measures of risk reducing of spreading Covid -19 infection. Over 63% of all University students stated that they managed to adapt well to the conditions of distance learning during the two waves of pandemic. However, the other quarter of respondents notified that the complexity of their study with the transition to emergency remote education increased. More detailed explanation see in chapter 4.3. About 6% of all respondents experienced considerable difficulties explained mainly by family reasons and home study conditions. Some discrepancies in representatives' responses between Russian and Czech students were revealed in terms of the comfort to study remotely: only 41 % of Russian respondents evaluated this form as very comfortable, 29% - answered that this form is comfortable but difficult, and almost 29% of Russian students evaluated remote learning as difficult and uncomfortable form to study. Almost 70 % of Czech students reported that they see this form of study as comfortable and easy, and 25% comfortable but difficult (Figure 1).
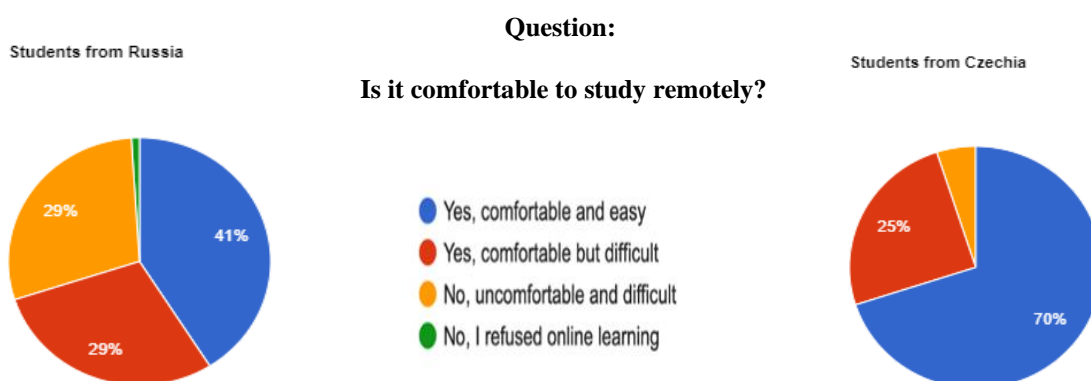
Figure 1. Students' perception of the convenience of remote learning (authors)

Zoom US is used for online learning by Russian students, and MS Teams is used by Czech students. Students also like the combination of tools in learning process: screencast, group chat, video-audio lessons and conferencing, collaborative documents in Google docs, other. For interaction with teachers they used also the official University e-mails. During exam sessions Czech respondents use also Moodle (65% Czech respondents against 15% of Russian students).

The work of the Universities staff within the framework of DLwas judged relatively well by all students: half of the students consider their work well, and 23 % - excellently.

4.2. Benefits of online/distance learning: students' perspective

The most important benefits to study online chosen are the following:

- Better time coordination. Saving the commuting costs. The possibility of learning at any time, in any place with the freedom to complete assigned tasks liked almost 49% Russian and about 70% of Czech students (Table1). This is also communities costs saving. About 20% of the Czech students added as the the benefit the „travel time savings and money economy". It is reasonable, as many of them live in the different regions of the Czech Republic. The study journey to Prague universities takes them several hours a day, sometimes the students are forced to stay in dormitories, or pay expensive rent. When the teaching moved to DL mode, students could connect from home, and not have to travel to the University.

- Strengthening the capacity to adopt and use of digital technologies(new digital tools)in the learning process. This motive for learning was noted by 58 % of Russian and 62% of the Czech students (Table 1). This fact as well as the increasing of popularity of digital learning platforms is the real manifestation of digitalization development.

- All the course and study materials are available as the benefit were choosen by 41% of Russian students and 49 % of the Czech students.

- Developing of self - control and self - education. The benefits motivated students to DL are presented in Table 1. Among other advantages were also mentioned: the possibility to combine work and study; learning in a comfortable and familiar environment; homemade food.

Table 1. Assessment of benefits of study online during pandemic: students' perspective

What the emergency remote/distance learning bring to me? What you liked about it? (multiply answers)	N=250	
	Percentage	
	RU students	CZ students
Strengthening the capacity to adopt and use of digital technologies (new digital tools) in the learning process	58	62
Increasing the degree of independence in the formation of knowledge and practical skills	35	38
Developing self – control and self-education	46	37
Better time coordination. Posibility of learning at any time, in any place with the freedom to complete assigned tasks	49	68
All the course or study materials are available online	41	49
Improving the quality of education	33	34
There is no improvement in the quality of education	36	28

4.3. Difficulties students face during remote learning

lmost 26% of students feel not very comfortable, facing difficulties during remote learning. The difficulties and disadvantages students face with emergency distance education an be divided into technical and non-technical problems. Technical problems connected with a bad internet connection, technical interruptions in the process of reproducing material; about 40 % experienced sound quality problems. Non-technical problems: a) a large amount of information for study which in turn leads to difficulties in processing information and reduces the quality of training. Almost 40,5 % RU and 65% of CZ students admitted that they do not always manage to do well their home tasks due to the high volume of study materials; b) problems with self-organization, self-discipline, planned procrastination when, for example, a student will only start to apply themselves to an assignment at the last possible moment before its deadline; c) time preparation. More than 33 % of

all respondents answered that the preparation for classes increased by 30 % and more, when remote online learning had started. About 38% respondents noted that it is difficult for them to keep their attention while watching video lectures. Students experienced psychological problems (figure2).
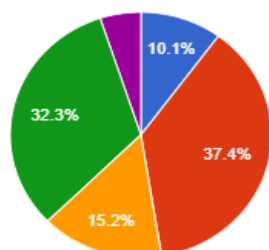

Figure 2. Difficulties students face during remote learning.(Source: Authors).
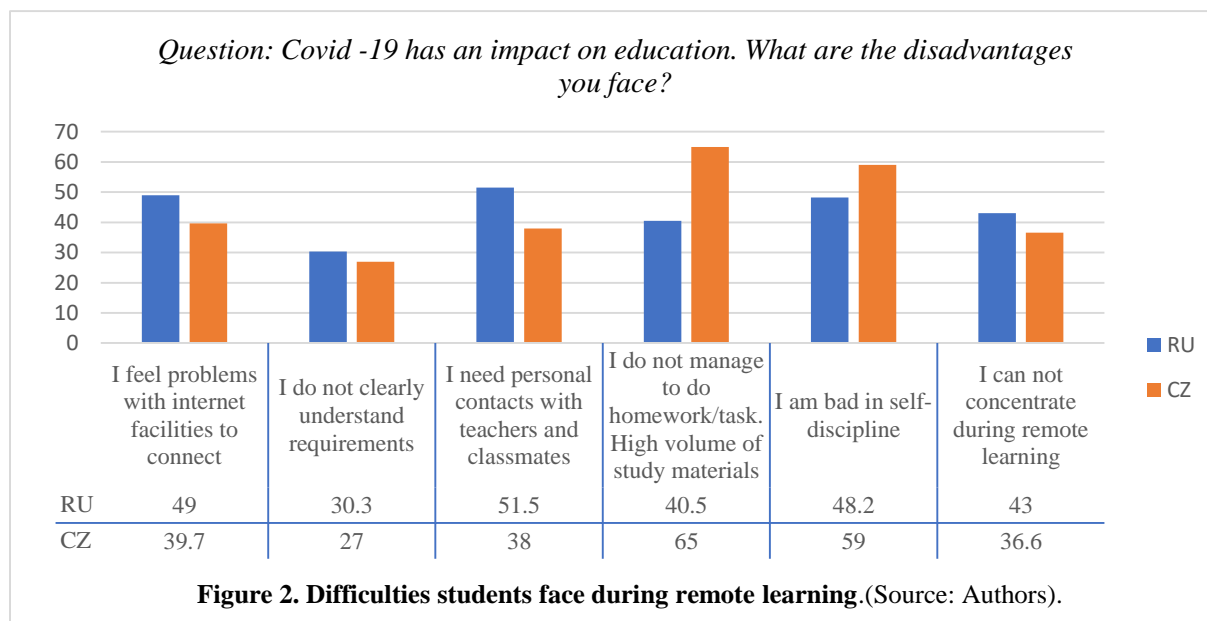
4.4. **Students' perceptions of DL and expectations to distance learning in the future**

The study was carried out in the autumn/winter of 2020 when most of the surveyed students already have been studying remotely for the second academic year. University students went through a certain stage of adaptation, therefore they could already more convincingly express their perception of DL, their expectations to the quality of DL, and the overall convenience of online mode education in the future. Students are ready to distance learning in the future connecting it with the high quality and good organization by the University staff (figure 3). The majority of students (68%) expected the teachers' good knowledge of digital technologies, creative approach, and the ability to form student Teams and moderate the educational process. In general, the students have no doubts about the necessity of distance learning in the future (figure 3).

Question: How do you expect DL in the future? Will the quality of your education improve with DL?

Students from Russia   **Students from Czechia**

Legend:
- Yes
- Yes, but in good distance teaching conditions
- Yes, provided that the quality of distance education will be controlled by the university administration
- No
- I have doubts about the necessity of distance learning
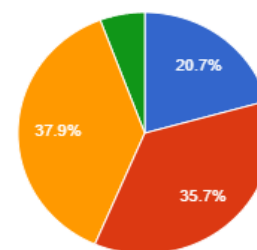
Figure 3. Students' perceptions and expectations of distance learning in the future (authors)

Almost 60% of students would prefer blended (hybrid) model of leaning, combining online and face-to-face after the end of the pandemic and in the future education.

5. Conclusion and Discussion

The present study was designed to determine the educational challenges and opportunities facing the Russian and Czech University students during the Covid-19 pandemic. The research findings confirmed that the majority of all respondents have no trouble with the emergency transition to remote learning, relatively quickly adapted to study online. More than 63 % of all respondents have found DL as a comfortable and easy mode to learn, which gives them opportunities for: strengthening the capacity to adapt and use digital tools implemented in the learning process; introducing the possibility of learning at any time, in any place with the freedom to complete assigned tasks; developing self-control and self-education. However, students experienced technical problems, non-technical problems, connected with the quality and organization of DL, and bad students 'self-organization. About 30 % of all respondents noted that studying online is difficult and more time-consuming than classical education. Still, nowadays students meet psychological difficulties, feeling stressed due to the lack of face-to-face communication with teachers and their classmates. These problems decrease the enthusiasm and motivation to study, impacting students' perception of quality and the convenience of DE in the future, as almost 26 % of all respondents answered that they do not see any improvement in the quality of their education with DL. In general, students are satisfied with online learning when the teacher is adaptable to a new practice of e-teaching, good in digital skills, and creative to keep students engaged; when students are informed about changes in time, and when the distance education process is well organized by university staff.

The study assimilated the knowledge across borders and countries and specified some general tendencies that could be expected in a normal future in University education. The transition of higher education after pandemic to more flexible modes: mixed as "hybrid learning and blended learning" seems reasonable. Our findings confirmed that almost 60% of students prefer blended learning "or "hybrid learn combining the study online and face-to-face after the end of the pandemic, and in the future, and they are in link with recent studies (García-Morales et.al, 2021). The Institutions have to be well prepared for any uncertainties happening in the future. New distance learning, experienced from the emergency remote learning during Covid-19 and the new application of new digital tools together with blended learning can be good alternatives in a future, full of uncertainties, and in the situations where the full-time presence of students is not needed (especially, when the practical teaching, laboratory exercises are not necessary). The challenges of

distance learning from teachers' perspectives and the new role of teachers and students in the transformation of higher education into more perspective educational models are the subjects of further research.

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ANNEX

Statement of the Publication Ethics and Publication Malpractice

IDIMT's Publication Ethics and Publication Malpractice Statement is based, in large part, on the guidelines and standards developed by the Committee on Publication Ethics (COPE).

We expect all parties commit to these publication ethics. We do not tolerate plagiarism or other unethical behaviour and will remove any manuscript that does not meet these standards.

The relevant duties and expectations of authors, reviewers, and editors are set out below:

1. Author Responsibilities

Authors must certify that their manuscripts are their original work.

Authors must certify that the manuscript has not previously been published elsewhere.

Authors must certify that the manuscript is not currently being considered for publication elsewhere.

Authors must notify us of any conflicts of interest.

Authors must identify all sources used in the creation of their manuscript.

Authors must report any errors they discover in their manuscript.

2. Reviewer Responsibilities

Reviewers must notify us of any conflicts of interest.

Reviewers must keep information pertaining to the manuscript confidential.

Reviewers must bring to the attention of the Editor-in-Chief any information that may be reason to reject publication of a manuscript.

Reviewers must at any time evaluate manuscripts only for their intellectual content without regard to race, gender, sexual orientation, religious belief, ethnic origin, citizenship, or political philosophy of the authors.

Reviewer who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should notify us and excuse himself from the review process.

3. Editorial Board Responsibilities

The Editorial Board must keep information pertaining to submitted manuscripts confidential.

The Editorial Board must disclose any conflicts of interest.

The Editorial Board must evaluate manuscripts only for their intellectual content.

The Editorial Board is responsible for making publication decisions for submitted manuscripts.

List of Authors