Welcome to IDIMT 2009!

A hearty welcome to the 17th IDIMT Conference!

Jindřichův Hradec, chosen in 2008 as the new location for IDIMT, has proven to be a good choice. You will again enjoy this beautiful old town with a historical market place, an old castle with a famous fountain, offering perhaps a show of a duel between knights, a prominent church, a beautiful river, many friendly people and excellent restaurants offering delicious food. Small streets, lovely little shops and a wide central plaza will invite you to stay and to wander around the town. Last but not least the famous Czech beer will inspire our discussions.

IDIMT was started in 1993 as a small bi-lateral conference between Czech and Austrian scientists. We now have the 17th anniversary and IDIMT has become a well-established conference for a scientifically and geographically diverse group of scientists. The main focuses of the conference are current and future challenges and the needs of a world dependent on Information and Communication Technology.

This year our main focus is the complex relationship between humans and software-intensive systems, especially information systems. These relationships range from questions of dependability, usability, connectivity, measurability, innovation, and open access to human factors and social responsibility.

In this spirit the key topics of this year's conference are:

- *ICT Innovation and Performance Measurement Models and Methods*
- *Information Management - Key Factors and Aspects of Enterprise Informatics*
- *Human Factors in Software Project Management*
- *Social Responsibility for Information by Informal Systems Thinking*
- *Safety and Security as a Systemic Challenge*
- *Computer Support of Cooperative Work*
- *The Magic of Open Everything: Open Source, Open Communities, Open Access?*

This year we have been able to accept 42 papers coming from eleven different countries. They have been arranged in 7 sessions; each session is organized by a Sessions Chairperson and will be opened, as it is the tradition, by a keynote. The other papers in each session give additional points of view. We still preserve the fundamental idea begun in 1993 of providing a solid base for the interdisciplinary exchange of thoughts as a result of offering ample time for discussions: one of the outstanding features of IDIMT.

The preparation and realization of IDIMT 2009 would not have been possible without the support of many organizations and persons. Therefore we would like to thank:

- *the Austrian Federal Ministry of Science and Research for financially supporting the preparation of the proceedings (Grant BMWF-4.010/0010-III/2/2009),*
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To a successful conference!

Gerhard Chroust

July 2009

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ICT Innovation and Performance Measurement Models and Methods

ICT PERFORMANCE REFERENCE MODEL IN THE CONTEXT OF CORPORATE PERFORMANCE MANAGEMENT SYSTEMS

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Abstract

Management of ICT in the enterprise has been increasing in importance and nowadays it is one of the critical success factors of any type of business. Therefore Reference Models have been elaborated to help companies with setup of their ICT Performance Management initiatives. In this paper we discuss the principles of reference models and their application into the ICT Performance Management systems. We also discuss the ways how these models could be formed and incorporated into the company overall performance management initiatives.

1. Introduction

ICT Performance Management is one of the most important performance management domains in the company. We can describe ICT Performance Management as the processes used to manage ICT Performance (such as ICT strategy formulation, budgeting, customer satisfaction management); the methodologies that drive some of the processes (such as the ICT balanced scorecard); and the metrics used to measure performance against strategic and ICT operational performance goals.

2. Reference Models

When we model the organization and its activities from different perspectives, we can use a number of different modeling and categorization techniques (e.g. business process modeling, functional modeling, data, object or business object modeling, service and product catalogues.). Since the early days of organization modeling, researchers and practitioners have been attempting to achieve reuse of models already developed in one organization for other similar organizations.

The term “reference model” is still not very well defined and we can find many variants of its definition. One of the reasons for such situation is that this area could cover wide range of model types used for different purposes. For our purpose we will use the following definition [2]:

“Reference model contains relevant structures and relationships among the model elements (process structures, levels, document structures) and also the predefined knowledge (best practice examples) already included in these structures.”

Reference models usually combine strengths of mathematical and data modeling techniques for its structure and knowledge management principles for its content. The most significant advantage of reference models is that they represent the best practices and knowledge in the formalized model structure, and therefore allow easier knowledge replication.

3. Reference Models in ICT Management

Management of ICT in the enterprise has been increasing in importance and nowadays it is one of the critical success factors of any type of business. Application functionality overlap, technology and knowledge heterogeneity and constantly changing business pressures make this task very difficult. There is a strong need for methodologies and recommended best practices in this area.

Using the reference model principles (formalized structure and predefined content) in the area of ICT management would help to address the above listed issues. If we accept that ICT management conforms to the same principles as the management of e.g. logistics or production, there is no reason for not applying reference models also in this area.

ICT management reference model should contain best practices, but they have to be expressed and managed as formalized procedures, forms, relationship tables and other structured content, which could be instantly used for ICT management. This suggestion is based on empirical experience gained while implementing the ICT management principles in real projects.

4. ICT Performance Reference Model

ICT Performance Management gains its momentum especially in the situation, when the ICT in the company is based on the service definition and SLA – service oriented ICT management. This situation brings ICT Management executives to the nearly the same position as they are managing in the whole company. ICT has its own product (service), customers, suppliers, processes etc. The only difference is that there have to be set up the strong relationship to the company business goals and performance goals.

ICT Performance Management Reference Model ITGPM developed at the Department of Information Technologies VSE Praha is depicted on the Figure 1. Core of the model is built around the ICT Management Processes.

Management of the particular domain is influenced by the approaches of the Performance Management – i.e. management methods, process classification, metrics, performance management tools and complex of analytic and planning applications, all based on the Business Intelligence principles.

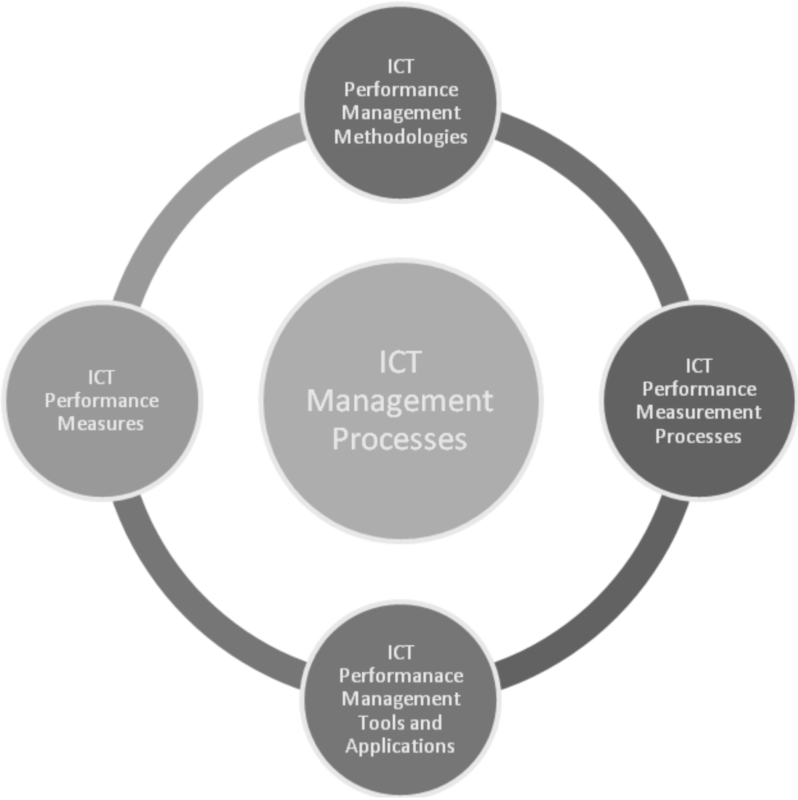

Figure 1: Basic Concept ICT Performance Reference Model ITGPM

In the framework of ITGPM model:

- ICT Performance management Methodologies comprise various applications of IT Balanced Scorecard as described in [7], Value Based approaches adapted for ICT, ICT effects estimation and their relationship into the company overall performance. Further research findings in this area are described in [1],[4],[5],[6].
- ICT Performance Measurement Processes contain specific activities oriented on automatic multidimensional ICT Performance measurement and its relationship to overall company overall performance. Further research findings in this area are described in [7]
- ICT Management Processes are updated to include the measures of their performance as a base for overall ICT Performance measurement. Further research findings in this area are described in [3] and [7].
- ICT Performance Measures is newly developed part of the model which provides the list and detailed multidimensional definitions of relevant ICT Performance measures. Further research findings in this area are described in [7].
- ICT Performance management Tools and Applications is a set of business intelligence based dashboards designed to report the ICT and overall company performance. Further research findings in this area are described in [7].

5. Conclusions - ICT Performance Reference Model in the context of Corporate Performance Management Systems

ICT Performance Reference Model could be in the context of Corporate Performance Management Systems understood in two ways:

- based on the common methodological patterns applied in both levels of management. In this context ICT Performance Reference Model forms detailed part of the overall company performance management. Specific methods are used in the overall company management and in the ICT Performance Management they are applied and elaborated into detail for the area of ICT,
- based on the premise, that ICT delivers valuable information for overall company performance management. In this case ICT Performance Reference Model contain specific tools, technologies and processes providing required information. ICT performance is in this case understood as performance of required information delivery.

Implementation of such models can provide most of the benefits when both approaches are taken into account. Tools elaborated for the required information delivery on the company level can be used for the ICT performance measurement and reporting. Company performance methodologies and systems could be applied to the ICT and bring company context into the ICT performance initiatives.

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IT INNOVATION: CASE OF ENTERPRISE WEB 2.0

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Abstract

The paper is split into four sections. The first section, based mostly on academic references, is used for clear and exact introduction into problem area of IT innovation. Innovation has been discussed in many disciplines with number of different classifications. Paper is oriented towards enterprise (organizational) innovation. IT innovation is defined as subset of innovation. Internet innovation (or Internet computing innovation) further narrows the scope of the paper. Disruptive innovation in context of Internet innovation is introduced. Second section, which is the core of the paper, introduces our concept of Enterprise Web 2.0, including analysis of benefits and their mapping into individual innovation classes. Finally third section presents, as practitioner's overview, results of two world-vide surveys of senior management on the topic of innovation including several "innovation views" e.g. innovation as corporate priority. Short conclusion is the final part of paper.

1. Introduction

Even in current economic downturn the innovation is high on agenda of corporate priorities for many corporations (see section 3). Our paper is oriented towards enterprise, i.e. organizational, innovation. Daft's [4] definition is the following „organizational innovation involves adoption of an idea, material artifact or behavior that is new to the organization adopting it"

IT innovation (sometimes labeled also as IS/IT innovation), as a sub-class of innovation, is defined by Swanson in [13] as "An information technology innovation can be defined as an innovation in digital and communication technologies and their applications [13]. In its simplest form IT innovation involve only a technological component (innovations in hardware and software), but it is often augmented with complementary organizational innovations including new form s of cognition, meaning, work process, business process or organizational structure." We understand IT innovation to be effective both in IT domain as well as in business domain.

Our orientation is towards innovations in Enterprise Web 2.0 domain, which is the subset of Internet computing. By Internet computing innovation we understand the innovation in Internet computing domain, where "Internet computing is a holistic concept that draws upon all protocols that enable computing in and open, distributed and heterogeneous environment running on top of Internet-based transmission protocols [7]".

Some innovations are disruptive in a sense that they significantly disrupt market situation/condition? Disruptive innovation was introduced by Christensen [3]. Lyytinen [7] concludes that for innovation to be disruptive "it must be simultaneously pervasive and radical" as well as "that Internet computing can meet all criteria of disruptive IT innovation".

1.1. Innovation classification

Several approaches to innovation classification are presented in literature, depending on the perspective taken for classification. Classification based on Porter's value chain (value network) activities and classification based on current management theory and practices are of our interest. Based on these approaches we may specify the following list (by no means exhaustive) of typical classes (types) of innovation

- product innovation
- service innovation
- process innovation
- customer experience innovation
- business model innovation (or innovation of its part e.g. business model for revenue streams)
- management innovation
- IT innovation (see above), which may be in many cases part of other "more complex" innovation classes e.g. of customer experience innovation, business model innovation, management innovation.

Relatively new customer experience innovation is the response towards increased bargaining power of end users [10]. "Customer experience is the internal and subjective response customers have to any direct or indirect contact with a company. It encompasses every aspect of a company offering – the quality of customer care, advertising, packaging, product and service features, ease of use and reliability."[9]

2. Enterprise Web 2.0 – innovation view

The term Web 2.0 was coined in 2004 by a group of specialists around O'Rilley. Young [14] perceives Web 2.0 as "A set of technologies and applications that enable efficient interaction among people, content and data in support of collectively fostering new businesses, technology offerings and social structures. It includes the new developments and trends in web space in technology, social and economic directions.

As "Enterprise Web 2.0" - we consider the common subset of technologies/applications presented in representative sources i.e. five following technologies/applications: RSS, blog, wiki, social networks, mashups – used by enterprises.

We view Enterprise Web 2.0 innovations as subset of Internet computing innovations which is further a subset of IT innovations. Especially blog, wiki and social networks, by supporting the social aspects (including communication, collaboration etc.) have significant innovative potential which has not yet been fully used.

2.1. RSS

RSS (Really Simple Syndication) is technology which allows user (without specific IT knowledge) to specify which information (in form of standard RSS feed provided by content owner) from which Internet sources he wants to be automatically transferred from these sources to his application (RSS reader). RSS is implementation of "publish and subscribe model" for delivery of content updates to users/subscribers [11].

Basic user benefits of this model are two-fold

- user is getting information (i.e. "new content" in form of RSS feeds) timely (e.g. up-to-date, immediate) and automatically, therefore he does not need to visit "manually" all sourcing web-sites in order to collect (or "pull") info, thus saving considerably on time
- User is getting all info updates from sourcing web-sites; therefore there is no chance of him to miss some info, as in traditional model.

Enterprise use of RSS

In enterprise RSS may be used for

- acquiring external information (as RSS feeds) by individual employees subscribing to (for individuals) relevant external info sources – typically news-sites, blog, wikis
- providing internal information to appropriate employees. Internal info sources may be
    - Enterprise (internal) blogs, wikis – which represent important enterprise collaboration platforms. Although some collaboration platforms may provide e-mail notifications, this is considered to be less effective.
    - Enterprise documents and newsletters, which are "distributed" by means of RSS (instead of by e-mail).
    - Enterprise applications. As an example stock control application may notify (automatically and immediately) managers, who subscribed to corresponding RSS feed, of certain item to drop below "minimal quantity".

Innovation potential

If used by own employees (mostly for getting info from external sources) RSS may lead towards process innovation (as well as towards cost-reduction). If used in external facing applications e.g. blogs, it has innovative potential for customer experience innovation.

2.2. Wikis

"Wiki is a web-based application, basically CMS (Content Management System), that allows many participants (without any technical expertise) to write collaboratively, where they can continue to add to or edit the content of documents and dynamically determine the relationship between sets of documents. Such documents can be anything supported by the web with hyperlinks to anywhere on the World Wide Web including text, image and video. Wiki in Hawaiian means "quick" or "fast", which symbolizes the speed of editing process.

Software tools for enterprise wikis [5] require some specific features (in comparison with "public" wikis) including identity management, rights management, security control, archiving as well as revision control, access control, statistics, "what's new" etc.

Enterprise use of wikis

Enterprise wikis are typically implemented as private wikis inside the enterprise (i.e. "beyond enterprise wall"). They may be used for the following typical activities [8]

- knowledge management

- document management
- project management
- ad-hoc collaboration
- e-learning
- marketing and customer relationship management
- replacement of static intranet
- design and documentation of software projects
- technical support of employees

Innovation potential

Use of enterprise internal wikis may lead towards process innovation in number of directions (see above) (as well as towards cost-reduction). Use of enterprise external-facing wikis has innovative potential for customer experience innovation e.g. customer after-sales support, marketing activities.

2.3. Blogs

Blogs (shorthand for "weB LOGS") are basically web-sites (web applications), which may be of three different types depending on who is providing blog content, i.e.

- personal (i.e. of individual) blogs
- group blogs
- corporate (enterprise blogs), which may be provided by employee, group of employees, executive, or "department" for promotion or newsletter oriented.

Personal blog is a personal web-site, dedicated to specific topic that is open to public to read and to interact with [6]. Blogs are often augmented by means of audience communication with blog – namely on-line feedback forms (which may be regarded as an instrument for "user generated content" typical for Web 2.0) - creating two-way (interactive) communication media. Other blog features include content evaluation by visitors, e-mail alerts, RSS, links to social bookmarking sites etc.

Presenting quality content (informative, up-to-date, credible, and valuable) in order to invoke public (i.e. blog readers') interest is the main aim of blogs.

Enterprise/corporate use of blogs

By corporation the following blog types may be used

- corporate blogs open to public - used typically for product development, customer service, product feedback, thought leadership, idea sharing, promotion or for improving PR
- internal corporate blogs – used typically for team collaboration.
- third-party public blogs for Internet advertising (banners, contextual ads PPC or affiliates and other forms for brand and product promotion/sale) as well as for paid independent evaluation of corporation's product written by blogger and posted on popular blog.

Especially for internal corporate blogs software tools provide specific features (in comparison with "public" blogs) similar as for wikis.

Innovation potential

Use of internal corporate blogs by own employees may lead towards process innovation (as well as towards cost-reduction). Use of corporate blogs open to public may lead towards product innovations as well as towards customer experience innovation (as well as use of third-party public blogs).

2.4. Social network-sites, virtual communities

Social network site (SNS) is defined by [2] as "web-based service that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connection and those made by others within the system. The nature and nomenclature of these connections may vary from site to site. SNS [2] are primarily organized around people; they are structured as personal (or "egocentric") networks, with the individual at the center of their own community."

Enterprise use of social networks

With huge user bases of individual SNS, they are typically used by enterprises for various ways of Internet marketing and communicating with (potential) consumers. SNS features made them very convenient for use as seed sites of viral marketing.

SNS are often regarded as specific subset of virtual community, the one which is organized around people and provides specific features (see above), while virtual communities are organized around interest. In number of business publications there is no difference between virtual communities and virtual social networks.

Innovation potential

Use of third-party public social networks by enterprise have a potential for customer experience innovation namely for marketing innovation. Evaluation of SNS enterprise benefits is hot topic at the moment.

2.5. Mashups

Mashup is defined [12] as "a web-based resource, be it content or application functionality, which has been created through reuse and composition of two or more different resources". Being another example of code/data re-use it is a result of "innovation in assembly" principle of software development. The aim is to empower end-user by simple to used tools (software) which would enable even end- user without specific programming experience to create mashups.

There are two types of mashups

- Consumer mashup – for satisfaction of personal end-user requirements. It is typically based on use of content and/or services publicly available on the web.
- Enterprise mashup – for satisfaction of more demanding professional end-user requirements (enterprise requirements). Enterprise internal resources (content, applications/services) are typically used as well as publicly available resources. Number of advanced features is required e.g. application/service integration, solution of security, scalability, governance and others in accord with enterprise IT policy.

Mashups are relatively new technology, with great speed of developments, which has not yet matured, especially in enterprise domain.

Enterprise use of mashups

Enterprise mashups may be used by enterprise mainly as a "lightweight" extension of SOA based on Web Services.

Innovation potential

Use of mashups (and corresponding tools for their generation) is considered as and important IS/ICT innovation instrument.

3. Innovation – practitioners view

Current view of innovation, as an important tool for corporation sustainable competitive advantage, may be well illustrated by results of BCG senior management survey [1] for the following reasons:

- survey is directed towards 2500 largest global companies, in each company directed towards top ten executives in charge of innovation. 2957 responses is very adequate
- survey, from geography point of view, covers well individual continents, e.g. 1259 US respondents, 1037 European respondents
- survey, from industry point of view, covers well individual industries e.g. with 575 respondents from technology and telecommunication industry.

The most important survey conclusions

- innovation is considered by 66% of respondents as company strategic top priority i.e. either top or top-three priority
- at the same time only about 44% of respondents, across all industries, are satisfied with Return on Innovation Spending
- as innovation types most critical for company future success are concerned the "new products and services for existing customers" (89%), followed by „new products and services that allow expansion into new customer groups" (85%) took top of list

Respondents also selected, by their votes, the world's most innovative companies. Company ranking is based 80% on voting, 20% on company economic indicators. Respondents also indicate the primary reason for their selection by choosing one of the following (innovation classes)":

- breakthrough product development (i.e. product innovation)
- breakthrough service development (i.e. service innovation)
- innovative operational processes employment (i.e. process innovation)
- unique customer experiences (that create loyalty) creation (i.e. customer experience innovation)
- new and differentiated business models for revenue streams (i.e. business model innovation)

Top of the list of 50 World's most innovative companies is the following

1. Apple (breakthrough products)

2. Google (unique customer experiences)
3. Toyota Motor (innovative processes)

IS/ICT innovation is not mentioned in the report at all, but it is very likely included as part of other mentioned classes of innovation.

Also IBM report [6] stresses innovation importance for corporations. Report is based on survey of 1130 top managers from around the world. "Their collective wisdom points to the enterprise of the future that is hungry for change, innovative beyond customer imagination, globally integrated, disruptive by nature and genuine, not just generous." Report includes also the (innovation related) following findings:

- "CEOs view a more demanding customer not as a treat, but as an opportunity to differentiate. CEOs are spending more to attract and retain increasingly prosperous, informed and socially aware customers.
- Nearly all CEOs are adapting their business models – nearly two-thirds are implementing extensive innovations. More than 40% are changing their enterprise models to be more collaborative."

4. Conclusion

Although there are still number of not fully covered areas both in academic as well as in practitioners investigations, this paper has shown the basic view of innovation potential of Enterprise web 2.0 instruments as well as innovation importance for enterprises even in current hard economic conditions.

This paper describes the outcome of a research that has been accomplished as a part of research programs funded by Grant Agency of Czech Republic grant No. GAČR 201/07/0455 and GAČR 201/08/0663

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ANALYZING COST EFFICIENCY OF BUSINESS INFORMATICS - A MODEL TO MEASURE DATA QUALITY COSTS -

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Abstract

Data quality is a growing concern of most organisations. Over the last decade research provided numerous suggestions for improving data quality in organisations. However, the measurement of the economic efficiency of data quality projects remains a challenge. This paper addresses the problem of managing cost efficiency of data quality projects. In this paper we propose an approach based on our work on cost efficiency of business informatics projects, in which we measure cost and benefits with business Intelligence (BI) approaches. Our research takes into account requirements of methodologies for the management of business informatics and methods and processes for evaluating and measuring business informatics. We define steps that must be taken into account during creating models for the management of cost efficiency. We propose a new model for the management of cost efficiency. The model has been created with reference to the ITGPM (IS/ICT Management Reference Model), which presents an example for an integrated reference model for managing business informatics. The model considers requirements from accounting as well as requirements from managers of companies. The methodologies, methods and processes are transformed into procedures that are appropriate for measuring and evaluating business informatics and data quality projects. Our proposed model enables monitoring of the actual situation and the evolution cost efficiency. It can be used for making investment or outsourcing decisions. Our model sources costs elements from various cost classifications and has been based on managerial requirements as well as in-house costs structures. It presents an instrument to evaluate the total costs of business informatics and data quality projects.

1. Introduction

Data quality is a major concern for most organisations, and in particular with the increasing amount of data, data quality has become crucial for the success of any organisations. Over more than two decades practitioners and researchers have aimed at addressing this problem, which has resulted in many frameworks and approaches to manage data quality. However, foremost research does not provide detailed cost benefit consideration of data quality projects. Alike many other information system investments, the cost and benefits of data quality projects are difficult to quantify. In this article we investigate this topic from a business informatics perspective, and propose a model and methodology to measure the efficiency of data quality projects.

Companies have to find answers to the following question: What kind of return on investment can an organization expect from its data quality initiative that is important for receiving accurate results from measuring? Many companies find this question difficult or even impossible to answer. The reason for this is the arduous task of quantifying the current costs of low quality data that will eventually be reduced because of deployed data quality activities (which again cause costs that need to be accounted for in an ROI calculation). Calculating the current costs is particularly difficult because many of these costs are indirect costs, that is to say costs where there is no immediate link between inadequate data quality and negative monetary effects. Consequently, it is difficult to identify these often hidden, indirect costs, let alone quantify them.

There are many resources in the field of measuring business informatics. [21], [28], [36], [31], CobiT [13] takes into account only specific aspects of measuring of Information Systems (IS) or Information and communication Technologies (ICT). None of these resources cover this field so complex to be applied consistently with management of costs efficiency of business informatics. It is appropriate to take into account national and international accounting standards as IFRS [12], US GAAP [7], DEU [3] in this sphere. Academia provided several suggestions such as at the Carnegie Mellon Software Engineering Institute ([23], [37]), University of California, Berkeley and Cambridge University [34] and at the Faculty of informatics and statistics at the University of Economics in Prague ([19], [20], [24], [26]), Czech Technical University in Prague [21] and others. Some of these publications are expand by this model. Complexity of questions that are connected with measuring of economic efficiency is caused by many factors. Some of these factors are for example: amount of indicators for measuring economic efficiency, complexity of business structures unions in national and transitional companies and complexity of in-house divisions/unions in national and in transitional companies ([1], [18], [19], [20], [21], [26]).

In the last year’s significance of and emphasis on measuring of cost, profits and gains is increasing. This is valid also for indicators of current situation/efficiency. We can say the importance of the economic viability of a business informatics related investment is high such as the related work of [17], [21], [33] and [1], [22], [30] indicates. Some indicators of cost efficiency for example are [5]:

- costs on IT as the percentage on turn-over,
- ratio on count of IT professional on count of all employee,
- ratio on internal IT professional to IT contractors and outsourcers,
- ratio on operational budget IT on one employee.

Recently approaches start to employ Business Intelligence (BI) tools and Corporate Performance Management (CPM) in the field of economic efficiency analysis [10]. BI and CPM allow setting up for measuring economic efficiency following items:

- Tools that guarantee automatic data transfer from in-house accounting and related data transformations and purifications ago their saving into the target Data Ware House (DWH).
- Defined systems of indicators (KPI, PI, and KRI): we can find out current situation and changes in economic position of business informatics through the medium of these indicators.
- Systems of indicators that are analyzed from various views.

However, the current approaches still have limitations to measure costs/benefits. As our previous research indicates, efficiency measures of data quality are particular challenging [5]. Although there is a plethora of literature that claims that the costs of missing data quality are substantial in many companies (e.g. [2], [4], [9], [11], [29]), there are still very few studies that actually demonstrate how to identify, categorize and measure such costs (and how to establish the causal links between data quality defects and monetary effects). Indeed, there is currently no validated economic theory of data quality costs that could be used as a basis for data quality cost analysis. So far there are only a few approaches analyzing the cost and benefit structure from an economic perspective, as for instance in [2].

Objective of this paper is to propose an approach for measuring cost/benefits. The work is based on our research of measuring the efficiency of business informatics projects and is aimed to provide a valuable discussion base for identifying critical points in cost/benefit considerations.

The remainder of the paper is structured as follows: In section 2 we discuss the requirements for a data quality cost benefit model. In Section 3 we outline our related work and present a framework and methodology for measuring efficiency. We propose a cost benefit approach in Section 4, which is applied in Section 5 within an organisational context. We conclude and summarize our research in Section 6.

2. Requirements for a Data Quality Cost Benefit Model

What kind of return on investment can an organization expect from its data quality initiative? Many companies find this question difficult or even impossible to answer. Although the plethora of literature that claims that the costs of missing data quality are substantial in many companies, there are still very few studies that actually demonstrate how to identify, categorize and measure such costs (and how to establish the causal links between data quality defects and monetary effects). This lack of insight regarding the monetary effects of low quality data, however, is not only an open research problem, but also a pressing practitioner issue. Humbert and Elisabeth Lesca, two information management consultants and university professors, conclude similarly that it is very rare that a company analyses the costs resulting from non-quality information [9]. Although we agree with the fact that data quality costs are context-dependent [2], that is to say that the types of damage caused by low quality data depend on the nature of the managed data, its uses and responses, we believe that proven approaches from other cost domains (such as accounting or manufacturing) can be fruitfully applied to the data quality field.

The reason for this is the arduous task of quantifying the current costs of low quality data that will eventually be reduced because of deployed data quality activities (which again cause costs that need to be accounted for in an ROI calculation). Calculating the current costs caused by insufficient levels of data quality is particularly difficult because many of these costs are indirect costs, that is to say costs where there is no immediate link between inadequate data quality and negative monetary effects. Consequently, it is difficult to identify these often hidden, indirect costs, let alone quantify them.

Cost Benefit analysis of data quality initiatives can enable practitioners to better argue their business case by more easily identifying current costs of low quality data. For researchers, a cost benefit approach can be helpful to develop more detailed and quantifiable measures of data quality costs and to prepare – subsequently – benchmarking studies, comparing different cost levels in different organizations in a coherent manner and based on consistent cost distinctions.

3. A Framework and methodology for measuring efficiency

Our work on data quality cost benefit measures is framed in our basic research aiming to provide cost efficiency approaches of business informatics. This research results from the work were carried out at the Department of information technology (KIT), School of Computing (SC) and from other literature. ([19], [20], [28], [26], [30]) In our work we identified following basic facts:

- Increasing costs on business informatics without transparent identification gains of rendered services.
- The existence of business informatics as a cost unit without transparent dividing costs between users of services provided by business informatics.
- Impossibility of recognition, whether the business informatics is sufficiently effective or whether it is profitable to use external provider.
- Problems with identifying all cost (=data quality input data sources) spend on services provided by business informatics.

Costs have the main role in the field of business informatics because almost any manager decision results from comparison costs (how much money we have to invest) with profits (how much money we gain). [1]

In the economic practice it is common a situation, when measuring direct costs doing not represent real costs that are connected with the subject of measuring. They usually contain in addition cost as depreciation of investment, defined ratio on overhead development costs etc. This has been already solved by TCO, but the basic gadgetry of this methodology is not public – this is Gartner's private methodology. [7]

It is important to provide comparable information about cost efficiency based on the identical principles as in other business units in the company with respect to dynamic economic changes and in a lot of cases due to grow staggering of requirement of business informatics on financial resources,. Another problem that affect evaluation of cost efficiency of business informatics, is the way, how are accounted services provided by business informatics and consume by other business units. Finally data quality is a common problem and costs that are important to spend on achieving desired data quality level.

The model of management of cost efficiency has arisen as a new part of Information Systems/and Information and Communication Technologies (IS/ICT) Management Reference Model (ITGPM) (Figure. 1). ITGPM is integrated reference model for managing business informatics. [35]

The first stage of creation of the costs efficiency model was based on an analysis and synthesis of existing management methodologies and evaluating/measuring methodologies that have been formed for business informatics as ITIL [14], CobiT [13], TCO[1] [7] etc.).

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1 TCO (Gartner, 2006) is one of the most significant approach to measuring not only business informatics cost but also business informatics' total costs of ownership and nowadays is TCO informal standard for this area of analysis.

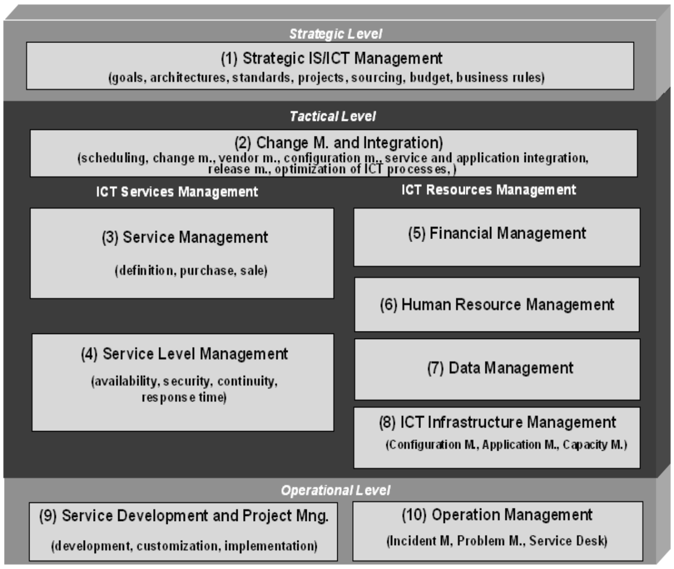

Figure 1: ITGPM [35]

Other analyzed methodologies whose basics are contained in ITGPM (block: "Financial management - Management of economic efficiency IS/ICT) are for example Corporate Performance Management (CPM) [36], Value-Based Management [16]. Current models of measuring of efficiency of business and business processes have been modified to be appropriate for requirements of business informatics or to be appropriate for conditions in the Czech Republic. Especially following resources [8], [19], [20], [26], [28], [30] were used from the field of measuring and evaluating of economic efficiency.

A proposed cost benefits approach:

In the following we describe, based on the framework discussed above, four basic steps of our proposed cost benefit approach. The four basic steps are as follows:

1. Definition of preliminary conditions of the model of cost efficiency.
2. Synthesis allows containing all of analysed models into one generic model.
3. Design of the model of cost efficiency.
4. Definition and relationship to a domain specific data quality model.

(1) Definition of preliminary conditions of the model of cost efficiency

Early were defined the basic principles of the in-house cost accounting and the principles of its use in management of business informatics. Suggested model is primarily based on them. Basic principles of this approach are identical with financial accounting. In other words we can say each accounting transaction, which is caused by activity in the in-house unit, is carried to the ledger by double entry. Really important is each in-house unit has its own evidence of cost and profits. Critical point of these activities is each in-house unit has to make a transfers of all relevant transactions from financial accounting into accounting of given in-house unit. In the in-house unit's accounting is valid that each unit has to record all business contacts with another in-house unit by double entry. By way of these principles we know all of accounting operation (cost and profits) that follow on services provided by business informatics to other in-house units.

All IS/ICT costs have to be recorded in the scope of defined model. This model also defines rules that have to be kept (for example costs are recalculated on each ICT service, costs are recalculated on each user of particular services in detail etc). The model can use traditional accountancy at the beginning of measuring economic efficiency IS/ICT. As soon as we want to implement effective management of economic efficiency of business informatics, it is necessary to have more detailed and fine analytical differentiation among accountancy. All costs caused by rendering services to other units have to be charged to the units that use this services/output.

(2) Synthesis allows containing all of analyzed models into one generic model.

Knowledge and skills acquisition from methodologies about management of companies were interconnected with the definition of mentioned preliminary conditions to creation of the model. (See Ad 1)) Final effects of this phase were determination of principles and specific properties at which is model based. For example: model for measuring of cost efficiency of business informatics is based on principles of field Business Intelligence (BI), model has to provided for costs analysis costs at the lowest level (on the each employee) and model has to taken into account the time factor. The model has to enable automatic calculations selected economic indicators (for example ROI, percentage change of costs in comparison with previous year, etc.) within the scope of the project.

(3) Design of the cost efficiency model

We have designed the model relating costs from aspects of investment, operative and another more detailed classification of activities (installation, HW service, training, administration etc) that are connected with their creation. Designed model have been based on above mentioned facts as companies and in-house costs structure. All of these activities are instruments to evaluation of total costs of business informatics and especially tag prices for services provided by business informatics to other in-house units.

The model of costs efficiency of business informatics is concerned of all basic fields that should be monitored in business informatics. This is done from the view of companies that is monitored their "profitability" and from the view of financial managers that care for financial health of business informatics and entire company.

We have defined the request "model is based on principles of BI" in previous phase. The consequence of this are selected following the most interesting dimensions and indicators included in the model. [18]

Dimensions

- Reality (plan, reality)
- Accounting view (cost, profit, gain)
- Complex service (SAP, Accounting…)
- Particular service (implementation, services, HW services…)
- Unit
- Employee
- Activity (installation, operation and maintenance)
- Component (HW components, SW components etc.)
- Time

Indicators

- Total costs
- Total profits

- Profits/Loss
- Costs development in time (% change)
- Profits development in time (% change)
- Gains development in time (% change)

Designed model of data level fulfil conditions defined in previous text[2]. The heart of the solution is one or more fact entities that contain all economic ("live", frequently changing) data. The model has been designed with respects to principles of BI. They allow easy and for managers friendly form of analysis of cost efficiency of business informatics.

Two main features of the practical solutions of the model of management of cost efficiency is analytical level and presentation level. Presentation level allow to user find out economical characteristic of business informatics that was defined on analytical level. Above defined dimension are used to finding changes in economic indicators from various views.[3]

(4) Definition of a domain specific data quality model

Data quality costs consist of two major types, namely improvement costs and costs due to low data quality [5]. Whereas improvement costs can be categorized along the information quality process (from prevention, detection, to repair), costs due to low quality data can be categorized in terms of their measurability or impact, e.g., direct versus indirect costs. Combining these two insights, we can devise a simple classification of data quality costs. Our classification is presented in Figure 2:

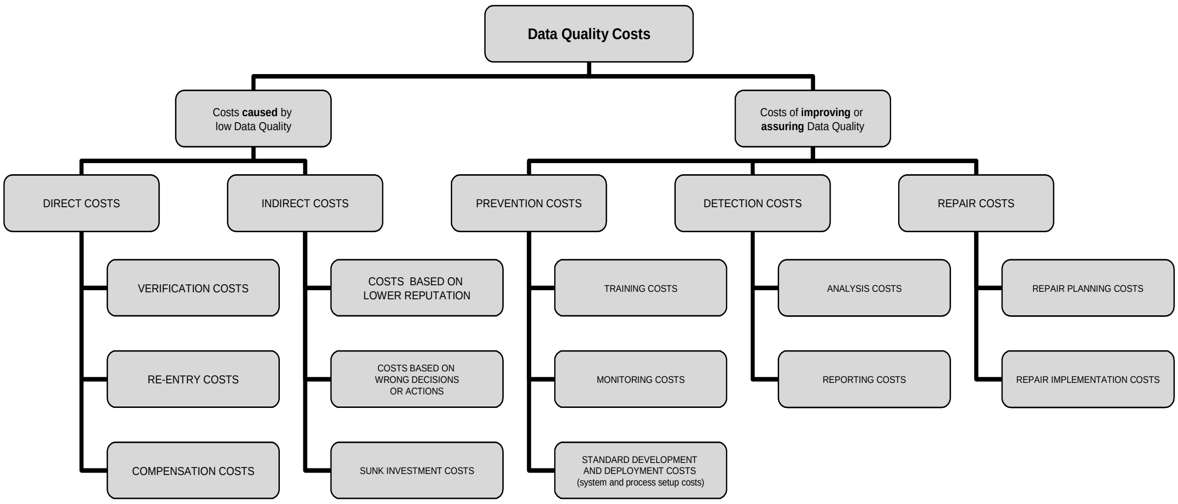

Figure 2: A data quality cost taxonomy [5]

Initial this data quality classification is based on the core distinction of costs due to low data quality versus costs caused by data quality assurance measures. In the low quality data cost section, the key distinction is, as stated, the one among direct costs and indirect costs. Direct costs are those negative

2 Simplifies diagram – full vision of the model cost efficiency is contained in dissertation thesis and grant project's IGA VSE 17/08. Full model of cost efficiency is the part of ITGPM.

3 Practical application of this model is in MS SQL Server 2005 that provides good opportunities for analytical solutions and also provides good possibilities for creating user level (for example connecting with MS Excel 2007).

monetary effects that arise immediately out of low data quality, namely the costs of verifying data because it is of questionable credibility, the costs of re-entering data because it is wrong or incomplete, and the costs of compensation for damages to others based on bad data. Indirect costs are those negative monetary effects that arise, through intermediate effects, from low quality data. Such indirect costs are loss of a price premium because of a deteriorating reputation, the costs incurred by sub-optimal decisions based on bad data, or the investment costs that have to be written off because of low quality data. In terms of costs that arise in order to improve data quality (that is to say to lower the costs of low data quality), we distinguish among prevention, detection, and (one-time) repair costs. While this classification is informative, it cannot yet be used for the pro-active cost management of information quality and the cost-benefit analysis of information quality programs.

Total data quality costs are determined from the summarization of all involved costs. We have carried out a confrontation of the model of measuring economic efficiency in companies practice in the third phase. Confrontation was made with specialist (especially managers) from companies (financial directors, directors of business informatics etc.). The last phase of the project was based on implementation of the model in companies practice. The model of cost efficiency is currently validated in private companies (e.g. Siemens IT Solutions and Services) and public company (Czech government for social security).

4. Application and Practical Implications

In the context of the data quality, there is presented a fraction of the model of in-house accounting of business informatics unit on the Figure 4 that have been applied in selected companies. The model has to be always modified according to situation in company where is applied. We have to take into account some critical success factors (CSF) when we want to set up management of cost efficiency into the company. Some of the really important CSF from various problem domains that have to be taken into account is following items:

- Definition of views in which firm is interested in.
- Basics perspectives on economical situation of business informatics.
- Specification of data sources for analysis of cost efficiency.
- Determination of data quality that guarantees accuracy of analysis.
- Bridging for transferring of data from in-house accounting to the analytical database.

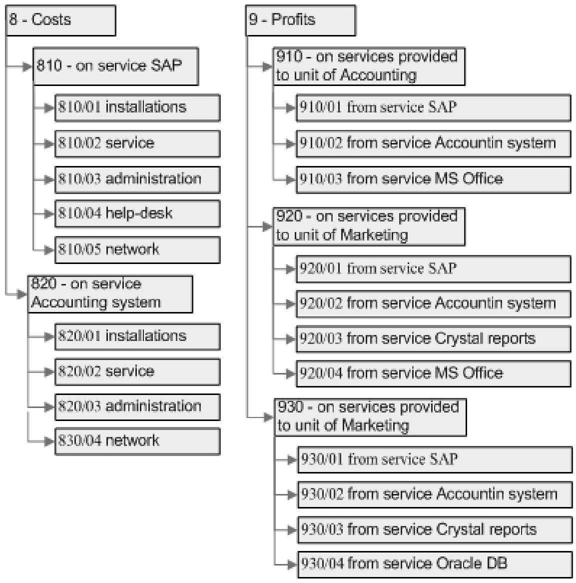

Figure 3: Illustrations of the model of in-house

Definition of budgeting procedures for costs that is not possible uniquely charged to specific user, in-house unit etc. Some of these uniquely not charged costs are administrative costs, costs on maintenance of property that are used by all in-house units/employee (Central Data Storage).

For the creation of the analytical level of the model of cost efficiency it is important that it is properly designed (See Figure 3) data level. Except this is necessary the data level have to be filled by correct data. This data have to be in required detail that gives information about present state and about changes in cost efficiency of business informatics in time. Detail evidence of costs, which is required by the model, is easily usable for measuring and evaluating of cost efficiency of business informatics. Note: There is important to respect above defined conditions in the model. Scientific and practical findings from the model can be used to decisions about outsourcing parts of business informatics or outsourcing entire business informatics.

Views on data in the fact table (there could be more than one fact table) analysed through the selection of appropriate dimensions is usually possible presents in the form of tables and graphs. We have to mention that in a lot of cases is not possible to add all analysed information into one table. One of examples could be interconnection of accounting information with information about employee's performance that is presented in following table.

Table 1: Details of cost structure – presents detailed view on selected costs in December 2008 that are segmented according to the various hierarchical levels of relationships between subordinate officers and supervisors in the company.

	Cost - IT - material consumption (PC)		Costs - Rent - Rent for building			
	Costs - reparation, maintenance, údržba,IT consultation - locality A	Costs - reparation, maintenance, údržba,IT consultation - locality B	Rent- locality A	Rent- locality B	Rent- locality C	Rent- locality D
year 2008	2 647,36	4 319,91	42 782,25	372 404,81	14 386,03	6 731,89
december 2008	2 647,36	4 319,91	42 782,25	372 404,81	14 386,03	6 731,89
Top manager 1	2 647,36	4 319,91		362 119,75		
Horizontal manager	2 647,36	4 319,91		362 119,75		
Account manager 1	2 647,36	4 319,91		362 119,75		
Team leader 1	240,67	111,76		34 283,53		
Team leader 2	842,34	1 993,55		117 849,62		
Team leader 3	842,34	1 713,04		110 564,37		
Team leader 4	120,33	222,17		17 141,76		
Team leader 5	601,67	279,39		82 280,46		
Top manager 2			42 782,25	10 285,06	14 386,03	6 731,89
Fictional team leader - employee with notice				5 142,53		
Fictional team leader - not identified employee			42 782,25	5 142,53	6 740,23	6 731,89
Fictional team leader - maternity leave					7 645,80	
Sum	**2 647,36**	**4 319,91**	**42 782,25**	**372 404,81**	**14 386,03**	**6 731,89**

Table 1: Details of cost structure

Table 2: Interconnection between costs – presents relation between accounting costs that are inscribed in accounting books and costs defined as internal cost rate. We present employee's profitability derived from employee hour's performance that has been recorded in defined month and accounting cost that was caused by employees in defined month in the table.

If we know the internal cost rate and the sum of offered hours for the project (this is defined in tender), we can specify our costs on the project and also final price of the project for the customer. In this table we compare basic accounting cost (without central costs) with all accounting cost (central costs included – this costs are budgeted according to the defined rules) and costs on project/employee according to the internal cost rates.

A last column of the table describes whether expected costs have been exceeded or not. If the expected cost weren't exceeded (negative) – employee is profitable. Analysis is pursuance on the detail of cost on each employee.

	Accounting costs 1 (withnout central costs)	Accounting costs 2 (central costs included)	Costs based on internal costs rate	Difference between Costs based on internal costs rate and Accounting costs 1	Savings on accounting costs 2 compared to internal costs rate (profit on position)	Internal cost rate compared with accounting costs exceeded 2 %
year 2008	**148 789,13**	**1 441 602,13**	**2 729 108,73**	**2 580 319,61**	**1 287 506,60**	**-47,18%**
december 2008	**148 789,13**	**1 441 602,13**	**2 729 108,73**	**2 580 319,61**	**1 287 506,60**	**-47,18%**
AM Team Leader	**16 407,36**	**167 641,82**	**55 677,49**	**39 270,13**	**-111 964,33**	**201,09%**
AM Team Leader 1	16 407,36	167 641,82	55 677,49	39 270,13	-111 964,33	201,09%
Business Consultant	**9 685,00**	**111 960,33**	**1 165 230,00**	**1 155 545,00**	**1 053 269,67**	**-90,39%**
Business Consultant 1	9 685,00	111 960,33	1 165 230,00	1 155 545,00	1 053 269,67	-90,39%
Call Center Senior Officer	**7 115,97**	**114 196,97**	**76 040,34**	**68 924,37**	**-38 156,63**	**50,18%**
Call Center Senior Officer 1	7 115,97	114 196,97	76 040,34	68 924,37	-38 156,63	50,18%
Practice Manager	**35 279,66**	**295 652,29**	**308 905,10**	**273 625,43**	**13 252,81**	**-4,29%**
Practice Manager 1	35 279,66	295 652,29	308 905,10	273 625,43	13 252,81	-4,29%
SAP Consultant	**25 457,38**	**261 359,75**	**436 903,83**	**411 446,45**	**175 544,08**	**-40,18%**
SAP Consultant 1	8 520,58	67 756,84	182 217,23	173 696,65	114 460,39	-62,82%
SAP Consultant 2	8 520,58	128 133,86	161 970,88	153 450,29	33 837,01	-20,89%
SAP Consultant 3	8 416,22	65 469,04	92 715,72	84 299,51	27 246,68	-29,39%
Junior SAP Consultant	**8 520,58**	**94 116,06**	**151 847,70**	**143 327,11**	**57 731,63**	**-38,02%**
Junior SAP Consultant 1	8 520,58	94 116,06	151 847,70	143 327,11	57 731,63	-38,02%
Senior SAP Consultant	**46 323,17**	**396 674,92**	**534 504,28**	**488 181,12**	**137 829,37**	**-25,79%**
Senior SAP Consultant 1	16 407,36	91 035,06	131 601,34	115 193,98	40 566,27	-30,83%
Senior SAP Consultant 2	8 520,58	86 051,01	113 885,77	105 365,19	27 834,76	-24,44%
Senior SAP Consultant 3	12 979,01	143 523,42	142 989,91	130 010,91	-533,50	0,37%
Senior SAP Consultant 4	8 416,22	76 065,42	146 027,26	137 611,05	69 961,84	-47,91%
Sum	**148 789,13**	**1 441 602,13**	**2 729 108,73**	**2 580 319,61**	**1 287 506,60**	**-47,18%**

Table 2: Interconnection between costs

Last table (Table 3: Assigned and recorded hour's on selected IT projects) compare hours assigned to the project (hours contained in tender) with hours recorded by employees on this project. The last column describes whether calculated sum of hours was exceeded or not. If the sum of hours defined in tender was not exceeded (negative) by sum of hours recorded by employees on the project, the profitability of the project was higher than expected. If the result is zero (sum of recorded hours and hours defined in tender are in balance), the profitability of the project is on expected level.

	Hours assigned to project	Allot hours	Hours assigned to project exceeded %
year 2007	**10 909,0**	**10992**	**0,76%**
Project 1	5 347,5	5483,5	2,54%
Project 2	1 582,5	1582,5	0,00%
Project 3	458,0	458	0,00%
Project 4	1 514,0	1382	-8,72%
Project 5	723,0	674	-6,78%
Project 6	120,0	120	0,00%
Project 7	761,0	889	16,82%
Project 8	253,0	253	0,00%
Project 9	150,0	150	0,00%
year 2008	**11 790,5**	**12050,5**	**2,21%**
Project 1	5 764,5	5905,5	2,45%
Project 2	1 740,0	1740	0,00%
Project 3	606,5	606,5	0,00%
Project 4	1 523,0	1523	0,00%
Project 5	700,5	700,5	0,00%
Project 6	172,0	172	0,00%
Project 7	859,0	978	13,85%
Project 8	306,0	306	0,00%
Project 9	119,0	119	0,00%
Sum	**22 699,5**	**23042,5**	**1,51%**

Table 3: Assigned and recorded hours on selected IT projects

In all of the examples users defines a level of granularity presented information through appropriate selection of dimensions and indicators. Important factor affecting usability of analysed data for preparation of prediction future evolution of business informatics and its economical situation is frequency of measuring/detection of results of indicators. Detection of some indicators only once could be worthless and couldn't provide any value added. If we want to make prediction of future evaluation, we have to make more shots of actual state of economics efficiency of business informatics.

Monitoring of costs etc. (on the one hand on services and on the other hand on property of company) has to be on the most detailed data level (granularity). The most suitable detail of data level is data-logging on the level of tasks/activities/services that are account to specific user (particular employee, unit etc.). Charging of services provided to a particular employee/unit is easy because we know causality between costs on services and their particular user. Really complicated is charging shared services (cost expended on them) to specific user/unit in specified value (e.g. costs on service "administration of business network", costs on service "administration of central data storage" etc.). In this case is really important correctly defined data-logging level, knowledge in causality between costs on services and their user and procedures for recalculating of costs.

5. Conclusions

Specification and calculation of data quality cost and benefits are as any business informatics economic evaluation challenging. Explicit and clear procedure should be kept. Procedures have to be transparent for every unit that use services rendered. Complexity of all mentioned factors is connected not only with calculation of costs but especially with definition of method how interconnect business accounting with accounting kept by business informatics. However, if the data quality field is to make significant progress in terms of its acceptance in the business world, the costs associated with low data quality must be made more explicit, prominent, and measurable. They must be compared to the cost of assuring data quality, so that an optimal investment point for data quality can be approximated. A systematic method for data quality cost benefit analysis can help companies to determine such an optimal level of investment in data quality.

As shown by our research and the proposed approach demonstrated in this paper, the ITGPM should allow optimizing of business informatics as a whole, and thus also for data quality cost benefit evaluations. Model of cost efficiency of business informatics that is presented in this article is one of parts of the ITGPM. Cost can be transparently assigned to other in-house units when they are finding out from accounting and cost analysis. Cost finding out by this way is possible assign to other in-house unit that use services provide by business informatics which increase cost their outcome which should be included into prices of final company outcome. In many cases can be found out in terms of executed measuring that for company is more efficient use external provider of business informatics services than to have own IT department.

Although we believe that this article provided some valuable insight in cost benefit consideration, this research has also its limitations. Indeed, further studies are required to further detail and validate our approach, and thus gain more generic cost benefit models and methodologies. These models and methodologies can then be applied to various domains.

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PERFORMANCE BASED EARNED VALUE: METHOD AND USE

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Abstract

The paper is outgoing from the principles and guidelines of the method published by P. Solomon and R. Young called Performance Based Earned Value (PBEV). The method is defined as an enhancement of the EVMS, Earned Value Management Systems standard. The second part of paper discusses some possible approaches to the use of the mentioned method in the context of IS/IT management. It also includes its comprehension into concepts and model solutions named ITGPM (IT Governance and Performance Management) developed at the Department of IT on the Prague University of Economics. The model integrates various methods and analytical applications based on the business intelligence infrastructure and PBEV became one of them.

1. Introduction

PBEV represents fundamental guidelines that are using the most effective measures of cost, schedule, and technical performance in project management. So, PBEV is one of the most effective tools of quantitative project management, yet it could be used in other fields of the corporate and IT management. The paper analyses the principles of Earned Value Management (EVM), Performance-Based Earned Value (PBEV) and possible use in broader sense, that is in IT management and IT performance management.

2. EVMS and PBEV Basic Characteristics

Performance-Based Earned Value is viewed as an enhancement to the Earned Value Management Systems (EVMS) national standard (PMBOK - Project Management Body of Knowledge*)*. PBEV added to this standard new principles and guidelines for comprehensive integration of project cost, schedule and technical performance. PBEV also incorporates product requirements and planned quality based on Performance Measurements Baseline (PMB).

EVM is declared as a project management tool focused at quantity of work, project costs, schedule, and performance analysis. Yet, the quantity of work used in project is primarily stressed. Rather less importance is afforded to the quality of work and technical parameters of final products (project outputs) in this method.

3. EVM, Earned Value Management

Earned Value Management ([1], [7], [9]) comprises sets of components structuring project works, products and organizational units and on the other hand sets of metrics enabling their effective measurements and analysis. The further text is respecting standards of PMBOK (Project Management Body of Knowledge, see [4]) and represents a brief summary of EVM including specifications just of basic components, metrics and their relationships.

EVM concept uses in project management various views and structures, see Figure 1.

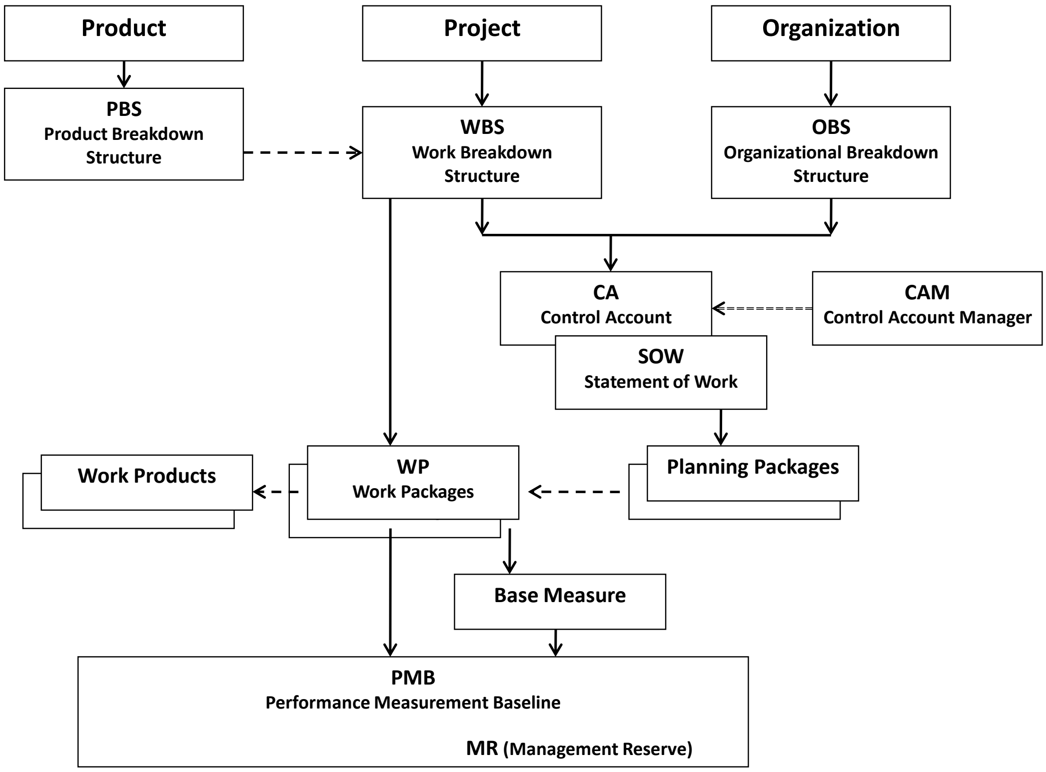

Figure 1: Basic Components of EVM (Source: author)

Three basic structures have been comprised in the figure above. The WBS (Work Breakdown Structure) is viewed as a product oriented decomposition of the entire project into different project tasks. “Product oriented” means the structure is primarily derived from PBS (Product Breakdown Structure), e.g. elementary modules or components of projected system, software products and others. It enables transparency of project works and control on their appropriate granularity named work packages (see later). WBS allows for the integration of technical, schedule and cost data. The Organizational Breakdown Structure (OBS) describes organizational units performing project tasks and work packages respectively. The assigned responsibility is important characteristic of organizational units too.

The Control Account (CA) means interlinks between WBS and OBS. Each CA is managed by Control Account Manager (CAM). The CAM prepares for CA Statement of Work (SOW) specifying all technical, budget, and schedule objectives. Planning and managing of project work are provided by CAM on the lowest level of work packages and planning packages.

The Performance Measurement Baseline (PMB) is an approved plan of project, typically integrating scope, schedule and cost parameters. Management Reserve (MR) represents the total available budget to mitigate schedule or cost risks. The PMB is based on the complex set of metrics documented by the next figure.

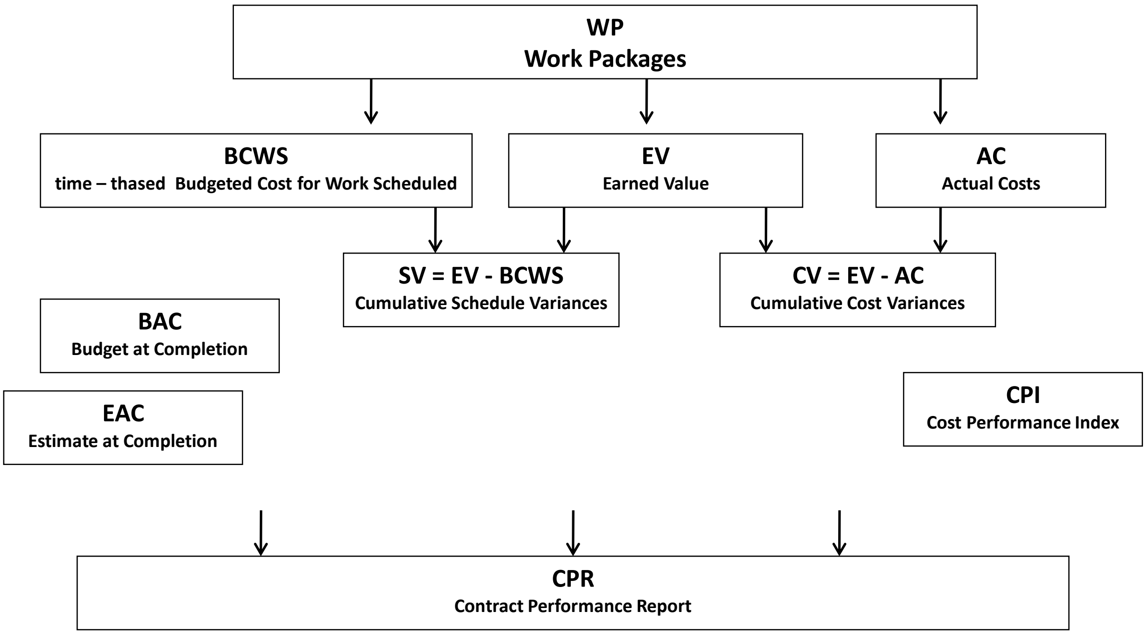

Figure 2: Measures in EVM

The initial work and measurement unit is called work package as mentioned above. The time phased Budgeted Cost for Work Scheduled is developed as one of base measures. During the project execution will be determined the value of the work that has actually been accomplished, called Earned Value (EV). BCWS, actual costs (AC) and earned value are basic metrics needed for variance analysis to look for where reality of project differs from planned or budgeted values. There are two variances measures:

Cumulative Cost Variances: CV = EV – AC

When the actual costs of the work accomplished exceed the planned costs will be cost overrun that means bad result.

Cumulative Schedule Variances: SV = EV – BCWS

When the planned value exceeds the earned value, the activity is behind the schedule that means also bad result

All basic and calculated measures are summarized according to work packages in the Control Performance Report (CPR). Besides already discussed measures it includes also another item – Cost Performance Index (CPI). The formula of it is rather simple:

CPI = EV / AC

It is a ratio of what is accomplished at the planned cost divided by the actual costs. If CPI < 1 it indicates the situation that it costs more to provide a unit of earned value, than we planned. That is the case of inefficient labor.

The example of such CPR document shows the following table.

WBS	BCWS	EV	AC	SV	CV	CPI
1 DWH – feas. study	5 000	5 000	5 000	0	0	1.00
2 DWH – analysis	1 000	900	900	-100	0	1.00
3 DWH – design						
3.1 Requirements anal.	1 500	1 100	1 150	-400	-50	0.96
3.2 Dimensional model	1 000	800	805	-200	-5	0.99
Total 3	2 500	1 900	1 955	-600	-55	

Table 1: The Example of CPR

4. PBEV, Performance Based Earned Value

PBEV formulates its principles in some broader sense. It incorporates clearly defined success criteria of solutions based on measurements and metrics reviewed during preplanned milestones within the project schedule. The qualitative parameters are more significant than others. PBEV is also based on the principles and results of risk management streaming to better indicating of possible failures or problems in schedule or cost fulfilling.

The fundamental concept of PBEV is to integrate cost, schedule, technical requirements and quality parameters into one project management tool. Some of its basic characteristics are as follows (see [6]):

- "The plan is driven by product requirements, not work requirements.
- Earned value is based on technical maturity and quality, in addition to work completed.
- Technical performance is determined by meeting success criteria of technical reviews.
- The approach:
  - Adheres to standards and models for systems engineering, software engineering, and project management,
  - Provide smart work package planning.
  - Enables insightful variance analysis.
  - Ensures a lean and cost-effective approach.
  - Enables scalable scope and complexity of management control, depending on risk.
  - Integrates risk management activities with Performance Measurement Baseline (PMB).
  - Incorporates quantified risk assessment into Estimate at Completion (EAC),
  - Is applicable to all development models and methods, including agile methods."

The PBEV process flow is actually consistent with the EVMS processes. In addition PBEV process respecting product requirements and risk management is more comprehensive and effective. The most important PBEV principles such as integration of risk management and EVM create needed platform for including PBEV into CPM concepts. Thus, PBEV formulates some of basic requests to the business processes, KPI and needed analytical tasks and applications. ´

5. PBEV and EVMS Principles

The PBEV is based on the 11 basic principles, 7 of them are those formulated formerly by the EVMS standard, 4 of them are newly defined by P. Solomon and R. Young especially in the PBEV context. Further items summarize all included principles creating logical fundamentals of PBEV method. (P) is marking new 4 principles specific for PBEV (see [6], p. 15):

1. “Plan all work for completion.
2. Integrate product requirements and quality into the project plan (P).
3. Break down work scope into finite pieces that can be assigned to a responsible person or organization for control of technical, schedule, and cost objectives.
4. Integrate project work scope schedule, and cost objectives into a performance measurements baseline against which accomplishments may be measured. Control changes to baseline.
5. Specify performance toward meeting product requirements, including planned quality, as a base measure of earned value. (P).
6. Use actual costs incurred and recorded in accomplishing the work performed.
7. Objectively assess accomplishments at the work performance level.
8. Analyze significant variances from the plan, forecast impacts, and prepare an estimate at completion based on performance to date and work to be performed.
9. Use EVMS information in the company´s management process.
10. Integrate risk management with earned value management (P).
11. Tailor the application of EVM according to the risk (P).”

Each principle mentioned above is described with a set of guidelines documenting needed activities leading to the respecting of the specified principle. For instance, to the principle “Integrate product requirements and quality into the project plan” are following guidelines defined [6]:

- Establish product requirements and allocate these to product components.
- Maintain bidirectional traceability of product and product component requirements among the project plans, work packages, planning packages, and work products.
- Identify changes that need to be made to the project plans, work packages, planning packages, and work products resulting from changes to the product requirements.

All PBEV principles are completed with guidelines. Detailed guidelines specifications include possible sources, practices and recommendations. In that manner PBEV forms the complex method for practical use.

6. PBEV Use in IS/IT Management

There are many methodologies and models in the field of complex IS/IT management such as ITIL, COBIT and others. The specific approach is focused on the IT Performance Management (IT PM) outgoing form concepts of Corporate Performance Management [5]. One of such models is being developed on the Department of IT, Prague University of Economics called ITGPM - IT Governance and Performance Management.

The general scheme of ITGPM shows the following figure (see [2],[3],[8]). One of the key principles of IT performance models is the effective integration of management methods, processes, metrics and analytical applications. Performance Based Earned Value Method and its elements could be comprised into the overall performance concept as is newly documented by the figure.

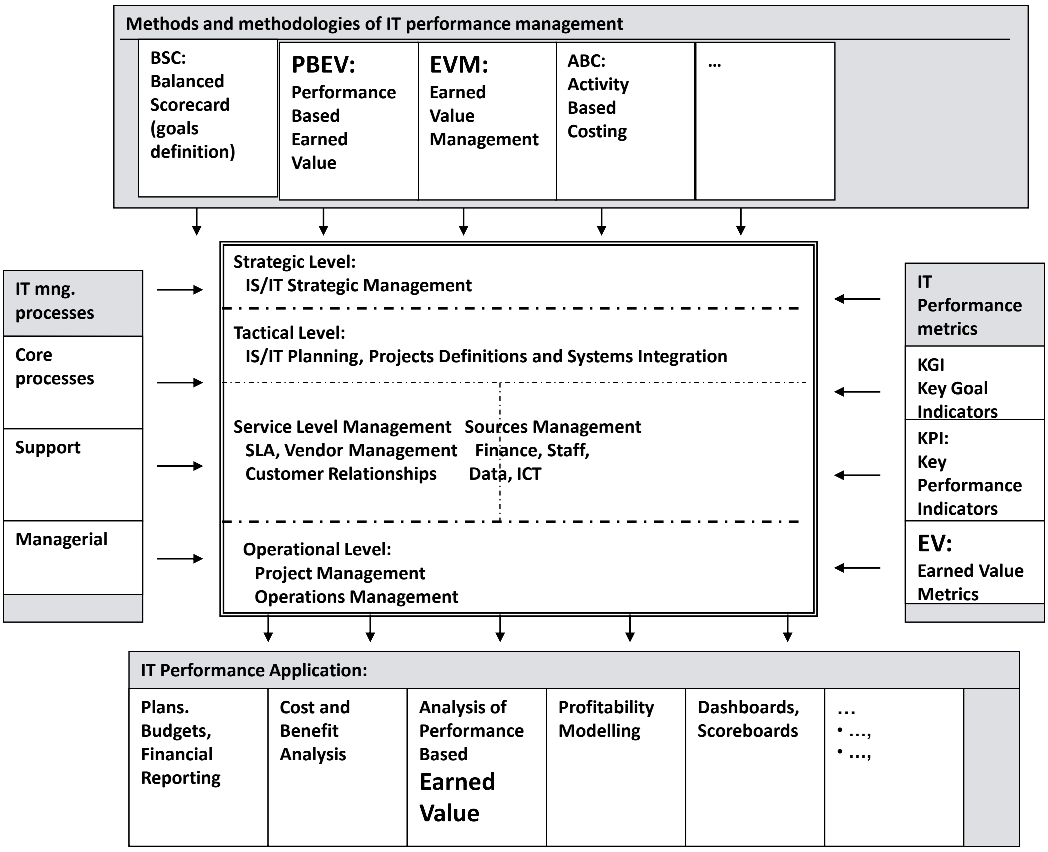

Figure 3: Map of ITGPM IT Governance and Performance Management with PBEV

7. Conclusion

The comprehensive ITGPM model comprising PBEV is able to bring new effects as follows:

- The principles of PBEV (incl. EVM) could be effectively used not only for project management but also for service management and other domains.
- The PBEV offers new special set of metrics and calculated measures needed for the strategic, tactical and operational level of IT management (see fig. 3).
- The principles and guidelines of PBEV bring innovation aspects to the process development both of corporate and IT management.
- The PBEV concept and set of metrics mentioned above define new requirements on analytical and planning applications including new measures (e.g. earned value, cumulative

cost variances, cumulative schedule variances, cost performance index and others), new dimensions (e.g. control accounts, work packages, product packages, planning packages) etc.

- The PBEV and EVM are supported by the worldwide de facto standards (PMI, PMBOK, CMMI and others). The application of such standards in IT PM models is evidently also needed and respected.

The trends of IT performance management are basically focused on the integration of new managerial methods and their elements of broader use. The use of PBEV in that context could be one of very significant examples.

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RESEARCH ON IMPACT OF ERP SYSTEM ADOPTION AND OF ITS EXTENT ON BUSINESS PERFORMANCE: SAMPLE SIZE MATTERS

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Abstract

A notion that information technology does not improve productivity and the terms technology/ technological/productivity paradox are around for at least two decades. This notion is now extended also to enterprise resource planning (ERP) systems. But probably the right question to ask is whether ERP systems do not matter at all or is it only the measurement that does not allow for identification of their impact. The research is based on data from Danish, Slovak, and Slovenian companies. Turnover development is used as a proxy for business performance, and the number of processes covered by an ERP system and the subjective estimate of the percentage of ERP system functionalities being used are used as proxies for the extent of the ERP system adoption. This paper investigates several different ways of estimating impact of ERP system adoption and/or its extent on business performance and illustrates to what extent the sample size matters in finding significant relationships.

1. Introduction

The enterprise resource planning (ERP) system is an integrated set of programs that provides support for core business processes, such as production, input and output logistics, finance and accounting, sales and marketing, and human resources. An ERP system helps different parts of an organization to share data, information to reduce costs, and to improve management of business processes [1]. Wier, Hunton, and HassabElnaby [24] argue that ERP systems aim to integrate business processes and ICT into a synchronized suite of procedures, applications and metrics which goes over firms' boundaries.

According to Peslak [18], ERP systems have become the de facto standard for large and medium companies to run all their major functional and process operations. Kumar and van Hillegersberg [15] go even further and describe ERP systems as the price of entry for running a business. These statements may raise a question that when so many companies standardize their processes through ERP system adoption, do ERP systems have any impact on business performance? Since according to [13], the European Union's Framework Program "research funding will focus on technologies, which most effectively promote competitiveness and employment in Europe", in case this includes ERP systems, what sample size should researchers plan for in order to achieve conclusive results?

In order to investigate if there is any relationship between ERP systems (adoption and/or its extent) and business performance, data collected the same way and at the same time in Denmark, Slovakia, and Slovenia are used. The differing sample sizes allow for accounting for different statistical power. The issue of statistical power in information systems research is known for at least 20 years now, when Baroudi and Orlikowski [4] estimated that information systems researchers typically have a 40% chance of not detecting the phenomenon under study, even though it, in fact, may exist. This way, not only the question whether ERP systems impact business performance or not can be answered but also a threshold sample size, which allows for identification of significant relationships, can be estimated. A discussion on technological paradox can be found e.g. in [23].

The rest of the paper is organized as follows: the second section describes the data sample and the methodology used. The third section contains the results from the analysis of the data. The fourth section discusses known limitations and the final section presents conclusions derived from the analyses.

2. Data and Methodology

This exploratory research is based on a questionnaire survey conducted in Denmark, Slovakia, and Slovenia in May and June 2007. Questionnaire forms, accompanied by a cover letter, were mailed to randomly selected companies in the three countries. Lists of addresses and information about the number of employees were retrieved from CD-direct in Denmark and from the respective Statistical Bureaus in Slovakia and Slovenia. Regarding the random sample, 600 questionnaires were sent to small, 300 to medium-sized enterprises, and 300 to large companies in each of the three countries. The number of questionnaires mailed to small companies was double the number of medium and large companies because small companies constitute the highest proportion of companies and based on our personal experience, they are less likely to respond.

The definition of company size used in this paper is consistent with the European Commission [11] definition of SMEs, i.e. companies with 10 to 49 employees are considered to be small, companies with 50 to 249 employees are considered to be medium-sized enterprises, and companies having 250+ employees are considered to be large companies. Responses were received from 70 small, 65 medium-sized, and 129 large companies, so doubling the number of questionnaires sent out to small companies proved to be useful. There were 21 responses from Denmark, 112 from Slovakia, and 131 from Slovenia. So in total, there were 264 responses out of 3600 mailings, i.e. the response rate was 7,3 %.

With the exception of 20 respondents, respondents provided information on their turnover development over the years 2004-2006. This means that the effective sample size is 244 companies. The reason for accounting for the turnover development over the period of 3 years is to avoid random effects of internal factors (such as tactical decisions) and of external factors (i.e. environment changes). The possible answers were (1) reduction in turnover, (2) stable turnover (i.e. zero growth), (3) turnover growth of 0-5 %, (4) turnover growth of 5-10 %, and (5) turnover growth of 10+ %. In the sample there are 19 companies with reduction in turnover, 47 with stable turnover, 39 with turnover growth of 0-5 %, 58 with turnover growth of 5-10 %, and 81 with turnover growth of 10+ %.

The adoption of ERP systems was estimated on the respondent's company ERP system stage, the stages included (1) ERP system is being considered, (2), ERP system is being evaluated for the selection of a specific solution, (3) ERP system is being configured and implemented, (4) an ERP system was recently implemented and is now being stabilized, (5) an ERP system is being used and maintained, and (6) the first ERP system was already substituted with a new one. The first two stages were interpreted as not having an ERP system, the third stage is about implementing an ERP system, and the remaining stages mean that an ERP system is in place and working. In the sample, there 71 companies without any ERP system, 26 companies in the process of implementation of an ERP system and 155 companies with an ERP system.

The extent of adoption was measured in two different ways. One approach was more objective and another more subjective. In order to be able to get a rather objective estimate, companies were asked which ERP modules they have, i.e. which processes are covered by their ERP system. The possibilities were (1) finance/controlling, (2) human resources, (3) manufacturing and logistics, (4) sales&distribution, and (5) other. The number of processes (1)-(4) is used in the analysis. Since the answers for (5) varied and there was no comparable way to account for them, they are not included. There are 12 companies in the sample, which reported one module, 30 reported two modules, 50 reported three modules, and 54 reported four modules. The rather subjective method was asking for an estimate of the percentage of the implemented ERP system functionality being used. The average of the answers was about 68 %.

The research question is whether ERP systems do not matter at all or is it only the measurement that does not allow for identification of their impact on business performance. The measurement is related to what is measured and on what sample size it is measured. In order to answer that, there need to be the following six hypotheses defined:

$H1_0$: There is no difference in turnover development between companies with ERP system, companies implementing ERP systems and companies without ERP systems.

$H2_0$: There is no difference in turnover development between companies with and without ERP systems.

$H3a/b_0$: There is no difference in turnover development between companies without ERP systems and companies with ERP systems with one, two, three, and four modules covered.

$H4a/b_0$: There is no difference in turnover development between companies with ERP systems with one, two, three, and four modules covered.

$H5_0$: There is no difference in turnover development between companies without ERP systems and companies with different percentage of utilization of ERP system functionalities.

$H6_0$: There is no difference in turnover development between companies with different percentage of utilization of ERP system functionalities.

The dependent variable is turnover development in all the cases. The hypotheses H1 and H2 account only for ERP system adoption, not for the extent of adoption. The hypothesis H2 differs from H1 in excluding companies, which are in the process of ERP system implementation. The idea behind including the companies in the process of implementation into the analysis is to estimate the disruptive effect of implementation on turnover development. The reason for excluding them from the analysis is their number, which may be not enough to make them significantly different from companies with or without ERP systems.

The remaining hypotheses account for the extent of ERP system adoption. The hypotheses H3a/b and H4a/b account for the number of ERP modules covered. The number of modules is treated as a categorical variable in the hypotheses H3a and H4a, and as a numeric variable in the hypotheses H3b and H4b. The hypotheses H5 and H6 account for the percentage of utilization of ERP system functionalities. The variable is treated as a numeric variable because respondents used a large number of different values from 3 to 100 %. The hypotheses H3a/b and H5 differ from the hypotheses H4a/b and H6 in including also companies without ERP systems. In both cases, the value 0 is used for companies without ERP systems.

Logistic regression will be used to assess the eight abovementioned models on the confidence level α = 0,05. It would be possible to use chi-square test in some of the cases but Cochrane's rule, which states that no expected frequency should be less than 1 and at least 80% of expected frequencies should be greater than 5 [7], would not hold in some of them. The p-values and sample sizes will be illustrated in Figures 1-4. (The lines should not be interpreted as a partially linear function; they only connect dots representing the same hypothesis tested on data from different countries.) Influence of sample size and the model on p-values will be assessed by analysis of variance (ANOVA) on the confidence level α = 0,05. An alternative solution would be to transform the p-values smaller than 0,05 into 0s and larger than 0,05 into 1s and use logistic regression to evaluate the model. The drawback of this solution is that given the specific data, the model would lead to quasi-separation and the results obtained from logistic regression might be biased.

In order to test for non-respondent bias, early and late respondents will be compared in the fourth section. Chi-square tests will be used for turnover development, ERP system stage, and number of ERP modules (i.e. groups of processes covered). ANOVA will be used for percentage of ERP systems functionalities utilization.

3. Results and Discussion

As stated in the previous section, the research question is tackled by trying out different models (which, due to incomplete data, also imply different sample sizes). The sample sizes and the p-values for the hypotheses H1 (full line) and H2 (dotted line) are presented in Figure 1. Regardless whether implementation was included or not, there is a significant relationship between ERP adoption and turnover development in Slovenia. It may be also concluded that including only companies with implemented ERP systems and no ERP systems results in lower p-values than the model, which includes besides companies with implemented ERP systems and no ERP systems also companies in the process of ERP system implementation.

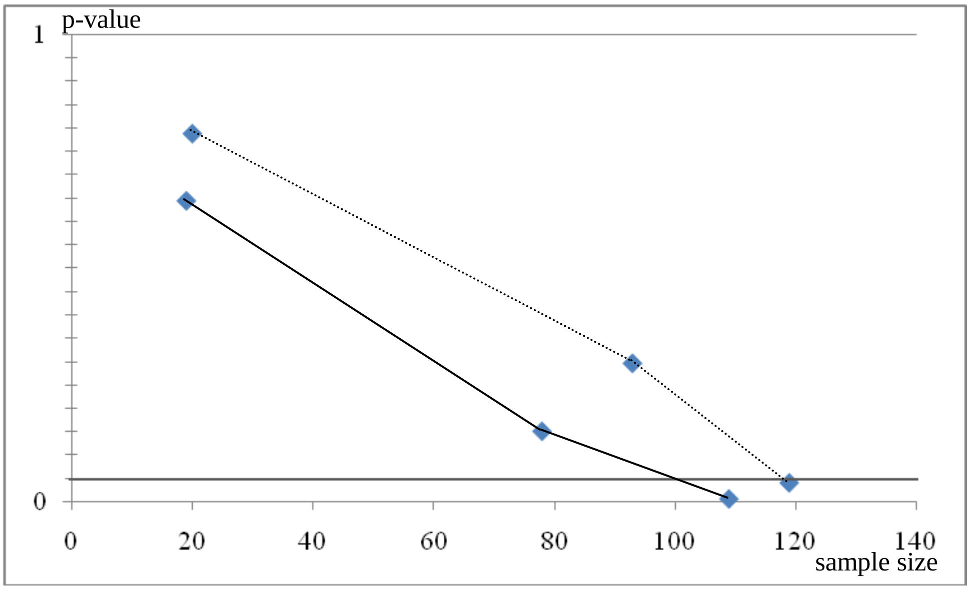

Figure 1 Relationship between sample sizes and p-values for hypotheses H1 and H2

The sample sizes and the p-values for the hypotheses H3a (full line) and H4a (dashed line) are presented in Figure 2. It may be concluded that not accounting for companies without ERP systems leads to higher p-values on average.

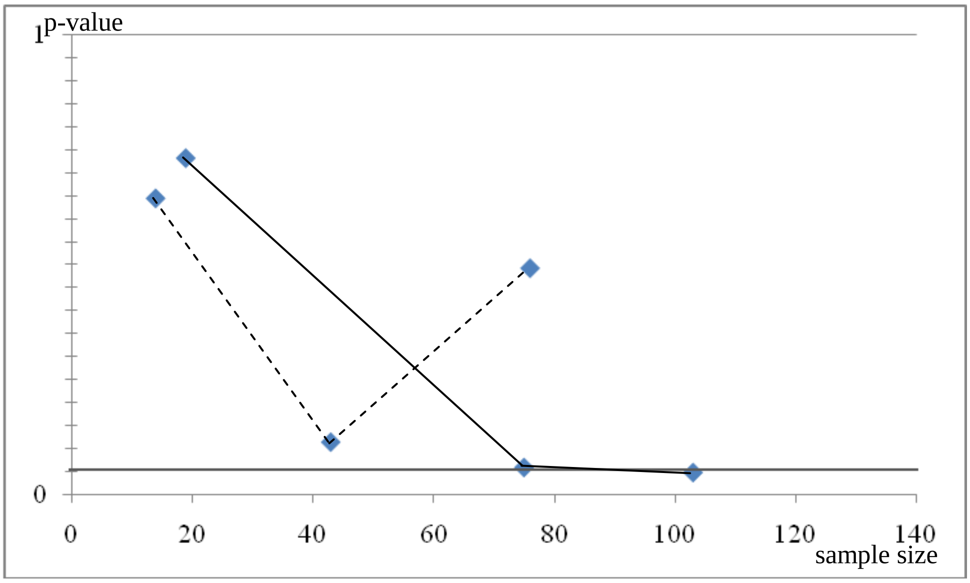

Figure 2 Relationship between sample sizes and p-values for hypotheses H3a and H4a

The sample sizes and the p-values for the hypotheses H3b (full line) and H4b (dashed line) are presented in Figure 3. It may be concluded that not accounting for companies without ERP systems leads to higher p-values on average.

Comparing the observations for hypotheses H4a and H4b in Figures 2 and 3, it may be assumed that the relationship between the number of modules and turnover development is not linear, and therefore it is better to model number of modules as a categorical as opposed to a numeric variable. The main reason is that if the relationship was linear, using the number of modules as a numeric variable, as opposed to a categorical variable, would decrease the number of degrees of freedom thus automatically decrease the p-value. But the result was opposite.

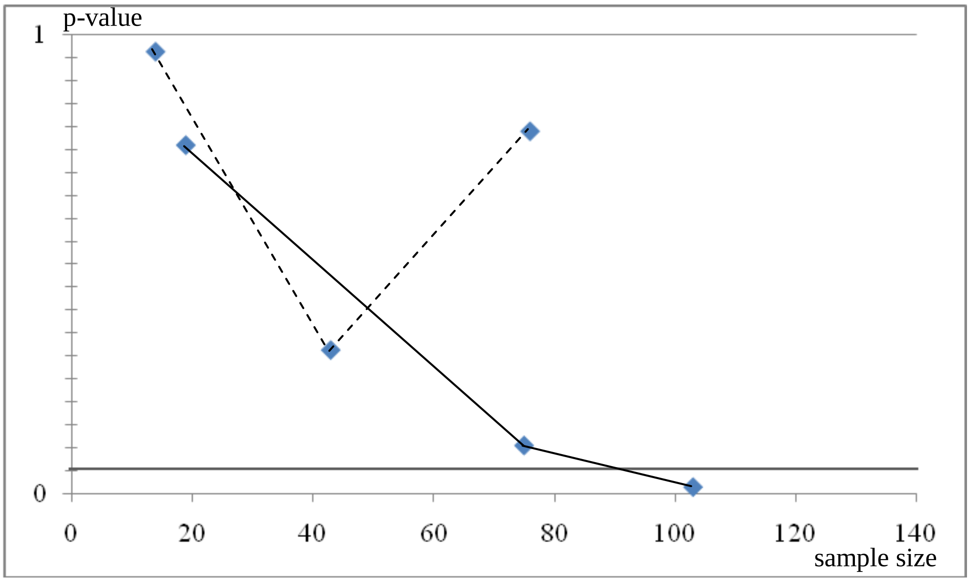

Figure 3 Relationship between sample sizes and p-values for hypotheses H3b and H4b

The sample sizes and the p-values for the hypotheses H5 (full line) and H6 (dashed line) are presented in Figure 4. Excluding Danish companies (because of their small number), it may be concluded that not accounting for companies without ERP systems leads to higher p-values on average.

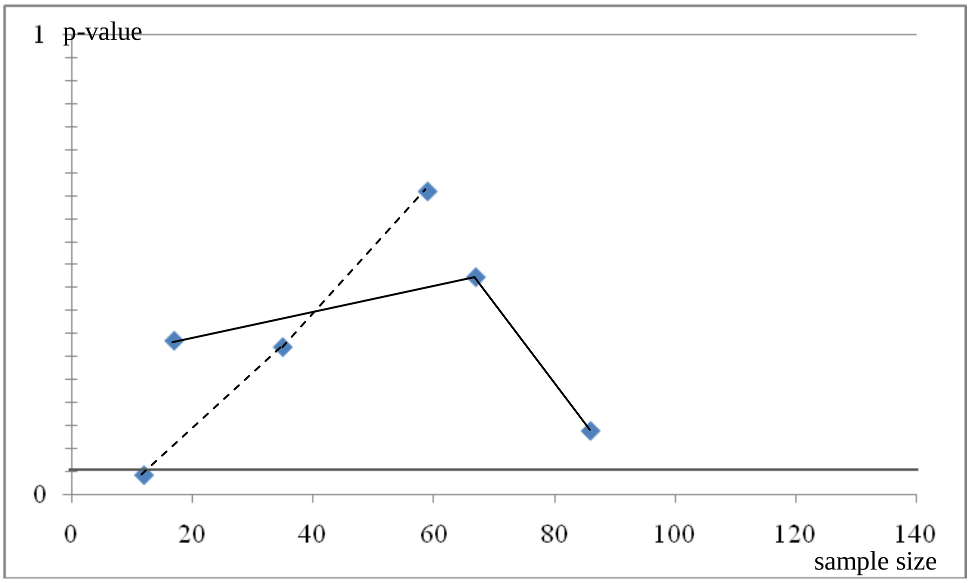

Figure 4 Relationship between sample sizes and p-values for hypotheses H5 and H6

The sample sizes and p-values from abovementioned models are presented in Table 1. With one exception – a pathological case (12 Danish companies in the hypothesis 6) – all models with the sample size of at least 103 led to significant relationships, while all sample sizes of 93 and smaller led did not uncover any significant relationship.

Model	Country	Sample size	P-value
1	Denmark	19	0,645966
1	Slovakia	78	0,151804
1	Slovenia	109	0,006810
2	Denmark	20	0,789977
2	Slovakia	93	0,297544
2	Slovenia	119	0,041158
3a	Denmark	19	0,733793
3a	Slovakia	75	0,060183
3a	Slovenia	103	0,049112
4a	Denmark	14	0,646240
4a	Slovakia	43	0,115384
4a	Slovenia	76	0,494002
3b	Denmark	19	0,761094
3b	Slovakia	75	0,105434
3b	Slovenia	103	0,014532
4b	Denmark	14	0,965006
4b	Slovakia	43	0,313769
4b	Slovenia	76	0,791346

5	Denmark	17	0,336049
5	Slovakia	67	0,474422
5	Slovenia	86	0,139453
6	Denmark	12	0,043141
6	Slovakia	35	0,322146
6	Slovenia	59	0,661266

Table 1 Description of models

ANOVA can be use to analyze the data from Table 1; in this model the p-value is a dependent variable and the sample size and the model are independent variables. The sample size is used as a covariate and the model is used as a factor. According to ANOVA, the sample size has a significant effect on the p-value (p-value = 0,005), while the model was not found to be significant (p-value = 0,710).

4. Known Limitations

The response rate was 7,3 % but as Armstrong and Overton [3] illustrate, even a response rate of 80% may lead to biased estimates. Therefore it is necessary to investigate possible impact of non-respondent bias on the obtained results. Extrapolation methods assume that subjects, who responded less readily, are more like non-respondents [17]. “Less readily” means answering later, or as requiring more prodding to answer. Since we did not remind or urge respondents to reply, our less readily respondents are only late respondents. So we compared whether there is a significant difference between early and late respondents in Slovak and Slovenian data. There were, virtually, no late responses in Denmark, so we did not conduct the same tests for Denmark. We consider the first 84 Slovak and 90 Slovenian respondents (who answered by the time we requested) to be early respondents, the remaining 28 Slovak and 41 Slovenian respondents are considered to be late respondents.

With the exception of the difference in the ERP stage between early and late Slovak respondents, there is no significant difference in early and late respondents when it comes to turnover development, ERP system stage, number of ERP modules, and percentage of ERP systems functionalities utilization. Regarding the turnover development, the value of chi-square statistics is 4,48, the corresponding p-value is 0,345 for Slovakia, and the value of chi-square statistics is 6,36, the corresponding p-value is 0,174 for Slovenia. Regarding the ERP stage, the value of chi-square statistics is 11,18, the corresponding p-value is 0,048 for Slovakia, and the value of chi-square statistics is 3,01, the corresponding p-value is 0,698 for Slovenia. Regarding number of ERP modules, the value of chi-square statistics is 7,26, the corresponding p-value is 0,064 for Slovakia, and the value of chi-square statistics is 0,19, the corresponding p-value is 0,980 for Slovenia. Regarding the ERP systems functionalities utilization in Slovak companies, we cannot exclude normal distribution (the test value for omnibus normality of residuals is 3,01, the corresponding p-value is 0,222) nor equal variance (the test value for modified-Levene equal-variance test is 0,26, the corresponding p-value is 0,612), so ANOVA can be used to compare the averages. There is not a significant difference in Slovak between early and late responses (the value of F-ratio is 3,16, the corresponding p-value is 0,082). Regarding the ERP systems functionalities utilization in Slovenian companies, we are able to exclude normal distribution (the test value for omnibus normality of residuals is 7,56, the corresponding p-value is 0,023) but not equal variance (the test value for modified-Levene equal-variance test is 1,45, the corresponding p-value is 0,233), so ANOVA cannot be used to compare the averages. Kruskal-Wallis test is used instead. In Slovenia, there is not a significant difference between early and late responses (the value of chi-square statistics is 2,44, the corresponding p-value is 0,119).

Although these tests do not prove that the non-respondents would give the same answers, at least it does not suggest that they would differ significantly. The questionnaire survey was rather narrowly focused and if the "interest hypothesis" [6, 9, 10, 12] holds, i.e. people interested in the topic, i.e. ERP systems, would respond more likely [5, 16, 19, 20, 22], it should have no impact on the relationship investigated in this paper because the paper does not investigate how many companies have, are in the process of implementing, or do not have ERP systems but what is the turnover development in each group.

5. Conclusions

As companies standardize their business process through ERP systems adoption, the impact of ERP systems may not be too large anymore but it is possible to uncover s significant relationship having a reasonably large research sample. In this setting, it seems that the threshold is between 93 and 103 companies. In other words, when planning for a research project (especially a large one, such as a Framework Program project), one should investigate at least one hundred companies in order to uncover underlying relationships. This suggestion holds regardless which type of the above-examined models is used.

Maybe a detailed view only on ERP-related costs and benefits would uncover a significant relationship even with a smaller sample. But although accounting for costs may be relatively easy (e.g. a survey on investments was conducted even in Slovakia [14]), a current literature review [21] uncovered that there is lack of empirical research of benefits. An in-depth longitudinal study might also bring more insight but e.g. like [2], it may not allow for a reasonably large sample to analyze using statistical methods and results of a qualitative (as opposed to quantitative) research may be harder to publish.

One of the implications can be not to incorporate companies in the implementation process into the model, unless their number is very similar to the number of companies, which have, and which do not have ERP systems. These suggestions should hold also for investigation of e-business solutions, which is described e.g. in [8].

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AGILE MODEL TO SUPPORT QUICK CHANGES IN PRODUCT LINES

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Abstract

In Product Lines the strategy of agile software development methodologies is a possibility to react flexible on new customer's or market demands while developing products. But careful, if changes occur to quickly they will risk the whole project.

Agile software development methodologies found in modern approaches to operations management and analysis. It is a mixture of lean manufacturing, soft systems methodology, "speech act theory" (network of conversations approach), and Six Sigma. These methods generally promote a disciplined project management process that encourages frequent inspection and adaptation of software codes. It needs a leadership philosophy that encourages teamwork, self-organization and accountability. These specified practices are sets of engineering best practices that allows a rapid delivery of high-quality software. Agile software development needs a business approach that aligns development with customer needs and company goals.

1. Introduction

Production of products started from unique and single production from the middle age and before. It changed mass manufacturing in plants and the hype started in industrial revolution; see Definition 1.

Definition 1 Mass Customisation [6]
Mass customisation is the large-scale production of goods tailored to individual customer's needs.

A very good example for mass production is car manufacturing of Henry Ford who got his idea from the meat market, which he visited. All the halved cows and picks where moved from one station to another and a butcher did a specific job on them up to the meat was ready for the butchers shops.

Cars at this time have been manufactured in garages and have been very expensive. Henry Ford's idea from the meat market was mass production and car prices came down. He manufactures the first mass produced car the Ford model T also well known as "Thin Lizzy". Other manufacturers followed. Volkswagen mass produced their "VW Käfer" or also well known as "Beatle". They started to manufacture two different but very similar versions of the Beatle. At 1st. July 1949 they started producing the export model and standard model. Both cars had the same platform (see **Definition 2**) and had certain components (see **Definition 3**) to differentiate the two models.

Definition 2 Platform [26]
Computing: A framework on which applications may be run. Car: A set of components shared by several vehicle models.

Definition 3 Component in IT [15], Glossary
Is a unit of composition with contractually specified component interfaces and explicit context dependencies only; it can be deployed independently and is subject to composition by third parties.

A definition of an IT component: "is a unit of composition with contractually specified component interfaces and explicit context dependencies only" [15], Glossary. How does the first part of the definition "is a unit of composition with contractually specified component interfaces" be interpreted? For an IT manufacturer this means e.g. to have a contracted supplier who delivers a software module for a specific IT process, which consists of software components. It includes defined interfaces to log this software module into the main process.

2. Product Lines

Software Product Line approach needs engineering, see **Definition 4**.

Definition 4 Engineering [1]
...the creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property...

Engineering is "the creative application of scientific principles to design or develop structures ..." [1] . For Software Product Line Engineering a structure is needed, which than can lead into a methodology.

Product Line Engineering is a methodology, which is differentiating from standard software development. The main difference is that standard software development develops software in iterations that means when the first software release is finished than on this release the next software release is developed, etc. up to the end of the software live cycle of these software products.

Product Line development defines a number of software releases, which are developed parallel as a bundle and each release must differentiates from each other of that bundle. An iterative development [25] is only possible for the whole set or a set of releases of that bundle.

Definition 5 Bundle in Software Product Line
A bundle is the whole set of all releases from a Software Product line.

The idea is to manufacture software for reuse and for a defined set of products (product 1, product 2, product n, etc.) as a bundle, which is displayed in the two-life-cycle model of Software Product Line Engineering. The two-life-cycle model is known as the standard model for Software Product Lines and can be found in most standard literature about Software Product Lines.

First the two-life-cycle model of Software Product Line Engineering splits into Domain Engineering, which is defined in the life-cycle model by Domain Engineering (developed by reuse) and Domain Artefacts including Variability Model. Domain Engineering is triggered through Product Management.

Secondly Product Line Engineering is split in the life-cycle by Application Engineering (developed for reuse) and the outcome is a bundle of software releases, see Figure 4.

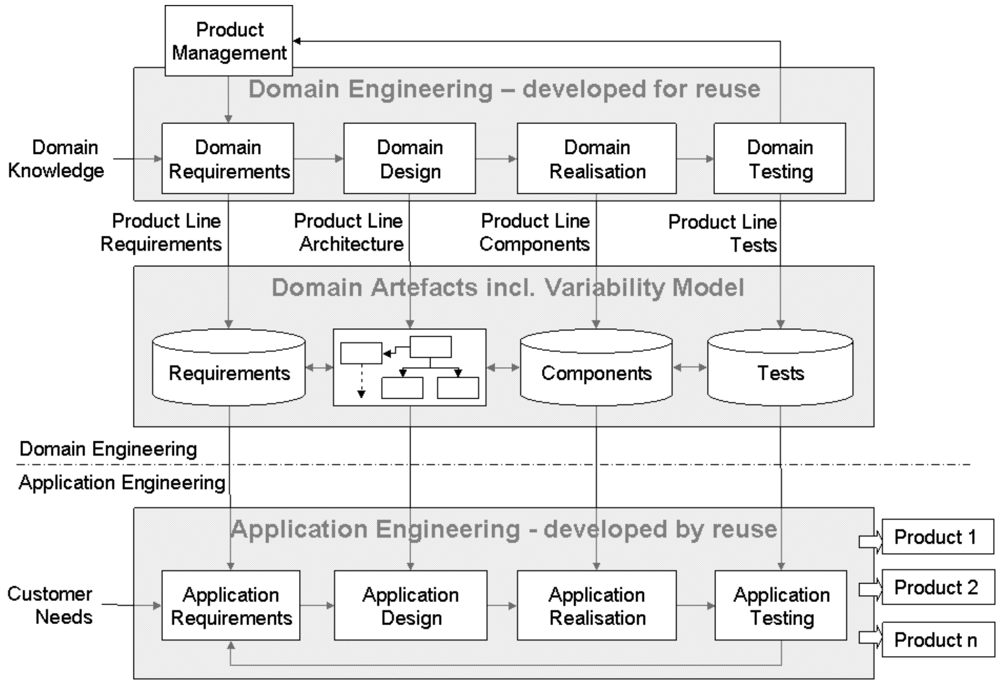

Figure 4 Two-life-cycle model of Software Product Line Engineering

In comparison to engineering the Software Product Line Engineering focuses on platforms and mass customisations for software applications. In software development mass customisation can be e.g. development of 3 applications of mobile phone software for a specific mobile phone platform. Starting with a range of monochrome display unit known as the cheap start-up model with base functionality and finishing up with a top of the range model including high definition display to watch TV and movies either down loaded via UMTS, WiFi or maybe by DVBT.

K. Pohl defined Software Product Line Engineering as the following, see **Definition 6**.

Definition 6 Software Product Line Engineering [15],
Software product line engineering is a paradigm to develop software applications (software intensive systems and software products) using platforms and mass customisation.

As defined in Software Product Line Engineering it is necessary to define a Software Product Line itself. The Software Engineering Institute Carnegie Mellon (SEI) defined a Software Product Line as is "... a set of software-intensive systems that share a common, managed set of features ..." [22]. Features can be technical platform (see Definition 2) or any IT component (see Definition 3)

As described in Figure 4 to "... share a common, managed set of features ..." the so called managed sets o features are organised and administered for reuse in Project Management.

2.1. Domain Engineering – developed for reuse

Domain Engineering, Domain Artefacts and Application Engineering are defined as the following.

Definition 7 Domaine Engineering [15]
Domain Engineering is the process of Software Product Line Engineering in which the commonality and the variability of the product line are defined and realised.

Domain Artefacts – inclusive variability model

Definition 8 Domain Artefacts [15]
Domain Artefacts reusable development artefacts created in sub-processes of domain engineering. A synonym in product line artefacts.

Application Engineering - developed by reuse

Definition 9 Application Engineering [15]
Application Engineering is the process of Software Product Line Engineering in which the applications are built by reusing domain artefacts and exploiting the product line variability.

Software Product Line

Definition 10 Software Product Line Engineering [22]
A software product line (SPL) is a set of software-intensive systems that share a common, managed set of features satisfying the specific needs of a particular market segment or mission and that are developed from a common set of core assets in a prescribed way.

The differences in Software Product Lines are on the one hand limited by the variability of the software, which is made of IT components (see Definition 3) and on the other hand dependent of the platform (see Definition 2). The variance in IT components is taking an influence in the specified software applications and the platform is the base for all applications of the bundle of software applications, which will run on it. There is always a limit to the variability of the platform to run the specified software applications.

Why taking all this dependencies into consideration? Klaus Pohl described it as to provide customised products at a reasonable cost (see [15]). Planning into the future as part of the strategy of Product Line Management becomes important.

3. Variability

Variability is one of the key success factors for Product Lines. It is the possibility to create a different set of artefacts, which differentiates in their planed behaviour and build on a set of core assets and common strategy also named as commonalities. This will be supported in a system or a development environment to support production of these artefacts.

Commonalities are a common strategy but variability is the ability of a core asset to be adapted to usage in the different product contexts that are in scope of the Product Line.

“Variability means the ability of a core asset to adapt to usages in the different product contexts that are within the product line scope. Implicit in this definition is the fact that variations in a product line context are anticipated. The developers of core assets have thought about the consequences of the variations and, presumably, constrained them in a way that the resulting core assets support the requirements and take into consideration the time and budget available to create the assets” (see [5])

Software Product Line engineering looks at a Product Line as a whole instead of understanding each individual system all by itself. Variability has to be defined, created, implemented, etc. Variability has to be managed trough the whole software Product Line lifetime (see [12]). As shown it is necessary to manage the whole time variability and not only to plan a little bit variability. From the idea managed variability it has been evolved the strategy of three different types of variability [12].

1. Commonality: it is a characteristic of functionality or non functionality, which is common to all products in the Product Line.
2. Variability: it is a characteristic, which is common to some but not to all products. It must be possible to have it modelled into variability as well as implemented in specific products only.
3. Product-specific: it is a characteristic of at least one or more products in which it will be used some where in the future. These features are not all ready requested in the market but in dependency of the market can be requested soon. To keep the Product Line flexible this variability will not be integrated into the platform, but the platform must be able to support them.

Definition 11 Commonality [12]
A characteristic (functionality or non functionality) can be common to all products in the product line. We call this a commonality. This is then implemented as part of the platform.
Definition 12 Commonalities (additionally)
Specification of a common strategy of a software product line, which is built on a set of core assets and represented by Domain Artefacts.
Definition 13 Variability
Defines variable characteristic of software Product Line by using commonalities and Core Assets form Domain Artefacts.

3.1. Why is variability management a key difference to single system development?

The general idea of software Product Lines is to develop more than one software product parallel. This offers the chance to reuse functionality, which will be used for all predefined software products of the Product Line. This could occur to reuse functionality e.g. in product A interface is LAN, in product B interface is WLAN, and in product C interface is Bluetooth. As the reader can see the technical specification for the interface to the outside world of the software products is specified by three different technical systems although there is an interface which varies. In this example Release Management has to make sure that the right interface has to be compiled to each product. To be able to do such compile procedure it is necessary to use variability management.

The variability of the same set of development artefacts has to derive multiple applications with different features. This has a strong influence on the development process and artefacts. To do so variability has to be defined. A variation point and a variant are high-level abstractions to be able to specify the reuse of functionality and dependencies as well as constraints. In these abstractions it has to be specified a restriction between the set of variants and different kinds of dependencies between variation points and variant. Variability modelling means communication between Product Line and customer (see [15]).

The difference to single system development is that development of the software products takes place sequentially and one release builds up on the previous release.

3.2. What are the variation points in core assets (e.g. models, code, documents)?

The target is always particular software Product Line, where differences exist in the final system (see [12]). It can be realised by a corresponding variability, where as objects have to be embedded into the software Product Line context. This is a subset of all possible variability subjects e.g. interface for LAN, WLAN and Bluetooth. These subsets are all possible variability objects from the real world.

Definition 14 Variability Subject [15]
A variability subject is a variable item of the real world or a variable property of such an item.
Definition 15 Variation Point [15]
A variable object is a particular instance of a variable subject.

A variant is the representation of a variability object. This definition applies to all kinds of artefacts e.g. requirements, architecture, design, code (reusable components) and tests.

Definition 16 Variant [15]
A variant is a representation of a variability object within domain artefacts.

The specification of a variant point induces details about embedding of the variability subject.

The reason for introducing variation points is for instance the different technical standards in software products of different countries, different stakeholder needs, different marketing strategies, etc.

Definition 17 Variation Point [12]
Is a point was variation occurs in a domain asset, i.e. at this point in the fact a selection needs to be made to arrive at an instantiated asset.

The transformation takes place as the following. A variation point is a point, were variation occurs in a domain asset. A variant is represented by a variability object within domain artefacts. A variable object is also a particular instance of a variable subject and this is a variable item of the real world.

Variation points and variants are self-contained entities that are distinct from artefacts like requirements, architecture, design, code (reusable components) and tests. A variant identifies a single option of a variation point. It is comparable with an artefact, which correspond to a particular option (see [15]).

Software Product Lines encompasses all assets (sometimes they are also called core assets) to cover the whole range from requirements to tests. Various assets contain explicit variability, which contain an explicit description of specific requirements that only apply for a certain subset of these products.

4. Agile Model to support quick Changes

As practise in Software development has shown it is very often necessary to have quick software changes. These changes very often occur of new customer or marketing demands while developing the software. This requests flexibility in the development process by the usage of feedback loops.

Why do changes always occur in software projects? Changes occur because of errors in software code or experiences in the developing software by functionally or usability [14].

Definition 18 Agile Software Development [24]
Agile software development refers to a group of software development methodologies based on iterative development, where requirements and solutions evolve through collaboration between self-organizing cross-functional teams. The term was coined in the year 2001 when the Agile Manifesto was formulated.

Agile software development methodologies are found in modern approaches to operations management and analysis. It is a kind of lean manufacturing “A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection.” [7]. As well as, software and systems engineering methodology, “speech act theory” (network of conversations approach) [20], and Six Sigma [23]. These methods generally promote a disciplined and flexible project management process that encourages frequent inspection and adaptation of software code and artefacts. These approaches require a leadership philosophy that encourages teamwork, self-organization and accountability. These specified practices are sets of engineering best practices that allows a rapid delivery of high-quality software products. Agile software development needs a business approach that aligns development with customer needs and company goals. This can state a paradigmen shift and aditionally needs support by company management for its success.

Nevertheless, frequent and rapid changes, from customers or marketing, can include a high risk for project and quality managers in terms of project delay, increased rework effort, expanding cost and possibly failure. To use agile software development methodology in a self organizing and cross-functional team adjustable time lines for changes will help to perform the needed processes quality.

Experiences from projects at an Austrian IT provider showed that the agile approach toward the plan driven approaches have its benefits e.g. new demands can be changed when needed without large effort in replanning [3]. The time interval between bundles of changes should not be to short. Otherwise chaotic situations will occur. Too long intervals will lead to a fall back to a plan driven behaviour (see Table 2). Thus, a trade off between flexibility and plan driven project management seems to be reasonable.

period for changes	quality	reason	effect	team acceptance
4 hours to 1 day	good	emergencies	bug fixing	only for emergencies
1 day	bad	change	chaotic	low
2 to 5 days	**good**	**change**	**coordinated**	**high**
> 5 days	good	change	plan driven	medium – concentration falls

Table 2 Period of Software Changes

The approach for Agile Software Development can be used only for Application Engineering, in Product Lines (see Figure 5).

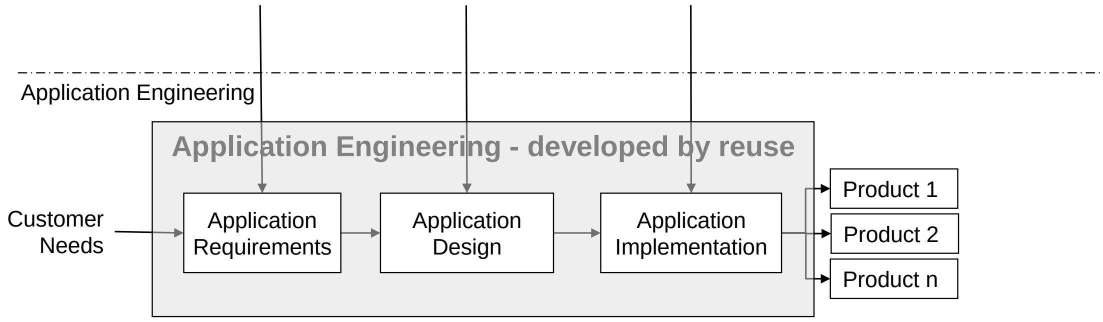

Figure 5 Agile Software Development can be used only for Application Engineering

Product Line Engineering is a strategy and plan driven approach. Any new change, interferes with the variability of any object (see Variability), and needs a realization period of 2 to 5 days. Any change entails a slew of actions like change and variability planning (this includes cost, impact and fallback), release, test, documentation, etc. The flexibility to develop simultaneously products is dependent to the speed of changes. Steering is possible trough synchronisation of changes, which can be controlled at milestones through shifted time lines or partly fulfilled deliverables.

Quality goals were reached, and coordination worked. The acceptance in the team was also high, see Table 2. The team was concentrating onto the job. There was the right pressure to keep the team busy.

The experiences we made is not only usable for Product Line approaches, it can be used at any other project.

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THE ROLE OF ICT IN BUSINESS INNOVATION

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Abstract

The article deals with the role of innovation in business, position of companies in innovation process and the role of information and communication technology (ICT) in business innovation. The article summarizes the basic types of innovation and the activities of innovation process. Two ICT roles are described 1) ICT is a part of innovation or it is the innovation by itself; and 2) ICT is one of the information system sources and it effectively supports development and/or innovation adaption and usage. The questionnaire survey was prepared as supplement of Innovation Management Framework and results are presented for the representative companies which have more than 250 employees, offer IT services, are oriented on domestic market, and their markets are growing.

1. Introduction

It is possible to agree with the Schumann's statement [25] that the innovation is basis for all other competitive advantages. Comparing for example the results of the EUROSTAT [21] and the results provided by independent organizations (for example [12] or [3]), it is obvious that so called innovators are usually market leaders. They can gain the significant market share and the goodwill as well. The decision about taking part in the innovation process and accepting the innovation has become a part of management and it has influence on the performance and competitiveness of a company.

The goal of this article is to describe the role of information and communication technology (ICT) in business innovation. The role of ICT in this case (as well as in other situation when we examine the role of ICT) depends on many factors which have typically an interdisciplinary character [8]. The following general factors could be :

- Does a company accept an innovation?
- What type of innovation is applied?
- How ICT supports the innovation life cycle?
- Is ICT a part of innovation or is ICT at least a support of innovation process?
- Is a company an innovator, only an adopter or a laggard?

2. Innovation attributes

The three key factors of innovation are crucial for the purpose of the article:

- Innovation typology
- Innovation life cycle
- Adoption of innovation by companies

The description of these factors based on the relevant literature study includes the following text.

We should start with the definition of an innovation. An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption [23] and two trends in the development of innovation typology can be identified. They both come out from the innovation categories derived from the innovation list done by Joseph Schumpeter [26]. The emphasis is put on the innovation oriented on development or modification of a product and innovation of a process. It means the ways how the product is created.

There is also possible to consider the innovation of services in addition to innovation of product. The innovation of services embodies namely different features [9], [11], [20].

Within the innovation, originally oriented on the innovation of technical systems, the organizational innovation has been detached. The reason for that is the fact that companies can realize process innovation not only by the way of using the new technology, e.g. to direct them into technical system innovation. However, the innovation can also lean into the administration changes [24], [14], [6].

Increasingly important is not only how the product is produced but also how it is offered to customers and generally to a market. The marketing activities have been separated from process innovation and the new independent type of innovation so called marketing innovation has been created [28], [16].

The OECD worldwide organization defines and formulates the main types of business innovation. Guidelines for Collecting and Interpreting Innovation Data (so-called Oslo Manual) define the types of innovation in the following manner [19]:

- A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended use. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- An organizational innovation is the implementation of a new organizational method in the firm’s business practices, workplace organization or external relations.
- A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

The life cycle is the further very important aspect of the innovation. It can be expressed as so-called “S-curve”. This curve is based not only on features of innovation but also on demand for innovation [1]. The starting point for definition of stages of life cycle is the “Product Life Cycle” [15]. The description of particular stages varies in different methods [29] but for the purpose of the article the following identification will be used [17]:

- Emergent

- Growth
- Maturity
- Declining

The combination of the innovation life cycle, innovation development and adoption processes, time of innovation application and characteristic of innovation recipient is shown on the following figure (Figure 1).

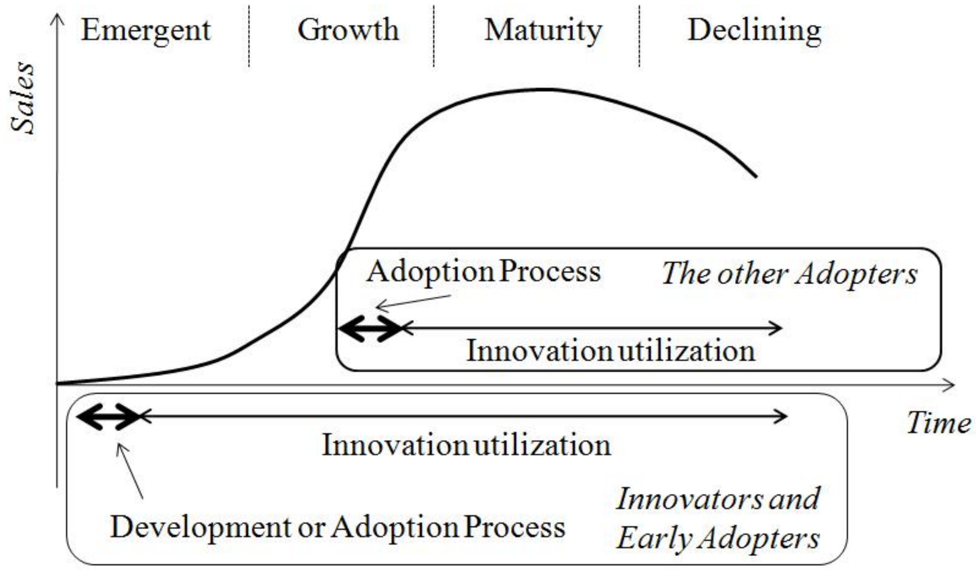

Figure 1: Innovation life cycle and processes

Those companies that adopt the innovation later than other have to compensate the shorter time of innovation utilization. They have to use all sources in a more effective way and try to apply other types of innovation. It can be process and organizational innovation in the stage of adoption. It can be innovation of process, organization and marketing in the stage of usage (innovation utilization).

The above figure of life cycle is valid not only for the product innovation which is maybe mostly known but the other types of innovation (process, organization and marketing) can be visualized in the same way.

There are more theories oriented on the description of the adoption of the innovation in companies. One of them is the Diffusion of Innovation theory by Rogers [23], where “Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system”.

The important from this theory for the purpose of this article is following two paradigms:

- Companies are divided into five basic groups depending on time, when innovation is adopted:
    - Innovators (2.5 % share)
    - Early adopters (13.5%)
    - Early majority (34%)
    - Late majority (34%)
    - Laggards (16%)

- Process of decision making about innovation acceptance (adoption process) is divided into following stages:
    - Knowledge – when we notify the need of innovation
    - Persuasion – when we build our attitude to the innovation
    - Decision – when we make final decision for or against innovation
    - Implementation – when we implement the innovation
    - Confirmation – when can continue in usage of innovation or can accept completely new decision

In case the innovation is developed by own sources in company or in cooperation with external partners the process of development can be understood as a creative activity [19]. There is new knowledge explored and new knowledge is combined with existing one. R&D activity is typical example of activity that is combined with other activities like research, purchase of patents, know-how, education of employees etc. This process (development process) covers usually three stages [5]: "Initiation, Development and Implementation".

3. ICT Role in Innovation

The innovation can by supported by different kind of activities and technologies. The ICT plays in this process very import role [7]. Seeking for the answer what kind of role the ICT plays in business innovation two main situations should be considered:

- ICT is a part of innovation or it is the innovation by itself
- ICT is one of the information system sources, it effectively supports development and/or innovation adaption and usage

The first situation can be described with examples when ICT is used like innovation element [19], [13], [2], [4] (see Table 1). The identification of ICT potential like an innovation element belongs to the enterprise informatics IT infrastructure services oriented on the research and development.

Type of innovation	**Examples of ICT usage like innovation element**
Product innovation (goods)	• Navigation systems in transport (GPS) • Mobile Phone (Communicator) with MP3 player, Office software, etc.
Product innovation (services)	• Internet banking • E-books • Internet ticket reservation, hotel room booking, etc.
Process innovation	• RFID chips for item identification • Optimization of supply chain paths • Services, SOA (Service Oriented Architecture) concept for effective integration of different processes incl. processes of partners

Type of innovation	Examples of ICT usage like innovation element
Organizational innovation	• Establishing of formal and informal teams with the goal to improve their access to knowledge and its exchange based on videoconferences, WIKI etc. • Using of „outsourcing“ for research tasks or for production needs, for example SaaS (Software as a Service) or Cloud Computing
Marketing innovation	• Aiming of marketing on a special group of population based on personalized information

Table 1: ICT role in innovation

The second situation, which means ICT support of innovation processes, is based on software. The application software help with information processing and business process support. There are following main application software categories in companies [10]:

- Transaction application software oriented on information support and automation of business activities (e-commerce, production control, etc.)
- Application software for decision support at all level of enterprise management, for example BI (Business Intelligence), CI (Competitive Intelligence), BAM (Business Activity Monitoring), CPM (Corporate Performance Management)
- Application software for development and innovation of product and services through the whole life cycle (for example Product Life-Cycle Management)
- Application software oriented on infrastructure and used across company (for example content management, knowledge management, process management, collaboration and cooperation management, individual learning)

The software tools for application software development and implementation could be added to this concept. All these tools together with application software and operational monitoring exploit the ICT infrastructure services (physical and management-oriented capabilities of ICT infrastructure [30]). This environment supports processes of development, adoption and utilization of innovations.

However, the meaning of ICT and its configuration can be various in different companies. In our opinion, it depends on the role of a company that can be an innovator but it can also be an innovation receiver. The content of development or adoption processes indicates how important is the role of the application for cooperation and collaboration support, knowledge management and product development support (design and prototyping). The companies – innovations receivers (adoption process is crucial) have also strong application support for monitoring and analysis of competitive behavior. The reason for that is the need to adopt the innovation earlier than competitors does.

The following application software categories have an increasing meaning during innovation utilization stage:

- Transaction application software for maximization of effects from innovations
- Process management support for maximization of time utilization before declination stage occurs

- Decision support application software, especially CPM and CI which provide information for qualified forecast or decision if an used innovation should be abandoned or a new innovation should be searched, e.g. a new innovation cycle should be started [18], [22].

4. Analysis of the Current Situation in the Selected Czech Companies

4.1. Survey Methodology

Main research questions were formulated as an outcome from above mentioned literature study oriented on the role of ICT in business innovation process.

- Question 1 – What is the role of ICT in the current Czech companies?
- Question 2 – What is the acceptance of innovation in the Czech companies?
- Question 3 – What is the usage of ICT within the innovation cycle?
- Question 4 – Is the ICT innovation typology valid also for the Czech companies?
- Question 5 – What is the general position of ICT in companies?

All these questions were incorporated into the questionnaire designed with 19 statements in three blocks:

1. Information about company – size, branch, stage of development, situation on market and attitude to ICT innovation.
2. Information about usage of ICT in company – significance of ICT for company's strategic goal and application of ICT benefit indicators.
3. Information about the role of ICT in business innovation (the most important part of survey) – importance of ICT innovation, role of ICT in company, position of ICT within innovation life cycle and type of ICT innovations.

The questions could be answered by following possibilities:

5: full agree

4: nearly agree

3: I do not know, I cannot express

2: nearly disagree

1: completely disagree

0: no answer

The questionnaire was distributed in the first half of this year, incl. the participants of the Systems Integration 2009 conference.

4.2. Survey Results – Case Study

Results of survey are for the representative companies which:

- have more than 250 employees,

- offer IT services,
- are oriented on domestic market, and
- their markets are growing.

Question 1 – Role of ICT in company

The most important role of ICT within the innovation was marked as a support of business innovation (4.3). The following possibilities were the opinion that ICT helps the business innovation at the same level like other technologies (4.0). Last position was for the meaning that ICT initiates the business innovation (3.5).

Question 2 – Acceptance of innovation in companies

The representative company can be described like early majority users. This kind of user applies news earlier than the other ones. This kind of company belongs with innovators and with early users to the first half of users.

Question 3 – Usage of ICT within the innovation cycle

The most important result of the survey is that ICT initiate the business innovation and innovation cycle (4.7). The importance of ICT in the following stages (emergent, market entry and growth) is lower (4.3). The minimum level of ICT usage is in the stage of declination (2.7).

Question 4 – ICT innovation typology

As was described earlier in this article there are four types of innovations (product, process, marketing and organizational). The survey results confirmed the significant meaning of product innovation and process innovation that have already been in companies for longer time. The meaning of organizational innovation was less importance and the respondent hardly knew anything about the marketing innovation.

Question 5 – General position of ICT in company

Last but not least the results of survey show the significant relation between ICT projects and business strategy (4.0). The business situation is regularly revised in the way, how ICT innovation could help (4.7).

5. Conclusion

The survey confirms the basic research question formulated above. Some important questions have been remained unanswered. For example, if the company has clear vision how ICT can help to be competitive and if the standard approach to continuous improvement is applied. These questions will be analyzed in the further steps of the research projects. The results of the projects will be a support for innovation steps in company in the ICT field.

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BENEFIT OF STORED DATA IN TIME OF DEPRESSION

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Abstract

Data stored in corporate databases are argued to serve as organization memory capable to aid information for managerial tasks in time of depression, although in times of growth such view is more common. Innovative use of corporate data does not need over costing. Technical arrangements for mining data on low expenses are outlined based on an experience.

1. Introduction

When long years were data put in a database to facilitate business processes then there are lots of them probably not really understood as a source for innovation. Data mining is well-known but often understood as some strange or obscure stirring in a database which occasionally outputs some useful knowledge for the business. What this paper aims at is a more general view, a view of an innovative and intensive utilization of memory stored in databases.

In time of economic growth IT effects are judged from different point of view (see [1],[2],[4]) then in time of depression. In economic depression the main strategic goals of a business are 1) business continuity 2) taking advantages of chance. Business continuity can be supported for instance by reduction of the costs or generally by optimization of the business. Taking advantages of chance needs getting to know of the chance and assessment of the chance. This paper deals with how new use of dusty data can aid these goals.

2. Business optimization

2.1. Costs

Costs are the easiest to investigate. Almost any business registers costs and costs can be easily monitored if wanted. With all the facts recorded in bookkeeping, store, inventory, transport etc., relevant criteria can be traced and new views on business costs can be supported based on new formulation of data retrieval requests. What is needed in this context is an innovative idea of what can be gained from resource records.

These ideas resemble multidimensional design for data-warehousing but do not be confused. No significant technological investment is needed to mine in your data. Speculation on great investment would not be wise in time of depression.

Technological aspects of mining of data as such will be discussed in chapter 4.

2.2. Processes

In lowered demand on the product of business, processes can be rethought and rearranged. Some activities may be performed another way, some can be omitted. Maybe some whole processes are unnecessary in the changed business conditions.

To get to know which processes, which activities can or should be changed or how, we must apply appropriate values. Maybe these values are monitored if your business underwent Business Process Reengineering (BPR). Maybe new values became more important in changed business conditions. Again, most probably relevant information is contained in records kept along your processes, and again, new approach to understanding of what your business needs is necessary.

Similarly to previous issue, this approach can resemble ideas and methodology for BPR, but do not be confused. In time of depression true BPR is overly expensive and risky. Although similar in some methods, the goal is other. The base of the processes system should be preserved but individual elements of it could be modified. So all the facilities, human capital, business culture will not be touched, but only processes will modify. No reengineering, only adaptation.

3. Taking advantages of chance

3.1. Discovering a chance

To discover a chance is another managerial task. The time of depression is a time of great changes in business environment. Information of what goes on out there hardly is stored in your database[4]. Can database technology help with this task too? Well, a database management system is best means to process a large amount of smartly correlated data. Compared to spreadsheets it can process much more data but it is more difficult to use. So depends on qualification what tool you will use. Consultation with your database expert can result in surprising outcome.

But honestly, much information relevant to this task comes through manager's intuition or qualified guess and is not to be found in organized databases.

3.2. Assessing a chance

Assessing a chance is in fact inherent part of discovering it. But we can count assessment as a different step in the course of taking advantage of or passing a chance.

We assess costs, possible profit, and risk. In relation to our strength or business position we take a stand to risk. The fewer funds the better assessment needed. Arguments and information are all around but some can be found inside our business, too. And again we arrive at data in our databases which carry information on how our business works, on our free resources, and which processes can employ new resources coming with the chance.

4 But thoroughly understood and mined your data can tell you something about what is out there, too.

4. How to mine in data at low expenses

The principles are quite simple which does not mean that are obvious. First, you must know what information you have at your disposal in your databases. Ideally you would have some intelligible corporate conceptual information model (for what such models should be like see [3]). Simply, you would have some information map of your business in terms what information you have, what relations between that information holds and where it is stored. To gain such a model if you do not have any, which is most probably the case, you have to consult a data analyst and together create one. It is possible to do without a conceptual information model but things are much easier with it.

Then you must ensure that you have satisfactory access to data you would request. This phase needs at first to perform a requirement analysis in terms of what information how correlated is or would be interested for you. While this task is similar to data analysis for purpose of data warehousing you in fact do not need to build a data warehouse (in a state of art meaning in information technology branch) to mine in your data. Following will explain this.

For this step it is quite recommendable to build a conceptual information or data model of your view of interesting data. This model would be derived from a subset of your corporate conceptual information model if you have had some. Such a model is a significant aid in formulation of information retrieval requests (again, see [3] for argumentation).

Now you are prepared to discover the access path(s) to your needed data. In lucky circumstances, you will need not much technical arrangement for this but this is most probably not the case. In this respect consider but that in an unhappy time of depression one benefit you can have is that your transaction processing systems (TPS) are not as busy as in other times and you can load them with your new explorative tasks. In such a case it would be necessary to work with assistance of your data administrator to guard accessibility of your databases for the business processes.

In most cases an extra load on your transaction processing systems would be unacceptable, maybe because of a risk of loss of business profit. In this case an export from TPS to storage for your disposal is the solution. What form would the exported data be of depends on used technology at both sides, the corporate database system and the manager's querying tool. An important question is of the manager's tool. It should serve as a trouble-free access point to data and a query formulation aid. A highly advanced possibility offers Active Query Builder; other affordable tools proven to be sufficiently user friendly are Microsoft Access or Microsoft Query. An open source OpenOffice Base is also an alternative. Of course, data can be investigated with use of a spreadsheet program, with less capability.

Investment in such a solution is minimal. Experience proves it to be useful. The most critical factor sees the author of this paper in the manager's PC literacy or skills. In that case some IT assistance carries out the job.

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Information Management - Key Factors and Aspects of Enterprise Informatics

ICT HUMAN CAPITAL - RESEARCH AND DEVELOPMENT WORK IN ICT

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Abstract

Information management represents nowadays a driving power and large potential for increasing effectiveness and efficiency of enterprises with process architecture. Some introducing aspects of information management (IM) history and changing roles of it in last ten year are presented in this contribution. The second part –information management on macro economics level - is dealing with one of key aspects of real applied information management – with human capital. Human aspect of information management is discussed here as a problem how to assure well educated, skilled and motivated employees on working positions for information management processes. Other contexts of the human capital as an influence factor of ICT on the whole economics and effects of research and development work on education of ICT experts are briefly presented in this contribution as a base for further presentations and discussions during the conference event.

1. Information Management - Key Factors and Aspects of Enterprise Informatics

"Information Management Superiority" concept presented [23] attempts to address challenge of aligning enterprise goals with information and communication technologies (ICT) processes especially with investments realized in this area. He formulated also five core ideas, why is information management predetermined to play leading role in management of synergic effects on the information technology improvement, methods of classical management and enterprise core business processes. Times there are changing and also roles and impacts of information management have been changed during these fifteen years from the edition of this Strassmann's book. How does the situation look in the field of information management and its role in enterprise - Czech experience - is presented in next paragraph.

1.1. Information Management – Process History

Definitions and settings of information management were proclaimed in my last contribution on IDIMT 2008 [6] and the general history of the term information management is presented for example in [31]. What I would like to present in this paragraph are my private experience with applied information management in Czech practice. The older participants, especially from former socialist countries, remember on very specific enterprise department that was in the past normally included into the regularly organization structure of national companies. It was *Department of Management Techniques* (abbreviation OTŘ in the Czech language). Its main role was to organize, to plan and to manage business processes in state companies. Information management roles and processes were executed by this department. From organizational point of view this department related two lines of managerial work - *information management and general (line) management aspects into one organization structure*. This department was organized on methodological base in order to support management processes, information flows, personal responsibilities and authorities, scopes of employment for all employees in the whole business unit. Increasing significance of information systems and information and communication technologies (IS/ICT) invoke not only changes in data processing, but this process of permanent changes is also closely associated with changes in management and in information management as well. Reins of information management slowly migrated from specialized department into hands of new age carriers – into the *Department of Information Technology* (IT department). The question why, could be answered by many ways, but the main reason, according to my opinion, is associated with business process reengineering techniques as a part of the first phase of IS/ICT improvement into enterprises. Each IS/ICT project became a solid based on previous more or less detail business process analysis and by innate IS/ICT improvement is important to set up enterprise processes into the software solution. It does mean to display visions of information processes into software application and by this way to support main material and managerial processes in the enterprise. Persons from the IT department are becoming, thanks to the IS/ICT awareness, specific V.I.P. persons with general overview about the whole organization. They know, how is the enterprise organized, what are weakness and strengthens of the enterprise organization, what are organization's limits, and how are core business processes supported by IS/ICT. These aspects produced professional requirements on non professionals in the area of management. One of the main roles of the IT department became to plan, to manage and to realize the maintenance of organizational structures. Also this period is, thanks to the increasing pressure on effectiveness of processes, slowly over. Today the Department of controlling has more important influence on process management and on general organization structures in an enterprise. This actual trend is associated with business process management and it includes also management of information needs, requirements, flows and processes – information management. All processes are (or better said, should be) supervised and controlled not only from the businesslike point of view but are also evaluated its financial aspects with the relation to performance, effectiveness and efficiency. What is still missing in process evaluation is distinction of its impact on the enterprise in time scale. It does mean that each process has a short and long term impact on enterprise' goal achieving and these impacts could be rather diverse. [22]

Actual situation in information management and in managing information processes displays duality in their management. Some part of process design, maintenance, monitoring and employees assignment to processes are managed under strong influence of IT department (in co-operation with line managers), process measurement evaluation, its appraisal of effectiveness, efficiency and performance are mostly supervised by financial departments – for operation management level is typical department of controlling. The weak point of this approach is laying in missing ability to distinguished the impact of enterprise processes (information processes as well) in timescale [34]. This fact is more related to methods and approaches of modern line management. These methods are more focused on achieving *short term goals* (prompt benefits). Long term benefits are mostly out of managerial scope and are not accented so markedly then short ones.

1.2. Challenges of Information Management in Information Society

Changes in *enterprise management* influence significantly also role of information management in modern – information society - organizations. Main challenges of information management in enterprises in the period of information society could be presented as following:

- *aligning enterprise goals with ICT, especially with new one which can deliver on the market,*
- exploiting ICT to generate competitive advantage,
- redesigning business processes to support the organization more effective,
- managing ICT risks to remove danger of ICT support loss for business processes,
- employing ICT to enhance productivity and quality,
- monitoring information processes, its measuring and evaluation,
- evaluation of effectiveness, efficiency and performance of ICT related process,
- justifying the ICT investments needed to achieve all of this.

1.3. Selected Aspects and Factors

Information management, as is presented by Department of System Analysis, content three main components (disciplines) – System Science, Management and Informatics. The research and development work of the department is more focused on interdisciplinary aspects of these disciplines. Selected aspects of information management that are on the topic of our interest are following:[5]

- *Information and Knowledge Elaboration*; application of system disciplines and system approach on data and information processing, changes in data processing paradigms, changes in general minds and enterprise culture [21], [13], [30],
- *Achieving goals*; concrete ICT process are linked to concrete enterprise goals – main problem is that theses goals should be formulated in two time levels as short time goals and goals for longer periods [2],
- *Risk management*; using of ICT represents not only potential benefits but it also contains significant risks for enterprise operation; these risks are called *operational risks* and for several braches (banking, insurance, reinsurance sector etc.) are crucial [27], [28], [29]
- *General Principles of Management*; Integrated Management System design, improvement and its maintenance in enterprise [10], [14], organization structures forming, responsibilities and authorities assignment [25],
- *Reference Models*; enterprise informatics management, ICT process models, [15], [16],
- *Human Factor*; ICT and another aspects of information management can not be managed if we do not have enough educated employees in required age and qualification structure, if we do not have clear defined processes of knowledge management (knowledge gathering, saving and distribution) and system of ICT related abilities education, [8],
- *Project Management* – models, methods, methodologies, organization structures, projects benefits evaluation etc. [9], [19],
- *Monitoring and Measurement* of processes effectiveness, efficiency and performance, [15],

[5] Selected aspects are assigned to research and development activities performed on informatics departments (Department of Information Technology and Department of System Analysis) at FIS, University of Economics, Prague.

- *Security Management* with accent on information security management [6], [7]
- *Audit*; auditing of enterprise informatics, information systems and IS/ICT projects, [28],
- Of course, there could be found a lot of other aspects, but topics for our work are presented above. With regard to dynamic progress in all three components of information management, we can expect further development of our topics.

2. Human Capital in ICT

All above presented challenges and aspects of information management in business units can not be realized without disposing of relevant human capital. We can find out several aspects of this information management factor, but it depends on the rate of required complexity by investigation it. The first influence of is the global relation between supply and demand on ICT experts market. It depends on capacity and quality of ICT higher education institutions and ICT education. They influence in the second plan the whole national economy, because ICT became one of the leading forces of information society. Its quality depends, except other aspects, also on research and development investments in this area (the third impact). These aspects are presented here in a short overview.

2.1. Actual situation with ICT Experts on the Czech Market

One of most important aspects having important influence on realization of information management functions and challenges is human resource management. For all activities are required human beings disposing relevant ICT abilities, skills knowledge and experience. Real situation on the demand side of the coin in the Czech Republic is following[6]:

- there are now (2005 - 2008) moving IS/ICT support centers of multinational companies, like e.g. DHL and Accenture in Prague or IBM in Brno, or other supporting service centers heavily dependent on IS/ICT (like e.g. centre for accounting and bookkeeping of Siemens in Frenštát pod Radhoštěm – Northern Moravia). Many other companies are building or expanding their IS/ICT development centers (e.g. IBM – in Brno, SUN Microsystems, Google, Skype in Prague, Quadbase in Jihlava – Southern Moravia). Significant demand for highly qualified staff is also created by system integrators, consulting and advisory companies [33],
- general estimated number of ICT experts required for years 2009 and further years (without new incoming big players on ICT expert market in the Czech Republic, but including analysis of demographical trends – retiring of persons over the age of 60) is 3000 – 4000 new persons on the market per year.

The other side of the same coin – the supply of ICT experts or better said ICT quite good skilled persons – is on domestic market following:

[6] These, in this paragraph presented data, are conclusions of the survey of ICT human resources analysis realized by FIS employees and supported by Czech Ministry of Education, Youth and Sports. This survey has been realized since 2004 to 2006 in cooperation with Czech Statistical Office, SPIS, CACIO and 54 university faculties and approximately with 1000 business units.

- for well educated and prepared persons for the ICT business is necessary to pass out university (with major or at minimum minor specialization in the area of ICT). Bachelor degree is acceptable for positions with lower requirements (Administrator of Applications and of ICT Infrastructure, ICT Expert User, Business person in ICT Products and Services) and master degree is recommended for other more crucial positions (Business Process Analyst/Designer, Developer / IS Architect, IS/ICT Development and Operation Manager),
- general "production" of master level graduates is actually approximately 2000 graduates per year from all Czech ICT oriented university specializations (the majority of ICT students graduates on master level and the number of outgoing bachelors to ICT business in minimal; perhaps is this feature typical for ICT education, because in ICT business are active only very few persons with bachelor graduation level in the Czech Republic at this time).

Partial conclusion 2.1: There are 1000 – 2000 ICT educated university graduates missing on the Czech market annually.

2.2. Other Aspects Outside of the ICT

There is a plenty of external aspects existing out of the ICT frame that influence conditions for effective information management in business units. I have selected three external factors which are normally out of authority of enterprise information management. There are relations to following realities:

- macroeconomics,
- research and development (R&D),
- demography.

2.2.1. Macroeconomics influence of ICT

Massive investments into ICT in last years should start an economic growth. But some of them were totally failed – for example the dot com boom in 90s and its intensive reduction on begin of the 21 century. There could be found different opinions how to influence nominate and real economic growth improving ICT into praxis and how measure their contributions to it in the world literature [1], [4] and more others. ICT dispose by specific properties very similar to utilities [3]. General frame of ICT impact on economics growth is shown on Figure 1.

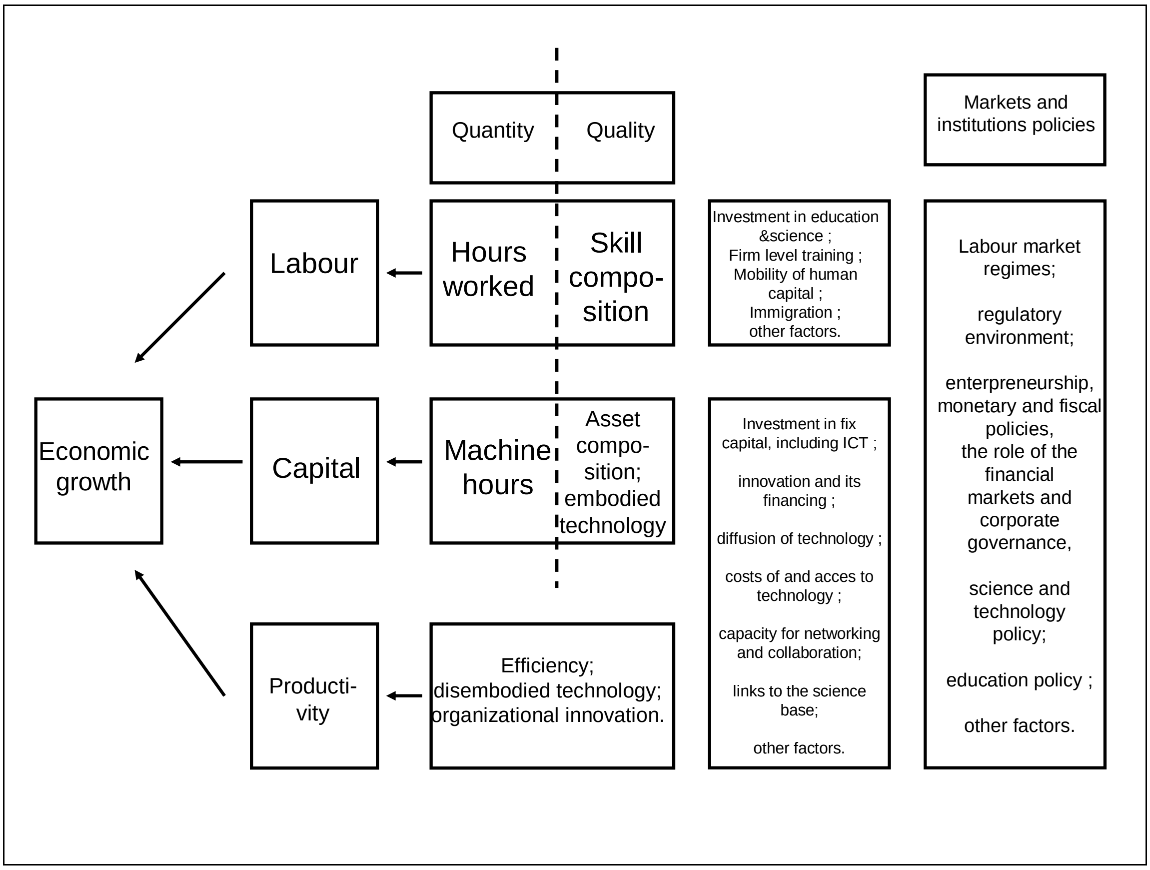


Figure 1: Analytical Framework for ICT Contribution Measurement to Economics Growth, [17]

More detail view on ICT influence on economics growth is presented on Figure 2. Very important fact is that ICT influence economy and its growth on two levels – on the level of *direct production* (ICT Producing Sector) and on the level of *indirect impacts* (ICT Using Sector). These two levels effects accumulate into common contribution of the ICT to general economics growth. Ways (three main processes A-C) how it is realized in practice are shown on the Figure 2.

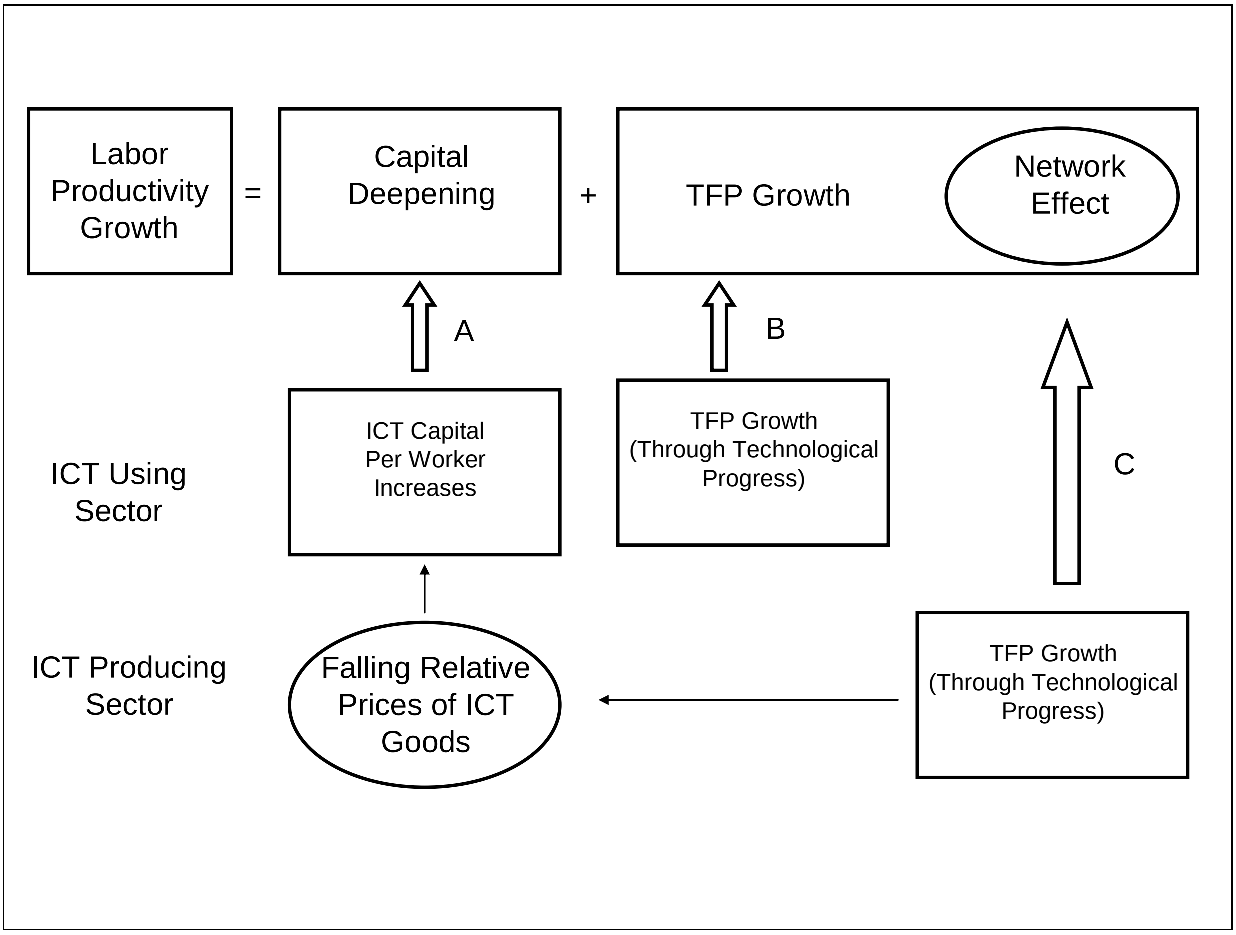


Figure 2: Channels of Contribution to Economics Growth by ICT, [20]

Remark to Figure 2: Abbreviation TFP represents "Total Factor Productivity"

Process A – this process may lead to an increase in the real capital stock per worker, ICT related capital deepening across the economy implying a lowering of the marginal cost of capital. In practice does it represent that this channel brings new products and permanent falling prices of them.

Process B – this is long term process and it represents innovations (structural changes in economy or in a sector of economy) in core business through ICT improvement into practice. It could represent new goods and services presented on market or new channels for their distribution using ICT infrastructure (for example e-marketplaces, E-shops, improvement of new inventions in hardware – disk fields etc.).

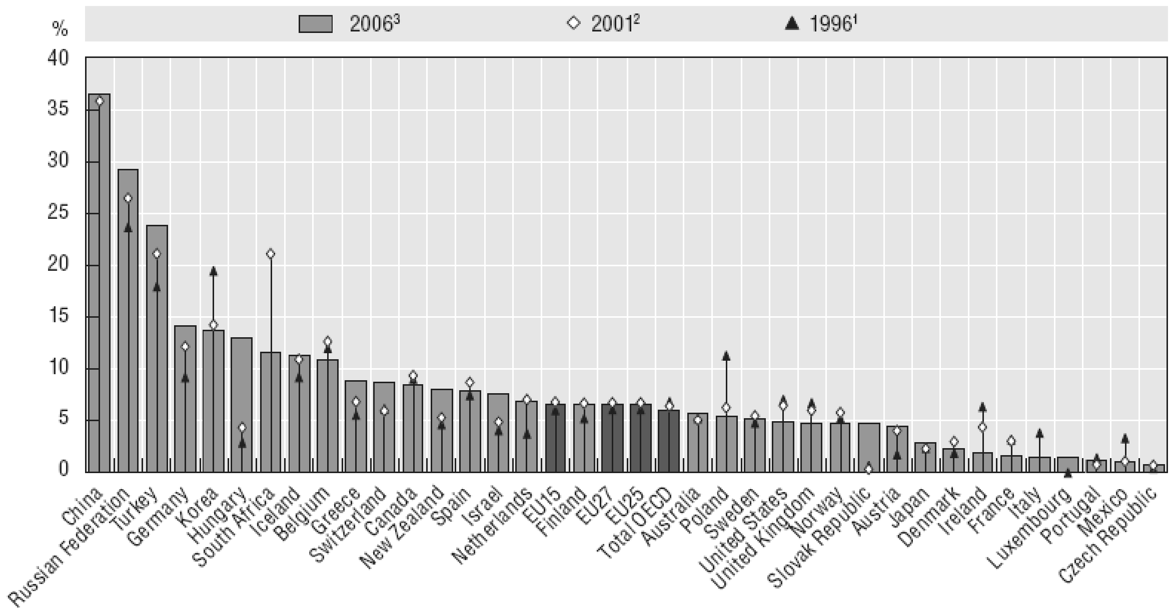
Process C – is representing the way of increasing of the economic grow by growth direct in ICT producing sector and in related industries. This way is typical represented by developing of new ICT products.

Partial conclusion 2.2.1. ICT effects positive the productivity and economics growth.

Remark: Influences were investigated in conditions of stabile economy period. Impact of investigated processes and factors in period of recession or crisis need not be necessary only positive. The rate of positivity or negativity depends on processes (A, B, C – Figure 2) and its share on global influence on economics.

2.2.2. Research and Development in ICT

According to [17] the ICT sector invested heavily in research and development in 2004, ICT manufacturing industries accounted for more than a quarter of total manufacturing research and development (R&D) expenditure in most OECD countries, and over half in Finland and Korea. The share of ICT in total patent applications rose in almost all countries from the middle 1990s to the beginning of the 2000s. In OECD countries, ICT-related patents represented, on average, 35% of total patent co-operation treaty filings in 2005. Over 50% were related to ICT in Finland and Singapore, and in China, the share of ICT in total patent applications more than doubled over 1996-2005 [17].



StatLink http://dx.doi.org/10.1787/450731005724

1. 1998 for Austria; 1997 for Finland, Greece, Iceland, New Zealand and Norway.
2. 2002 instead of 2001 for Australia, Austria and Switzerland; 2003 for China.
3. 2005 for Belgium, Denmark, France, Germany, Greece, Iceland, Italy, Luxembourg, Mexico, New Zealand, Norway, Portugal, Sweden and the United Kingdom; 2004 for Australia, Austria and Switzerland; 2003 for the Netherlands and Israel.

Source: OECD, *Main Science and Technology Indicators (MSTI) Database 2008/1.*

Figure 3: ICT R&D investments – in % of GDP, [17]

Partial conclusion 2.2.2. Investments in ICT R&D are in the Czech Republic marginal in comparison to other developed European countries.

Remark: Positive message. In absolute terms, spending on R&D in the *higher education sector* has been strong in recent years. The Slovak Republic experienced the highest real average increase from 2001 to 2006 at 22%, followed by China (17%), Ireland (13%) and the Czech Republic (10%). Luxembourg's annual growth was particularly strong (46%) because it established its first university in 2003. Growth across the OECD area and the EU27 was 3,3% and 2,8%, respectively, between 2001 and 2006, or more than the growth rates in the business and government sectors. This strong growth in the higher education sector may reflect the growing recognition that R&D in higher education institutions is an important stimulus to economic growth and improved social outcomes. [17]

2.2.3. Demographical

Another problem represents fact that number of teenagers is decreasing in the whole Czech population. Our forecast (based on data from survey from 2004 - 2006) of share of ICT students that must admit each year to Czech universities – ICT oriented specializations - on the whole 19 –year-old population, in order to save the same level of ICT experts in Czech economy is shown on Figure 4.

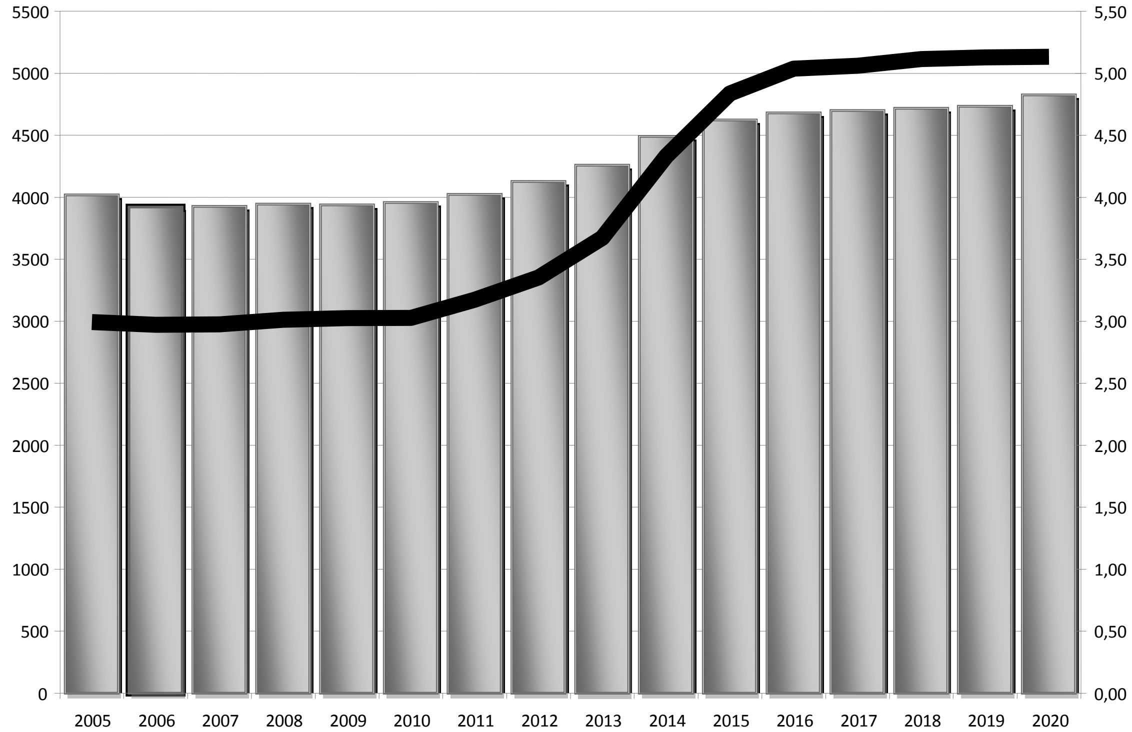


Figure 4: Required number of ICT bachelor students – comparison with all the 19-year-old population in the Czech Republic [8].

Remark to Figure 4: Bars in bar chart represent number of 19-years old population each year, the curve represents required share of ICT students on the 19-year-old population.

Partial conclusion 2.2.3.: Relative share of ICT student on 19-year-old-population must increase from 3, 00 % in 2010 up to 5, 15 % in 2020 according to demographic forecast for future years in the Czech Republic.

Remark: This partial conclusion represents a challenge for all universities, and HEIs (Higher Education Institutions), for their marketing departments and for their staff to complete high ambitious study programmes with actual, comprehensible, understandable and modern courses.

3. Conclusions

Information management effects in two different levels – the *first one is an enterprise level*. Here are main challenges in areas presented in paragraph 1.1. Some selected aspects are also presented in 1.2. The *second* one is out of business units and *information management on macro economics level could be presented as political feature of the society* – management and establishment of information society, information systems for support state and public administration functions, legal frame innovation etc.

ICT have different and various effects on economics growth and are influenced by demographical aspects namely on ICT experts' availability (number of potential ICT experts - quantity). Investments into ICT research and development work imply quality of ICT graduates and they have relevant impact on ICT university education and its quality as well. These aspects of information management show that information management deals with problems of large complexity and enterprise information management is able to manage business defined problems and these ones that are out of this second macro economical level. But on the other hand macro economical, demography and for example financial aspects have strong impact on enterprise information management.

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BUSINESS PROCESS MODELLING IN GOVERNMENT INSTITUTIONS

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Abstract

The main aim of the paper is to summarize the evolving tools that help to bridge the gap between business processes and the IT environment. From bottom up (IT perspective) these tools are CMBD, autodiscovery tools and service impact modelling tools. From the top down (business perspective) the business process management (BPM) tools have been developed. Paper focuses on the business perspective and discusses different aspects of BPM (languages, layers and tools).Special attention is given to the specifics in government institutions. Those specifics are illustrated by the practical project of Public administration process modelling and reengineering in the Czech Republic.

1. Introduction

One of the main goals of Information Management concept is to bridge the gap between business processes and the IT environment and thus „attempts to address challenge of aligning enterprise goals with information and communication technologies (ICT) processes especially with investments realized in this area“ [2]. But there is an obstacle to that alignment. That obstacle is due to the significant difference in perspective between IT professionals and line business owners. This obstacle seems to be superimposed within the area of government institutions. There are in general three reasons for this ultimate pressure on the government and ICT processes alignment:

- Government processes are very vulnerable to the agility, quality of services, regulatory compliance, cost reduction and risk reduction,
- Number of "end users " – citizens is enormous and thus the volume of business – government services is high (service is viewed as the process output),
- Government IT spending is still lower in Czech Republic comparing other countries, so we can anticipate its growth.

Over the past several years, both IT (bottom up approach) and line of business owners (top-down approach) have been evolving tools that give line of business owners a better understanding of the IT environment and give IT staff a better understanding of the business.

2. IT Service Management Evolution

IT service management solution vendors have been working from the bottom up to evolve tools that enable IT to improve IT service management abilities. Three technologies have been fundamental in this evolution:

- *CMBD* defines a set of configuration items (CIs) and maintains information about all resources – technology assets, IT processes, and people – as configuration records in the database
- *Autodiscovery tools* were developed to discover hardware and software resources in the IT environment, thus giving IT a comprehensive view of the assets in the IT infrastructure from both the physical and logical perspectives (which hardware assets support which enterprise resource planning applications
- *Service impact modelling tools* permit IT to create and maintain models that map IT infrastructure components to the IT business services they support (for example, what business services a particular Web server supports).

This “bottom up” approach to bridging the gap between IT and business is currently supported by the relatively new branch of software tools called BSM – business service management tools. Sample Vendors: BMC; CA; Compuware; HP; IBM Tivoli; Indicative; Interlink Software; Novell Managed Objects

3. Business Process Management Evolution

While IT was evolving IT service management tools from the bottom up, the business side was evolving business process management tools from the top down. Business process engineers developed business process management methodologies and supporting platforms and tools that permit organizations to create and maintain business process models of their organizations.

Looking into the history we can distinguish three waves of process evolution since its postindustrial revolution inception [7].

In the 1960s, technology increasingly became a business driver and amplified the speed of change. This launched the first wave of process orientation. An international (Japanese) company became much more competitive, due in part to their focus on quality improvement programs and reduces defects.

The second wave of process orientation covered the late 1980s to early 1990s. Focus shifted to process innovation, best practices, “better, faster cheaper” ideas and e-business. The enablers of this wave were e.g. Activity Based Costing, Six Sigma, and process redesign and reengineering methods.

The third wave began in the mid 1990s and continues in the present as the “coming of age” of process-centric business. The focus is on assessment, adaptability, agility and continual transformation. The available tools are Balanced Scorecard, outsourcing, Co-sourcing, In-sourcing and BPM methods.

Currently some authors [6] declare, that there exist next BPM wave, which considers the fact, that business environment is characterized by the borderless enterprises and seamless processes as well as real-time business. Adaptive business networks instead of linear wired value chains spawn new challenges in the context of modelling business processes both on internal (private) and public level. According to popular business opinion, IT will thereby be transformed into a commodity meaning a common infrastructure like telephone or power grids. On top of SOA BPM will act as an intermediary between IT infrastructure and strategy layer.

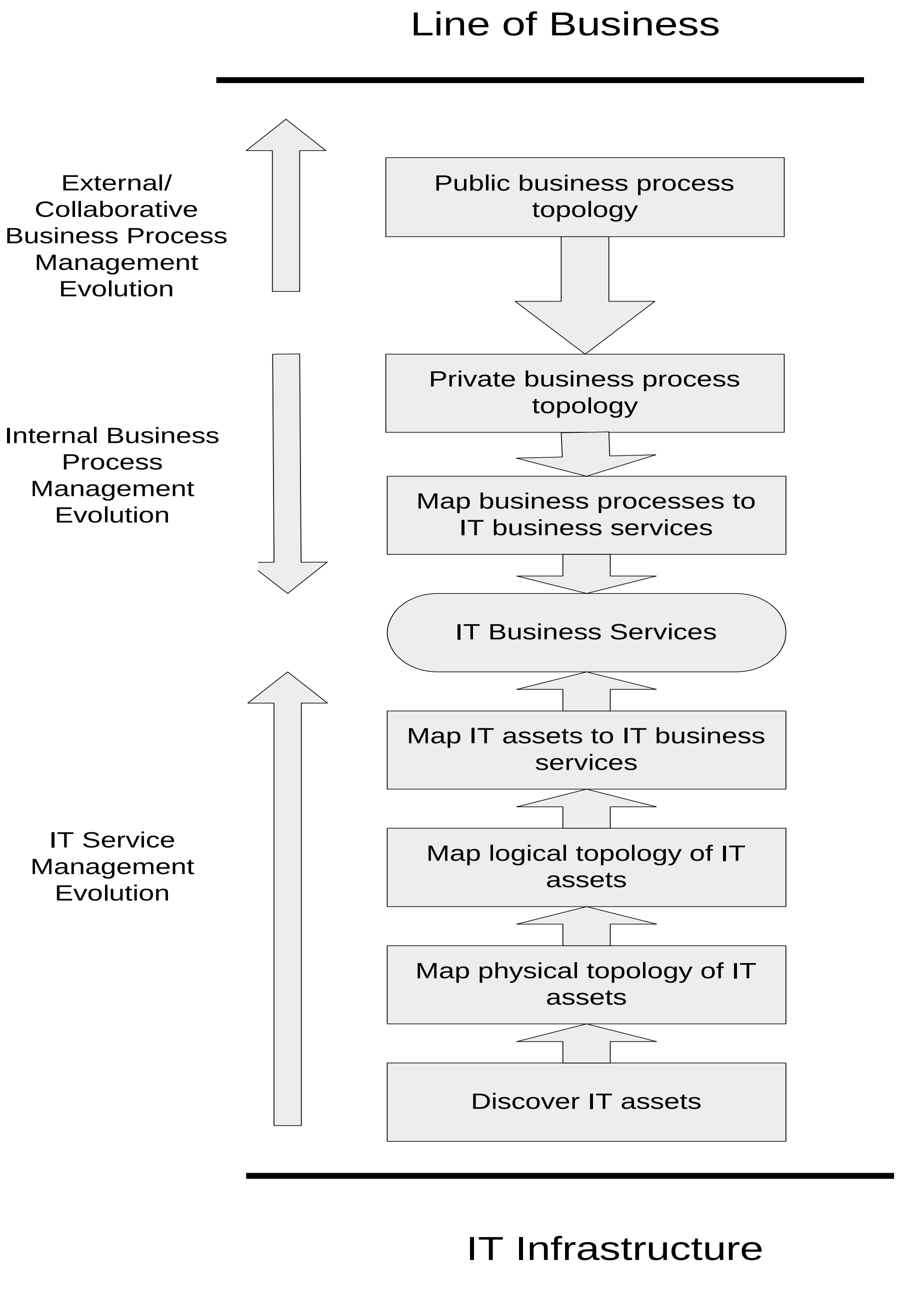

Figure 1: The common meeting point of IT business services [8]

3.1. Business Process Modelling Languages

A business process modelling language is an artificial language used to map existing processes or to design ones. Each modelling language is defined by set of rules which consists of syntax (the notation) and semantic (the meaning) [5].

Both textual and graphical languages exist. In the domain of BPM graphical models are often preferred, as they allow for an overview of the whole process and the presentation of timely and factual interrelations. The decision to employ a specific modelling language should be made in regard to the modelling purpose. The purpose range from pure documentation or auditing to the automation of processes. The construction of a model can reduce the complexity of an actual situation as a model usually just represents the relevant aspects. While for instance when modelling internal – private processes, we prefer process transparency based on identification of all relevant activities, information (sensitive included) and organizational structures, but when focusing on public /collaborative processes we have to apply concepts of information hiding which is necessary to protect critical internal information, building the foundation for competitive advantages.

Basically there exist three internationally accepted BPM languages: UML, BPMN and EPC.

The Unified Modelling Language (UML) is an open method used to specify, visualize, modify, construct and document the artifacts of an object-oriented software intensive system under development. UML combines the best practice from data modelling concepts such as entity relationship diagrams, business modelling (work flow), object modelling and component modelling. It can be used with all processes, throughout the software development life cycle, and across different implementation technologies.

In spite to the fact, that UML models are not primary intended to model business processes and thus to support their optimalization, there exist many different approaches how to exploit the UML diagrams (mainly Use Case , Activity and Sequence Diagrams) for this reason. One of the most known is that from Eriksson, H.-E.; and Penker, M. [3].

The Business Process Modelling Notation (BPMN) is a standard for business process modelling, and provides a graphical notation for specifying business processes in a Business Process Diagram (BPD), based on a flowcharting technique very similar to activity diagrams from Unified Modelling Language (UML). The objective of BPMN is to support business process management for both technical users and business users by providing a notation that is intuitive to business users yet able to represent complex process semantics. The BPMN specification also provides a mapping between the graphics of the notation to the underlying constructs of execution languages, particularly Business Process Execution Language.

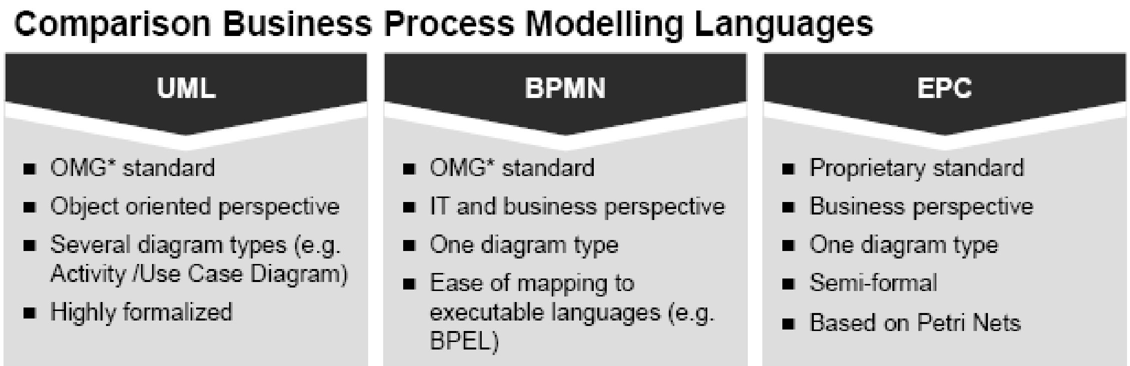

Figure 2: Business process modelling languages comparison [11]

Event-driven Process Chain (EPC) or extended Event-driven Process Chains (eEPC) are next examples of BPM language. Original EPC consists of events, functions and logical connectors and are used for the description of logical sequences of business processes. Events trigger functions which produce new events and therefore an alternating sequence of events and functions develops. As also other information beside the control flow can be relevant for business process models, the

EPC modelling language was extended by the usage of elements for resources, data, time and probabilities building the eEPC). This way, also roles carrying out functions can be modelled as the people and organizational units that are responsible for special tasks can be included in the model. Data flow including input objects and output products can be described as well. Extended EPCs represent the main modelling language for process modelling in ARIS (Architecture of Integrated Information Systems) by IDS Scheer AG.

3.2. Business Process Modelling Layers

Business process modelling can be provided at different layers each of which differs in the level of detail and purpose layers (Figure 3).

Collaborative business process layer defines the interactions of two or more business entities taking place between the defined public processes. One possible language for modelling collaborative processes could be the BPMN, which consolidates the ideas from divergent notations into a single standard notation. BPMN has priority over UML as UML does not explicitly assist the discrimination of different modelling layers. Furthermore, BPMN is easier to understand for people with a non-technical background.

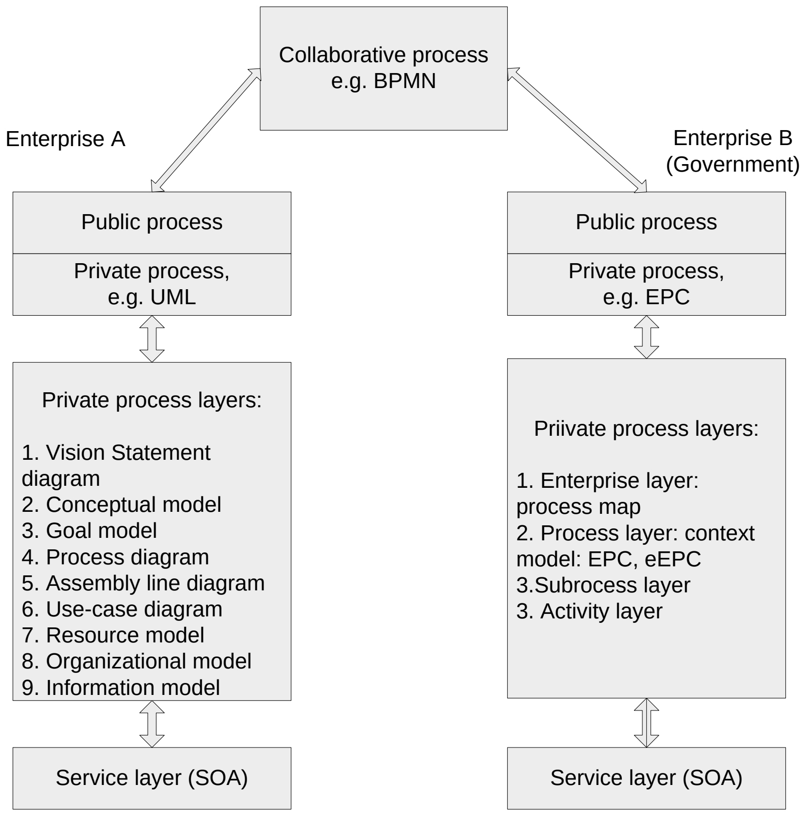

Figure 3: Business Process Modelling Layers

Public process layer enables to hide the internal process implementation and protect the critical internal information. Thus it provides connection between the private processes and collaborative processes. According to the SOA paradigm public process views are comparable to web service descriptions in the Web Service Definition Language (WSDL).

On *private process layer* organizations model their internal business processes according to a modelling approach or notation that is most suitable for internal demands independently of the modelling methodologies used by the business partners. At this level EPC has wide industry dissemination especially in German-speaking regions, Czech Republic included.

Within this level we can furthermore distinguish next private business process layers which differ in the level detail and applied methodology. In the Figure 3 you can compare partial layers of UML and EPC languages. While for UML they are represented by the different types of models and diagrams, for EPC there exist one diagram which can be applied at different levels: enterprise, process, subprocess and activity.

Service layer (SOA) represents the technical implementation of the business processes within the enterprise.

3.3. Business Process Management Tools

Trying to describe the market with business process management tools we are facing the problem with the disparity between BPM definitions. The BPM software market is very diffuse, a phenomenon which we can encounter almost daily when talking to students or customers. Analysts have tried to categorize the different types of software but many organizations find it hard to figure out the differences. We are all familiar with the two-, three- and four-letter abbreviations: BPA, BPMS, ERP, SOA and BI. All support business processes one way or another. Which does what? Let me focus on two of them: BPM and BPMS.

First and foremost, is BPM a management discipline or a technology? Depending on the context it can be both. When we define BPM as an approach to methodically design, implement, execute, control and improve business processes than we can argue it is a management discipline. In addition, there is technology to support this discipline in all of its stages. Due to their modelling capabilities, two types of technology are often confused:

- Business Process Analysis (BPA) tools such as IDS Scheer's ARIS;
- Business Process Management Suites (BPMS) such as Pegasystems, Lombardi, Software AG, Savvion and Metastorm.

The primary purpose of Business Process Analysis (BPA) tools is to visualize, analyze and improve business processes. BPA tools help translate every day business complexity into structured models (scope: from business to model). They provide insight into an enterprise's structure – i.e. how strategy, products and services, processes, roles, information and systems are related and influence one another. They strive to improve the communication between various stakeholders in a company, safeguard corporate knowledge and support decision-making and change management. Most notable user groups are business managers, process owners, quality managers, business analysts, risk & compliance officers and enterprise architects.

Business Process Management Suites (BPMS) on the other hand serve a different purpose and target a different audience. While they do offer modelling capabilities, their primary purpose is to automate, execute and monitor business processes based on technical models (scope: from model to execution). Notable user groups are business- and information analysts, process engineers, software developers and system administrators. BPMS do not offer such rich semantics as BPA tools in the sense that their metamodel does not comprise concepts for performance management, risk and compliance management or architecture management. Then again, these concepts are not required to automate processes.

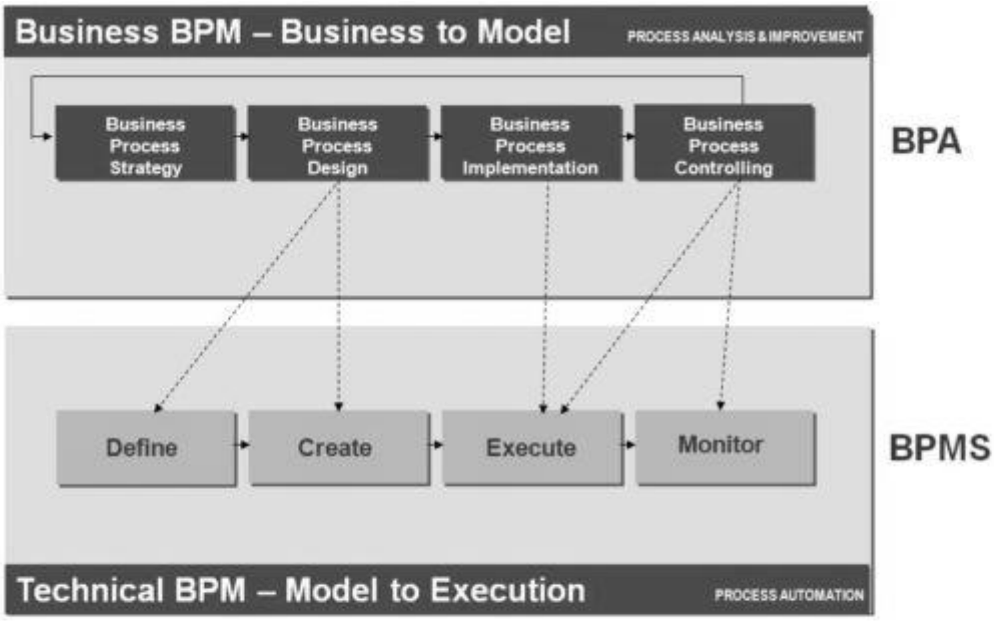

Figure 4: BPA and BPMS comparison

According to [4] there exist three categories of BPA tool buyer focus:

Architects

Close to half of buyers are primarily looking to do BP modelling in a coordinated manner with others who are modelling the enterprise architecture or doing IT modelling in support of application development, packages purchase or BPMS projects. Those in this category are looking for a model-driven systematic approach to BP improvement. There is a great concern about the rigor of methodology being used (e.g. SixSigma), adherence to architectural standards (TOGAF, FEAF, ITIL) and industry-specific frameworks, correctness of the models and how the models are moved forward in the design and implementation process than in the other two categories. As a result. this category of tools is the most complex and costly. The users are enterprise architects, data architects and IT modellers.

BP Modellers

This represents the primary focus for about a third of buyers. The BP modellers category wants more than just a drawing tool, but neither are they looking for complex costly tools. They are focused on modelling BP to improve understanding and look for process improvements without immediate concern on how these processes will be (or have been) implemented in IT systems or BPMSs. Many BP modellers start with Microsoft Visio because of its ease to use, low cost and integration with Microsoft Office.

BPMS Modellers

BPMS modellers are the approximately one-third of buyers who are primarily looking for BPA tool that is tightly integrated with their BPM tool of choice. The ability to understand a BP from concept through assembly and automation of services as a part of BPMS is the primary objective. There exist next scenarios for BPMS modellers:

- buyers want BPM with a robust BPA tool using a rigorous systematic approach to designing and implementing business services

- they want less functional BPA tools as they focus on BPM tools first and later add BPA tools. It is a natural progression to use the BPA tools of the BPM vendor. In this case there exist generally two possibilities:
    - BPM tool vendors have their own modelling tools (about 5%), and they are in most cases well integrated each other, but they do not have leading functionality,
    - BPM tool vendors do not have their own BPA product and they sell it as a separate product (18% of overall BPMS revenue). in this case we can notice better functionality, but worth integration.

4. Bridging the Gap between Government Processes and IT Environment – Practical Case

In the Czech Republic the "business oriented" top down approach in bridging the gap between government processes and the IT environment has been applied. In the 11^{th} of July 2007 the government decree No 757 has been accepted. The main aim of this document is to declare the strategy of the effective and friendly public services. This strategy is aligned with the common programs of European Union known under the name „Europe without Barriers“. The main aim of this program is to optimize the administrative procedures, provide cost cutting, to improve the process transparency and availability. This document was a starting point for new project identification. The project goal is to provide process modelling of the main public services agendas. This project was agreed in June 2008 and it became a subject of the public tender. The document Request for Proposal has been published in compliance to the Czech law No. 137/2006 in the 6^{th} of April 2009. The sponsor of the project was the Ministry of Interior, but the project covers the agendas processes across the government institutions. The value of the tender is about 5 560 000 EUR (150 mil CZK).

The Department of Systems Analysis has been asked to provide consultancy for RFP preparation and later on to help to provide evaluation of the proposals. On the base of this experience and in context of previous business process management theory let me summarize the main problems of process modelling in the Czech government.

Coordination problems within the eGovernment program among the separate projects

The Czech Republic launching the European project depicted the most important milstones/projects, which should provide the reduction and simplification of administrative burden: CzechPOINTs, KIVS – the public administration communication infrastructure, the eGovernment Act and the project of eBoxes, which is currently reaching its peak.

At the beginning the project of Procedural audits of agendas in public administration was prepared**,** later on it was renamed as Public administration process modelling and reengineering**.** This project has a close relation to the projects of primary registers. This project covers the design and development of four central registers as a reliable source of the most frequently used data in the public administration. The data stored in these registers should be shared among public authorities in a safe and controlled manner. The four registers are:

- Register of inhabitants
- Register of persons
- Register of territorial identification, addresses and real estates property

- Register of rights and duties.

The project of Public administration process modelling has primary importance for the Register of rights and duties as the process models should provide input data for it. Even to this fact both these projects were started in time, where there was no clear idea, what should be the content of the register. Therefore in the Request for proposal for the Public administration process modelling project there were no requirements dealing the need to integrate outputs of process models with the data in register. As a consequence the project was cancelled in the stage of proposals assessment because of "changing propositions".

Specification of the project subject (parts of tender)

Submitter identified three parts of tender:

1. Process modelling management (solution concept delivery, methodology, personal aspects of the project, project management, results communication – process publication)
2. Delivery and implementation of the application software (multi-licenses for 500 concurrent users, central model base delivery, DB operating and server hosting, help-desk, system support, support of user reporting, time unlimited access of users)
3. Education training and documentation (for 100 users of the process modelling, for 150 users of the process modelling methodology)
4. Design of 240 public administration agendas/process models (process, organizational, functional model, process must comply to legal standards, activity level is needed, inputs and outputs must be part of model, process expenditures summarization).

There are two very important items missing:

- Even to the fact, that hosting, help-desk and system support was requested, there was no demand on IT services specification (quality performance indicators versus price) in the phase of system maintenance. The submitter is asked to figure out only the price of SW delivery and implementation, project management and training.
- The request for the system architecture design and technical specifications was missing, which declares fact, that the Request for proposal was prepared without any internal IT professional's consultancy. This situation can result in unplanned IT infrastructure expenses.

Specification of the process modelling tool

In the chapter about Business process modelling tools there are different types of tools and users discussed. During our consultancy we made conclusion, that software tool should comply the capability of BPA tools and Czech government thus represents the category of buyers named BP modellers. In this case they can buy relatively cheap product, but from long-term point of view this solution can be insufficient as there will be no support of BPM capability.

Furthermore, there was no clear idea about what type of business process modelling language is preferred. As I already described, there exist basically three possibilities: UML, EPC and BPMN. In this case only two of them are acceptable: EPC and BPMN. Again in the long- term perspective the BPMN standard should be recommended.

There were only two competitors and they offered two different tools:

1. Aris Platform (modules: Aris business simulator, Aris business optimizer, Aris business publisher) and Craft Case tool for data gathering and IT description

2. QPR ProcessGuide.

Specification of the business process modelling layers

The Request for proposal did not specify the desired business process modelling layers. The vendors were only asked to demonstrate the capability of modelling tool on the sample agenda Citizen Assembly (Czech law No. 84/1990 About the Right of Assembly). Both the vendors focused on the private process layer. No SOA, public or collaborative model layers were described..

5. Conclusion

The projects of process modelling are always problematic as they provide graphical presentation of mental models, so it is difficult to apply any standardization. Nowadays there exists a great variety of the process modelling purposes /objectives, modelling languages, supporting software tools and modelling layers. To find the right mixture of these different aspects and thus assure the balance between the process model benefits and costs is a great challenge which is accelerated in governmental environment because of the missing profit pressure.

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HUMAN RESOURCES IN THE CZECH REPUBLIC 50 YEARS AGO AND 50 YEARS AFTER

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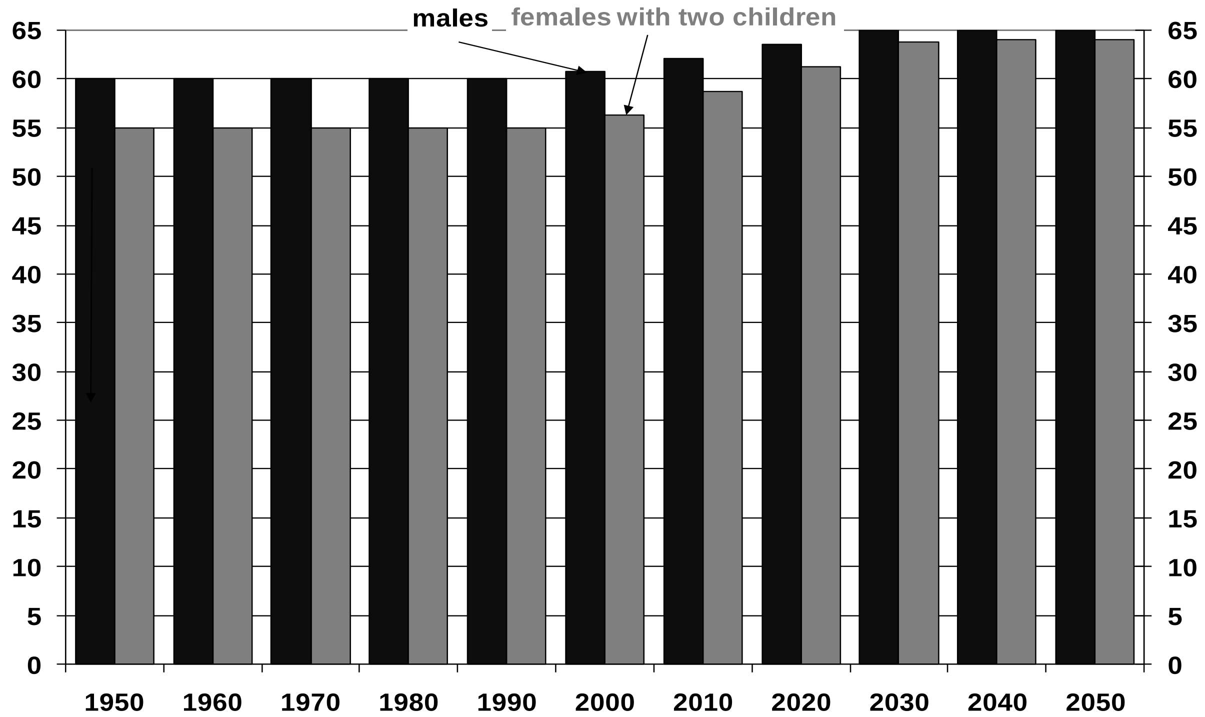
Abstract

The paper deals with the basic demographic analysis of the development of the population of the Czech Republic in productive age in the second half of the previous century and with the analysis of the supposed development in the first half of this century. Not only the age structure according to ten-years-age-groups but also the structure according to education level is analyzed. An implication of the demographic development for the information scientists is mentioned. Possible modification of the old-age-dependency ratio taking into account the dependence of the production on the education level is given in the last chapter.

1. Introduction

For the development of the economy not only material or financial resources are important, but also human resources, i.e. the number or the proportion of persons of productive age. The article deals with a brief analysis of the development of the population of productive age in the Czech Republic from the second half of last century up to the present and one of the possible variants of the prognosis of this development up to the end of 2050. Because, an analysis of the education level of the population is being carried out, data are given only for the moment close to the population census, i.e. only data as of the end of the years that are divisible by ten. For this reason and for the sake of the clarity of the graphs the analysis according to age is carried out according to ten-year age-groups [5].

At the present time in the Czech Republic, as in other economically advanced countries, very few people begin economic activity immediately after completing elementary school. For this reason the value of 20 years has been chosen as the lower limit of productive age and not the value of 15 years (formerly frequently used). From 1996 there has been a gradual raise of retirement age in the Czech Republic and the upper limit of productive age used is not constant, but equaling the retirement age at the given moment for the appropriate gender (Graph 1). The retirement age of females depends on the number of their children, for simplicity we suppose that each woman has two children.



Graph 1: Retirement age (source: own calculations based on the law of pension instance)

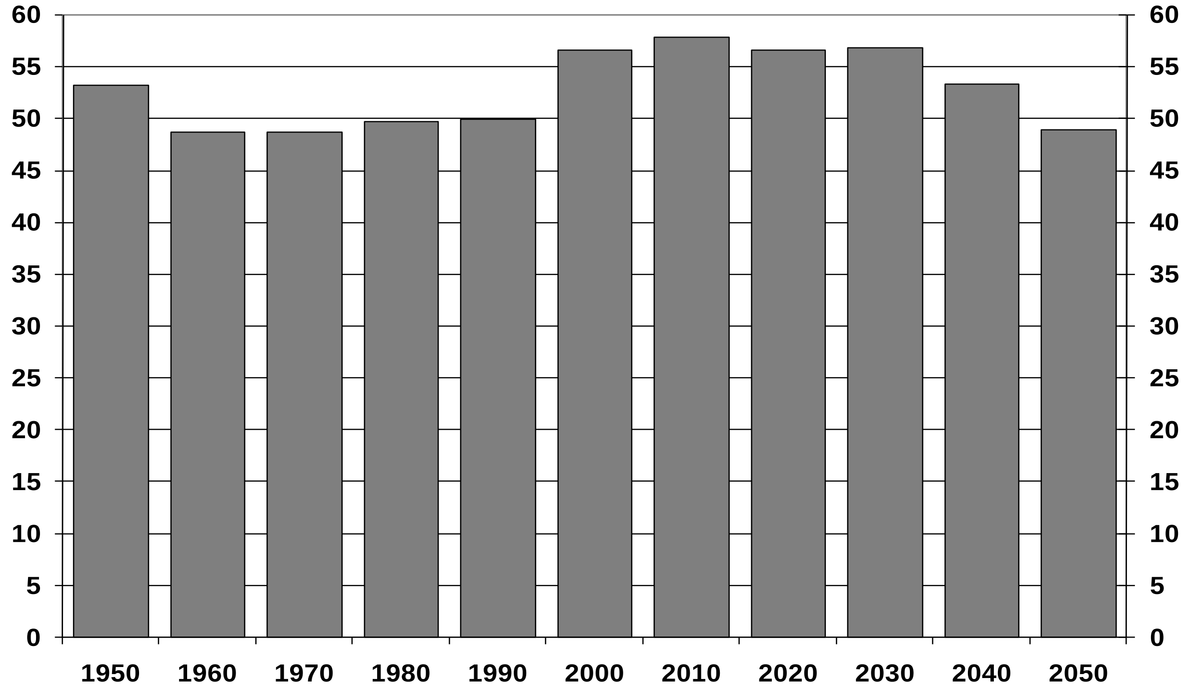
2. Data and projection used

The analysis for the period 1950 – 2000 was carried out on the basis of the demographic structure of the population of the Czech Republic published by the Czech Statistical Office [10]. Assumed development up to 2050 was calculated on the basis of the population projection of the Czech Republic prepared at the Department of Demography of the Faculty of Informatics and Statistics of the University of Economics, Prague, in 2007. More detailed information concerning the methodology of the projection can be found e.g. in [1] and [4], the assumptions concerning immigration are based on [6] and [9].

The analysis of the population of productive age according to education level for the period up to the year 2000 was based on the information from the population census, the expected development in the next fifty years comes from the prognosis of the development of education in the Czech Republic [8] prepared jointly by the Department of Demography and the Institute for Information in Education.

3. Age composition of the population of productive age

The development of the share of the population of productive age in the total population is given by Graph 2. In the second half of last century there was no very strong fluctuation of this part. After 1950 the value of this part dropped to just under 50% and it remained at roughly this level up to the end of 1990. At the end of last century productive age was progressively reached by the strong population years born in the 1970's and also the retirement age began to rise. The share of persons of productive age at present is therefore over 55% and due to the increasing retirement age it will probably remain at around this level for a further 30 years or so. Only at the end of the first half of this century (as a result of the retirement of the strong years of the 1970's) can any more marked drop in the share of persons of productive age be expected, perhaps even to below 50%.

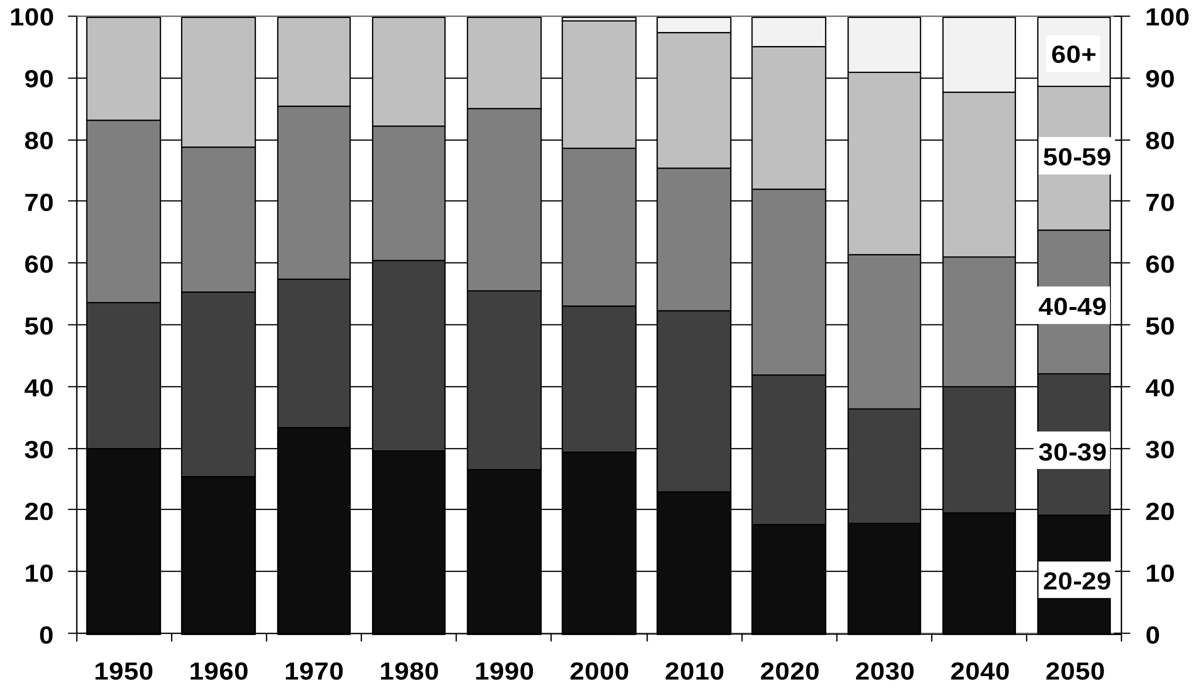


Graph 2: Share of persons of productive age in the total population (in %) (source: own calculations based on data from the Czech Statistical Office)

The age composition of the population of productive age according to ten-year age-groups is depicted in Graph 3. In the second half of last century there were no great changes in this age structure, more a certain degree of fluctuation. The proportion of those aged 20-29 years was around 30% and more than half the persons of productive age were under the age of 40. On the other hand the proportion of persons older than 50 years only exceeded 20% in certain years and only slightly.

In the first half of this century, however, it is anticipated that persons of productive age will grow older. The share of 20-29-year-olds will evidently drop to roughly 20% and the share of persons younger than 40 will only be somewhere around 40%. The proportion of those aged 50-59 will increase and as a result of the raising of retirement age to over 60 years the group of those older than 60 will be "added" to the persons of productive age. Around 2040 almost 40% of the persons of productive age might be over the age of 50 and roughly every tenth person of productive age would be over the age of 60.

The development of the ageing of the population of productive age is also documented by the increase of its average age. Whereas in the years 1950–2000 the average age of persons of productive age hovered around the limit of 37-39 years, in the present century this will evidently rise and in only 20 years from now will reach values of around 44 years. (Apart from the continuing ageing of the population a further reason for this growth is also the gradual raising of the age for retirement.)



Graph 3: Age structure of persons in productive age (in %) (source: own calculations based on data from the Czech Statistical Office)

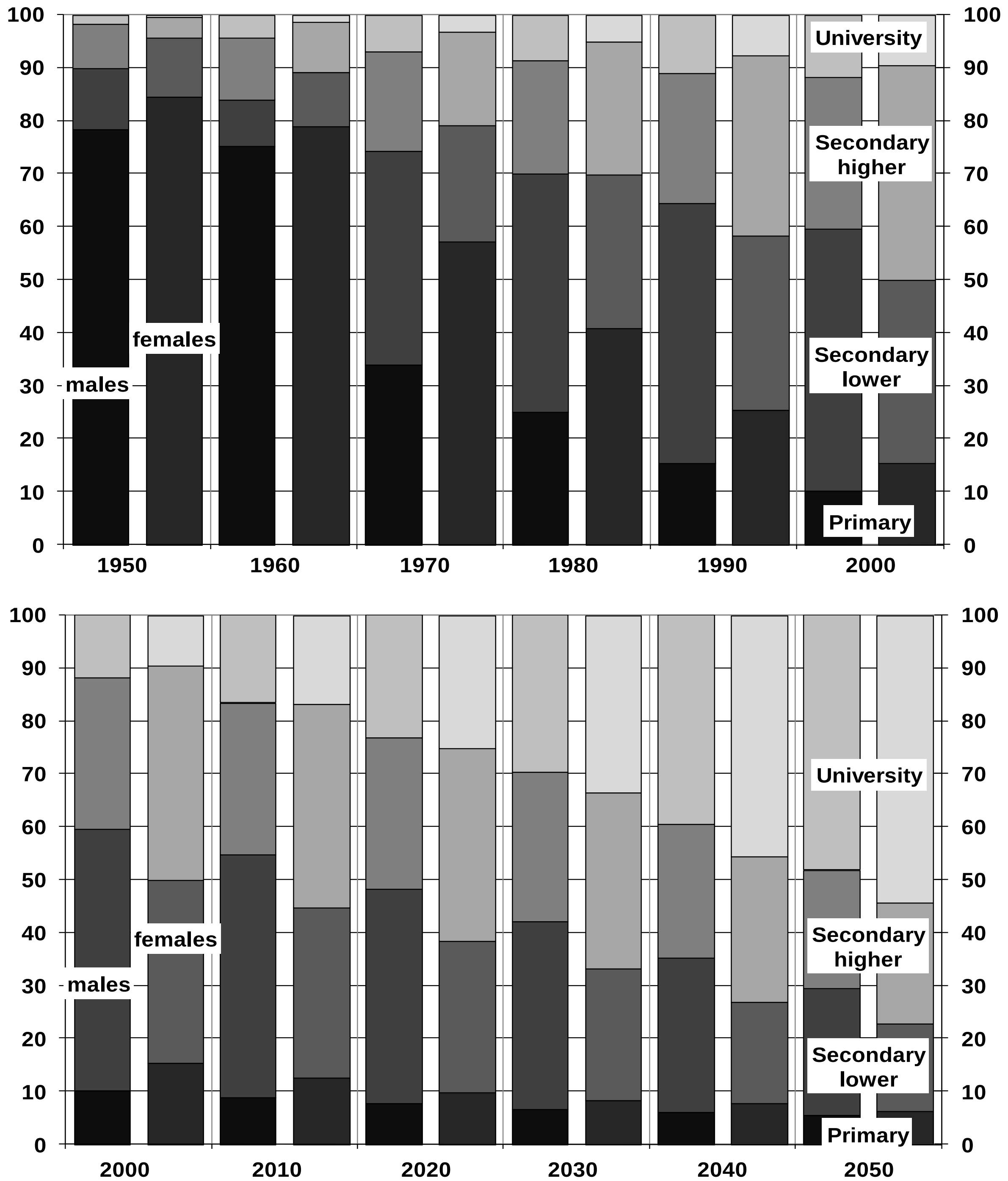
4. Composition of the population of productive age according to education level

For the development of the economy not only the age of persons of productive age, but also their qualifications are of increasing significance. A certain measure (although very rough) of qualification may be the level of education achieved. For simplification and the possibility of comparison we are considering only four groups of highest completed education level:

- Primary education (here were also included persons without education and persons with unspecified education),
- Secondary lower education (without school-leaving exam),
- Secondary higher education (with school-leaving exam) – including further education studies and higher vocational education,
- University education.

Because (especially in the past) there was sometimes quite considerable difference in the achieved education of men and women, we also classify according to gender in the analysis. The development of the structure of persons of productive age according to gender and education in the second half of last century is shown in Graph 4.

It is evident that the educational level of persons of productive age was gradually rising. Whereas in 1950 around 80% of persons of productive age had only primary education, after 50 years this proportion was only around 10%. In men a very marked increase in education is clear in the period 1961-1970, when the proportion of men with only primary education dropped to roughly half and there was a strong increase in the proportion of men with lower secondary education. In the case of women the increasing of education was smoother. In the whole period the share of persons with only primary education was somewhat higher among women than among men; on the other hand the proportion of persons with higher secondary and university education is somewhat higher among women in the 1990's and 2000's than among men.



Graph 4: Population in productive age according to gender and education level (in %) (Source: Own calculations based on data from the Czech Statistical Office)

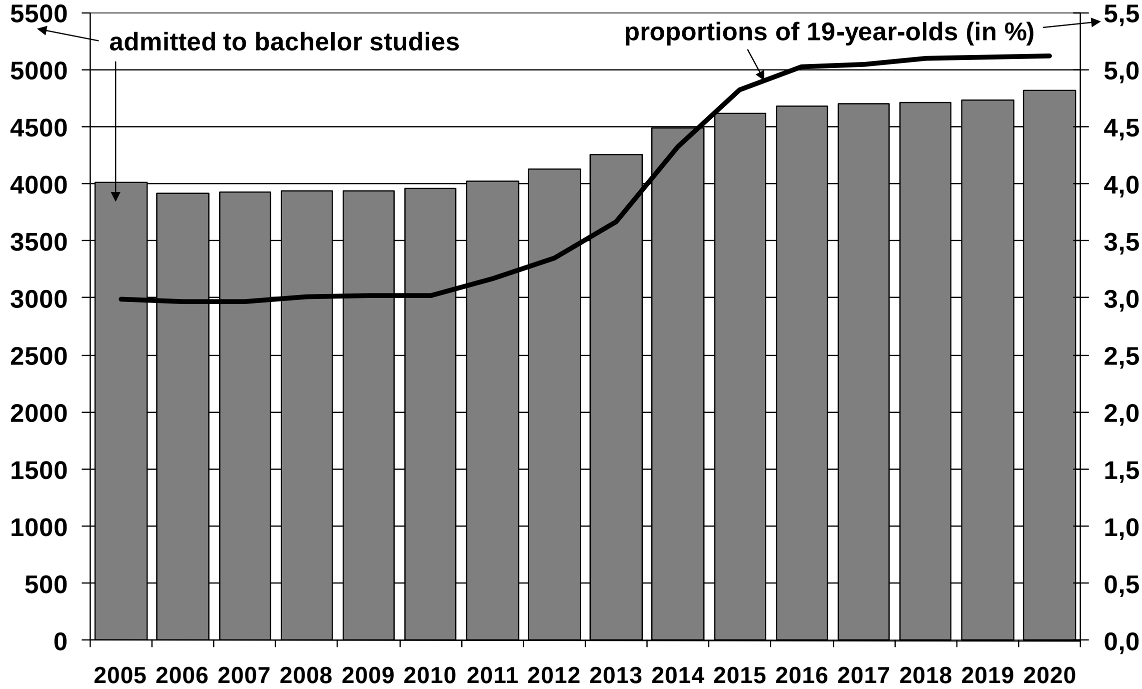
In the present century it is anticipated there will be a constant and relatively marked rise in the number of persons with university education and in the future this should be somewhat higher among women then among men. There arises of course a question, if the high increase of the proportion of university educated people (from 10 % to 50 % of the population) will not result in a decrease of the quality of the education.

5. An implication of the demographic development for the information scientists

The population projection focused on the information scientists (see [2] or [3]) shows that the number of information scientists dying would be roughly around 400 per year, the number of information scientists retiring will increase roughly from 3 000 to 4 000 per year. It is probable that the increase will not be so sudden, rather smoother, but in any case the number of information scientists taking up retirement in the next few years will increase.

We assume that all the information scientists who have died or retired should be replaced by young graduates from various schools (we are not considering, then, immigration from abroad or the situation where they are replaced by an older graduate who has not worked in informatics before). What would the numbers of graduates need to be?

Let us consider that roughly 57% of these young "new" information scientists should be university graduates and the remaining roughly 43% would be information scientists without university education (i.e. graduates of further education colleges, unsuccessful students from bachelor courses, etc.). Experience shows that roughly only 20% of graduates with bachelor's degrees take up employment immediately. The remaining 80% continue with the two years of master's studies, which 90% of them complete successfully and they therefore start working after these two years.



Graph 5. Required numbers of those admitted to bachelor studies in informatics and their share in the total population of the appropriate age (source: own computations)

With regard to the expected marked increase in the number of information scientists retiring at the end of this decade the annual number of graduates with bachelor's degrees in informatics subjects should at the present time be around 2 400 each year. In the second half of the next decade the annual number of graduates should rise further up to 2 800.

At the same time not every student accepted for bachelor studies will complete the course successfully. Experience shows that only around 60% of those admitted actually complete their bachelor studies. The numbers of students admitted to bachelor studies should therefore be considerably higher (and, of course, grow adequately “in advance”). See Graph 5.

We can see that at present the number admitted for bachelor study of informatics should be around 4 000 a year. But already in the second half of the next decade this should increase gradually to 4 500 and at the end of the second decade come close to the value of 5 000. With regard to the decline in the number of young people in the population and the competition among universities it may clearly be increasingly difficult to acquire suitable candidates for studies. At present it is enough for around 3% of the 19-year-olds to begin studying informatics. In the first half of the next decade, however, this proportion should rise to over 5%.

6. Importance of education for reducing the economic consequences of population ageing

A person with higher education will find implementation on the labour market more easily and therefore has a higher income. At the same time it may be assumed that their production is on average somewhat higher than the production of a person with lower education. It is very difficult to measure the level and quality of education, but as a very rough guide it is possible to use the length of education expressed in years.

A number of the analyses carried out show that each year of additional education (on average for the population as a whole) represents an increase in production of around 3-6%. At the same time this increase is higher in the advanced countries than in developing countries (one of the possible explanations is the quality of education). See, for instance [7]. The Czech Republic is one of the advanced countries and we therefore assume that increasing the length of education by 1 year in the Czech Republic means an increase in production of 5%.

We can estimate the overall production in the Czech Republic as the sum of the production of individual persons where we make the average value of the production of an individual with a total period of education of v years equal the value 1.05^{v-v_0} , where v_0 is the period of education regarded as standard.

Statistics show that at present in Europe the average period of education is around 12 years and so let us select this period as standard (this is roughly the period of education of a person with lower secondary education). A person with primary education therefore has a period of education 3 years shorter, a person with higher secondary education roughly a year longer and a person with university education roughly 5 years longer than standard. (We are taking the average length of university studies to be only 4 years because the 3-year bachelor courses of study are also considered as university studies.)

We often characterize the economic burden imposed on society by seniors as the old-age-dependency ratio defined as the ratio of the number of persons of post-productive age to the number of persons of productive age

$$OADR_{clas} = \frac{S_{III}}{S_{II}},$$

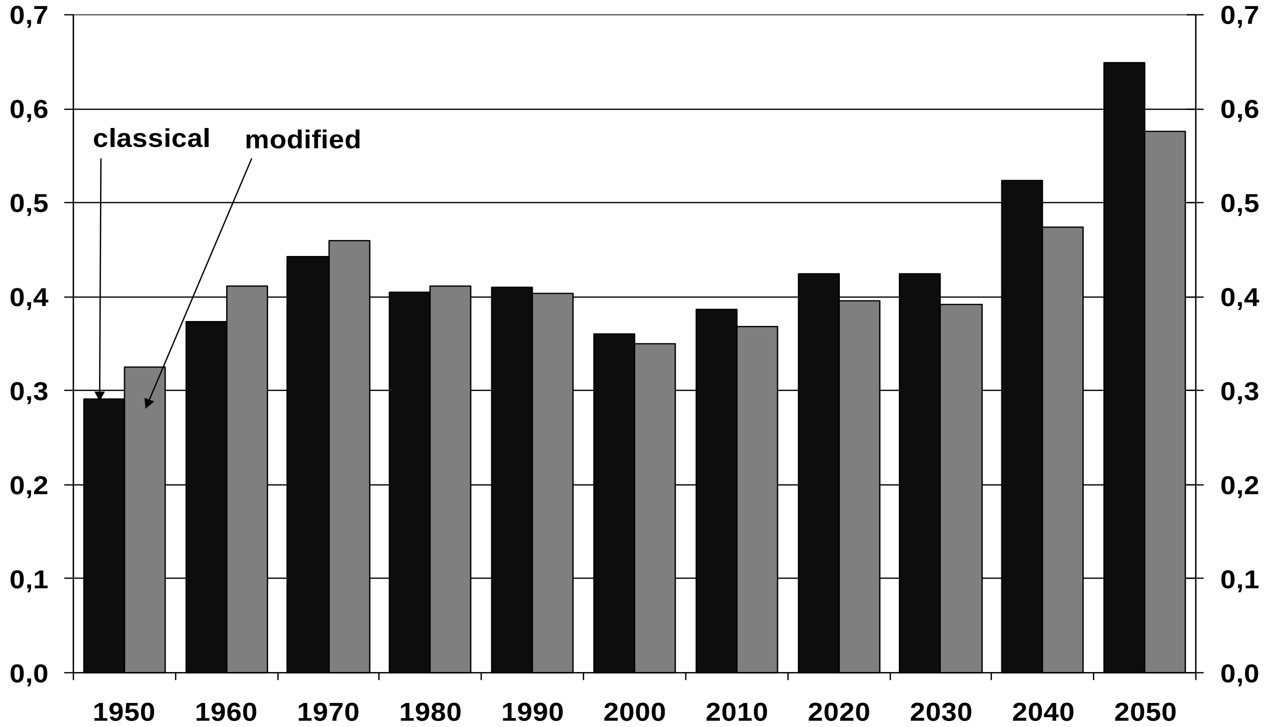
where S_{II} is the number of persons of productive age, S_{III} is the number of persons of post-productive age. This index, then, assumes that not only consumption, but also production depends only on the number of persons of the appropriate age.

Let us compare the values of this "classical" index with a modified index, where in the denominator there is not the sum of the number of persons of productive age, but the sum of the total production calculated with regard to the assumptions stated above

$$OADR_{\mathrm{mod}} = \frac{S_{III}}{1{,}05^{-3} \cdot S_{II,prim} + S_{II,\mathrm{sec}-l} + 1{,}05 \cdot S_{II,\mathrm{sec}-h} + 1{,}05^{5} \cdot S_{II,univ}},$$

where $S_{II,prim}$, $S_{II,sec\text{-}l}$, $S_{II,sec\text{-}h}$, $S_{II,univ}$ is in order the number of persons of productive age with primary, secondary lower, secondary higher and university education.

Graph 6 shows the comparison of the development of both indexes.



Graph 6: Old-age-dependency ratio (source: own calculations based on data from the Czech Statistical Office)

The increase in the dependency of seniors would, taking into account the rising level of education, be lower than according to the index calculated in the classical manner. The value of the "classical" index in 2050 would be almost 90% higher than in 2000; in the modified index the increase is only 60%. In this there was taken into consideration as the measure of qualification and the level of production only the normally registered "standard" formal education. Postgraduate studies and various forms of lifelong education were not taken into account at all.

7. Conclusions

The development of the population of productive age in the next 50 years will, in certain aspects, be other than in the years gone by. There will be ageing in the population of productive age. The proportion of persons aged 20-29 years of all persons of productive age will drop from the present 30% to around 20%. On the other hand the proportion of persons aged 50 and older will increase from the present level of around 20% to twice as much. The average age of persons of productive age will rise from just under 40 today to close to 44 years.

Fifty years ago the majority of people had only primary education and the education of the population has gradually risen. The most striking decline in the proportion of men with only primary education and the increase in particular of the share with lower secondary education occurred in the years 1961-1970 in almost all age categories of productive age. The share of persons with only primary education among women is somewhat higher than among men, but on the other hand the share of women with a school-leaving exam certificate, including university education, is somewhat higher than in the case of men.

The expected further growth in education may lead to a partial lessening of the economic consequences of the ageing of the population. Persons with better education are better implemented on the labour market and it can be assumed that they will also have higher production. It is naturally important that their education should be of sufficient quality and that their education does not end with the completion of formal education in school, but continues with various forms of lifelong education.

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LABOUR PRODUCTIVITY AND LABOUR COSTS IN ICT IN THE CZECH REPUBLIC

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Abstract

The aim of the paper is to point out the most important trends in the Czech ICT sector in relation to the economy as a whole. The paper is focused on the analysis of labour productivity in ICT sector in the Czech Republic and in its parts. Labour productivity in ICT is compared with the productivity in national economy. The regional point of view is also taken into account. The level of productivity is compared with the labour costs and the labour productivity to labour costs ratio in ICT is compared with the ratio for the whole economy. The structure of ICT sector (labour costs, gross value added) is also analysed. The relevance of statistical sources is discussed.

1. Introduction

The information and communication technologies sector (ICT) is one of the key sectors of the modern economy. Contrary to many other sectors, it directly influences the economic performance of the other sectors (through ICT material, ICT services and last but not least ICT human capital). It is known that not only in the Czech Republic the demand for ICT labour force is higher than its supply, so the wages in ICT are higher than average wages of the national economy and, in case of people with tertiary education, higher than average wages of people with tertiary education. But what is the relation between labour productivity in ICT and unit labour costs? Are higher labour costs attended by higher productivity? It is not a simple question (although it seems to be). The analysis of the *impact* of ICT usage to labour productivity in sectors which use ICT is complicated and will be a subject of further research. In this paper, we just analyse the relation of labour productivity and labour costs in typical ICT sectors (in manufacturing and services as well). Roughly speaking, our point of view is from the supply side of ICT and not from the side of usage.

2. Data and Methodology

For our analysis we use data from the Czech Statistical Office[7]. This data set includes data on number of enterprises, employees, turnover, labour costs (wages and salaries) and value added, in

[7] INFORMATION ECONOMY IN FIGURES 2008. REGISTERED NUMBER OF EMPLOYEES AND THEIR WAGES IN THE CZECH REPUBLIC.

division to manufacturing and services. The data is also divided by the classification of economic activities (CZ-NACE) by 3-digits code.

We consider these economic activities as the ICT sector:

Manufacturing: CZ-NACE 30, 32, 332, 333

Services: CZ-NACE 642, 72

For the analysis of competitiveness of the branch we use the simple condition

$$C_1/Y_1 < C_0/Y_0 , (1)$$

where C…labour costs

Y…value added

After an adjustment we can state

$$C_1/C_0 < Y_1 /Y_0, (2)$$

which could be interpreted as a requirement of slower increase of labour costs in comparison with the change of value added.

After the division of both parts of the inequation by the labour force index, we get

$$C_1/C_0 : L_1/L_0 < Y_1 /Y : L_1/L_0 , (3)$$

and after the algebraic adjustment

$$C_1/L_1 : C_0/L_0 < Y_1/L_1 : Y_0/L_0. (4)$$

It means that average labour costs should increase slower than labour productivity. Alternatively we can consider compensation of employees as *C*, but in short time we can suppose the constant ratio of social contributions to wages and salaries. It implies that the inequation (4) expresses the relation between average wages and labour productivity.

We compute the average wages from the data of the Czech Statistical Office using this equation

$$w = W/(E*n) (5)$$

where *w*…average wage

W…wages without others personal costs in monitored period

E…average registered number of employees in monitored period

n…number of months in monitoring period

At the beginning, it is necessary to define who employees are. Employees are all those workers older than 15 years who hold the type of job defined as paid employment jobs. It is not decisive if their labour activity has permanent, temporary, seasonal or occasional character and weather they have just one or more jobs simultaneously[8].

Even if we compare the development of labour productivity and labour costs, we express the difference between the two quantities in question in percentage points for better interpretation.

[8] Labour Force Sample Survey

3. Results

Number of employees increased in time period 2003 – 2006 (table 1):

	2003	2004	2005	2006
Manufacturing	48,757	52,442	51,032	56,003
Services	58,279	57,943	61,284	66,520
Total	**107,036**	**110,385**	**112,316**	**122,523**

Table 1 Employees in ICT (persons) (Source: Czech Statistical Office).

	2003	2004	2005	2006
National Economy	15,936	17,006	17,827	18,976
ICT Manufacturing	16,721	18,599	19,393	21,603
ICT Services	33,156	35,144	37,545	38,883

Table 2 Average wages in ICT sectors and national economy (CZK) (Source: Czech Statistical Office, computations of authors)

One can see the difference between ICT manufacturing, ICT services and the national economy. While the average wage in the national economy is 18,976 CZK in 2006, in manufacturing it reaches 21,603 CZK and in ICT services it amounts to 38,883 CZK due to higher share of value added in turnover (which leads to the employment of more qualified and skilled workers). The average wage in ICT services is more than twice as high as in the national economy due to the excess of demand over supply of labour force. Focusing on average annual growth we can see the difference, too. ICT sectors developed in a dissimilar way to the national economy. While in ICT services the average annual growth recorded was 5.5%, the national economy grew by 6% in average and ICT manufacturing by 8.9%.

	2003	2004	2005	2006
30 Manuf. of computers equipment	15,300	17,040	18,865	19,022
32 M. of radio, TV and commun. equip.	16,815	18,850	19,024	22,015
321 M. of electronic components	14,212	15,862	14,701	18,612
322 M. of communication equipment	23,244	27,206	29,762	30,613
323 M. of consumer electronics	15,921	15,847	17,063	19,154
332 M. of instrum. for measur., testing	16,375	17,545	18,854	20,424
333 M. of ind. process control equip.	23,695	25,628	27,401	29,498

Table 3 Average wages in ICT manufacturing by industry (CZK) (Source: Czech Statistical Office, computations of authors)

Average wages are quite different among individual branches in ICT manufacturing. The highest wage is reached in manufacturing of communication equipment, the lowest in manufacturing of electronic components.

	2003	2004	2005	2006
0 - 19 employees	16,879	17,230	17,249	17,370
20 - 49 employees	18,100	20,301	21,011	22,282
50 - 249 employees	16,967	18,836	18,837	20,467
250 + employees	16,447	18,571	19,781	22,678

Table 4 Average wages in ICT manufacturing by size group of enterprise (CZK) (Source: Czech Statistical Office, computations of authors)

There is also a difference in average wages divided by the size of the company where the lowest wages are paid in the smallest companies. It imitates the same phenomenon visible in the whole economy and it could be related to tax optimizations.

	2003	2004	2005	2006
private entrepreneurs	11,838	12,822	13,691	13,955
business companies	16,843	18,744	19,561	21,812
of which foreign affiliates	17,035	19,320	20,087	22,492

Table 5 Average wages in ICT manufacturing by legal form (CZK) (Source: Czech Statistical Office, computations of authors)

The results of the comparison based on the legal form are influenced by statistical practice where a part of the revenue of private entrepreneurs is realised by the mixed income, which is a part neither of wages and salaries nor compensation of employees. We need to remind the readers that employees are all those workers older than 15 years who hold the type of job defined as paid employment jobs.

	2003	2004	2005	2006
Praha	29,131	32,320	34,654	36,345
Středočeský	17,290	20,078	20,899	23,420
Jihočeský	13,762	15,352	15,494	17,088
Plzeňský	16,739	17,148	17,428	22,551
Karlovarský	14,918	17,339	15,651	16,017
Ústecký	14,792	15,490	16,909	18,008
Liberecký	13,990	16,145	15,904	17,383
Královéhradecký	14,962	16,097	18,031	19,074
Pardubický	14,735	15,565	17,201	17,943
Vysočina	12,999	15,204	19,970	21,303
Jihomoravský	15,537	17,562	18,403	19,755
Olomoucký	16,016	17,242	14,991	20,903
Zlínský	15,026	17,465	16,575	18,862
Moravskoslezský	19,916	19,981	21,580	22,745

Table 6 Average wages in ICT manufacturing by regions (CZK) (Source: Czech Statistical Office, computations of authors)

One can also see the differences between the Czech regions – as in the national economy, Prague stands out the most. However, the difference in the ICT sector is higher than in other sectors.

Prague is a specific region because of concentration of the largest national and international ICT sector companies. The lowest average wages are in the region of Liberec, Pardubice and South Bohemia. It is because of different aims of the regions and also because of less qualified labour force. While the average annual wage growth in the national economy divided by regions is about 6%, it reaches 17.9% in ICT manufacturing in the region of Vysočina and 10% in the regions of Central Bohemia and Plzeň. The possible cause may be that the developing new companies focus on ICT manufacturing and that there are significant differences in education among the regions in question.

	2003	2004	2005	2006
642 Telecommunications	35,401	38,254	41,079	40,238
72 Computer and related activities	31,550	33,230	35,539	38,167
721 Hardware consultancy	24,874	23,869	29,833	30,419
722 Software consultancy and supply	34,497	36,308	38,032	40,828

723 Data processing	26,372	26,117	28,124	29,848
724 Data base activities	20,544	20,400	22,349	24,822
725 Repair of computing machinery	23,003	23,603	26,767	29,757
726 Other computer related activities	27,168	17,657	18,194	16,354

Table 7 Average wages in ICT services by industry (CZK) (Source: Czech Statistical Office, computations of authors)

Average wages in ICT services are much higher than in manufacturing due to higher share of value added in turnover. It leads to hiring more educated employees who are more competitive. The difference among the branches of ICT services is quite gross. The highest average wage is reached in Software consultancy and supply, the lowest in other computer related activities.

	2003	2004	2005	2006
0 - 19 employees	22,256	21,730	22,624	25,308
20 - 49 employees	32,212	33,661	34,373	34,496
50 - 249 employees	38,735	40,737	40,435	42,434
250 + employees	37,094	41,607	46,392	45,943

Table 8 Average wages in ICT services by size group of enterprise (CZK) (Source: Czech Statistical Office, computations of authors)

	2004	2005	2006
0 - 19 employees	12,579	12,168	12,975
20 - 49 employees	16,409	16,004	16,819
50 - 249 employees	17,001	16,584	17,694
250 + employees	19,402	19,136	20,592

Table 9 Average wages in the national economy by size group of enterprise (CZK) (Source: Czech Statistical Office)

The spread of wages in ICT services divided by the size of enterprise follows the same pattern as ICT manufacturing. The lowest wages are paid in small enterprises. We can see the big difference between average wages in ICT services and the national economy. While the average wages in ICT services for the smallest enterprises reached 25,308 CZK in 2006, in the national economy the average wage was 12,975 CZK. The most significant difference is in the largest enterprises. In 2006 the average wage in ICT services reached 45,953 CZK. On the other hand in the national economy it was only 20,592 CZK in the same year. The average annual wage growth in the national economy between the years 2004 and 2006 was 1.6% for the smallest enterprises while in ICT services it reached 7.9%. The average annual wage growth in the enterprises with 20 to 49 and 50 to 249 employees in the ICT services copied the development in the national economy. The largest enterprises in ICT services proved to be different from the average of the national economy. The average annual growth in ICT services was 5.1% and 3% in the national economy.

	2003	2004	2005	2006
business companies	33,206	35,509	37,919	39,023
of which foreign affiliates	47,017	47,017	48,484	48,652

Table 10 Average wages in ICT services by legal form (CZK) (Source: Czech Statistical Office, computations of authors)

The comparison of average wages with the ICT services divided by legal form proves that the highest wages are in business companies with foreign affiliates. These companies are usually persistent in the market and obtain larger orders. Because of this, the companies can afford paying off higher wages. In ICT services it is common that firms want to have the best labour force possible. That is why they are willing to pay such high wages.

In the final part, we compare the relations between labour productivity and labour costs in ICT sector during the period between 2003 and 2006. We express the difference between labour productivity and labour cost in per cent for easier interpretation.

	Productivity	Costs	Difference
Total	10.2	8.9	1.3
by Industry (CZ-NACE)			
30 Manuf. of computers equipment	24.7	7.5	17.2
32 M. of radio, TV and commun. equip.	14.6	9.4	5.2
321 M. of electronic components	12.9	9.4	3.5
322 M. of communication equipment	14.6	9.6	5.0
323 M. of consumer electronics	15.7	6.4	9.3
332 M. of instrum. for measur., testing	-8.4	7.6	-16.0
333 M. of ind. process control equip.	6.1	7.6	-1.5
by size group of enterprise			
0 - 19 employees	7.8	1.0	6.8
20 - 49 employees	10.5	7.2	3.3
50 - 249 employees	24.2	6.5	17.7
250 + employees	4.8	11.3	-6.5

Table 11 Change in labour productivity and labour costs – Manufacturing (2003 – 2006, average annual growth, %) (Source: Czech Statistical Office, computations of authors)

	Productivity	Costs	Difference
Total	2.5	5.5	-3.0
by Industry (CZ-NACE)			
642 Telecommunications	4.5	4.4	0.2
72 Computer and related activities	6.6	6.6	0.0
721 Hardware consultancy	-4.3	6.9	-11.2
722 Software consultancy and supply	6.8	5.8	1.0
723 Data processing	5.7	4.2	1.5
724 Data base activities	7.8	6.5	1.3
725 Repair of computing machinery	5.1	9.0	-3.9
by size group of enterprise			
0 - 19 employees	0.6	4.4	-3.8
20 - 49 employees	3.4	2.3	1.1
50 - 249 employees	0.0	3.1	-3.0
250 + employees	4.8	7.4	-2.6

Table 12 Change in labour productivity and labour costs – Services (2003 – 2006, average annual growth, %) (Source: Czech Statistical Office, computations of authors)

One can see that there are some differences between ICT manufacturing and ICT services. While in manufacturing the labour productivity growth between 2003 and 2006 increased more quickly than the labour costs, in ICT services the situation was different. The annual gap between costs and productivity was about 3 per cent. It implies that the ICT service sector, unlike the ICT manufacturing sector, could lose some competitiveness.

4. Conclusions

We analysed some trends in the ICT sector in the Czech Republic in the period between 2003 and 2006. The number of employees increased in both parts of the sector and the average wages as well.

The difference in these parts of ICT sector was in the relationship between the development of labour productivity and labour costs. That could mean worse trends in ICT services in comparison with ICT manufacturing from the point of view of sectoral competitiveness.

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NEW POSSIBILITIES OF INFORMATION SERVICES FOR SPECIAL SITUATIONS

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Abstract

The contemporary society is with increasing intensity exposed to various situations that need to mediate different actual information for different places and different groups of people. The current emergency and communication systems in the Czech Republic, controlled mostly by governmental agencies, are not able to satisfy concrete information needs of individuals as well as to distribute required information just to affected areas.

The sharing, distribution and dissemination of adequate information in special and unexpected situations is one of the crucial roles of any governmental level. Not always this role is fulfilled right. With proper distribution of information could be possible often saved not only material values but also human lives.

The article describes Radio-Help as possible solution based on the integration and exploitation of existing ICT. The special broadcasting sender transmits in HD-Radio or DRM mode data and voice to Personal Communication Terminals (PCT) that are mostly an integrated part of mobile phones. The position of PCT is compared with position codes of digital broadcasting. Conformity of internal and received codes activates the forced radio reception.

1. Introduction

The 2009 European floods are a series of natural disasters taking place in June 2009 in Central Europe. Austria, the Czech Republic, Hungary, Poland, Romania and Slovakia have all been affected. The heavy rains caused overflowing of the rivers Oder, Vistula, Elbe and Danube. At least 13 people were killed only in the Czech Republic. Foudroyant cloud-bursts caused floods not only near big rivers but also in the country. The water level in small rivers raised in few minutes tenths times (e.g. from 35 cm to 6 m in region Novy Jicin). One of the first affects of these floods was lost of the electricity with an impossibility to watch the TV and listen to the radio. The cells of mobile phones were also damaged. The governor of the hardest hit region, Jaroslav Palas, said the damages now would run into the tens of millions of dollars [16].

Austria has also now experienced its heaviest rainfalls in half a century. The Danube after the rainfalls isolated several villages. Approximately 13,000 emergency workers were called to assist. The Albertina Museum in Vienna evacuated 950,000 artworks... Do we have a chance in information age to be in time informed and get better chance for saving lives, animals, and materials? Different people in different places and different situations and positions need to be served *in-time* by adequate information. Is there a chance to do that?

2. Communication needs in special situations

The civilization of the 21st century has been more and more often exposed to various crises whether it is natural scourge, operation breakdowns, or terrorism. Besides the crises plaguing vast areas and regions, the crises and unexpected situations of local character emerge with increasing intensity – be it in the range of traffic (calamity situations on the motorways), or with relation to e.g. climatic influences (local floods, wind storms etc.). The scope of economic and human losses during these situations depends substantially on in-time and high-quality notification of every affected person of urgent danger and of directions to organize the lifesaving and health and property protection.

Since 1900 to 2001 twenty eight “major” industrial accidents have occurred worldwide (“major” meaning 50 or more deaths). The half of this amount has occurred after 1986. There has been a sharp increase in the sheer number of accidents, and the time between them is shrinking dramatically. Crisis situation have become an inevitable, natural integral feature of our daily life. Crises are no longer a rare, random or peripheral feature of our time. They are built into very fabric and fiber of modern society [6].

The information age has brought not only international terrorism but also creeping awareness of new types of contingencies [2] – breakdowns of information and communication systems, fall-outs of energy, emerging natural threats, bio-nuclear terrorism etc. The current technical infrastructure of the system of crisis notification – in the interstate as well as intrastate context – is not designed to handle even such “soft” situations like electric power black-outs leading to total loss of functionality of basically every modern technology.

It is usefull to mention the absence of appropriate crisis communication during in media such broadly publicized disasters as tsunami in 2004, floods in New Orleans in 2005, or terrorist attacks in London in July 2005. In the territory of the Czech Republic one can hardly omit such situations as floods in 1997, 2002, and 2006, damage caused by hurricanes Kyrill and Ema etc. The common attribute of all such situations was the lack of adequate information. All of us are daily confronted by large or small crises. We need to understand what can be done to lessen their impact.

Mitroff and Anagnos [7] outline among ten major types of crises following ones:

- *Informational* (loss of proprietary information, false information or tampering with computer records).
- *Human resource* (loss of key executives, personnel or workplace violence).

Both of them induce and adhere to the lost of information and communication ability. Most major organizations (business as well as governmental) have some preparations for handling one or two types of crises, but few companies are prepared to deal with all types [7]. Preparing for at least one crisis of each type familiarizes the organization with the processes for that whole type. As one of first steps to prevent crises and/or eliminate their consequences is to immediate information to right persons in right place.

3. Role of the state

People and other subjects are increasingly confronted not only with crucial crises but also with circumstances that need to obtain immediate adequate information, that allow them to react right on the unexpected situations. Such information is often needed in smaller locations, respectively in different locations in which people need to gain different information but adequate and in conjunction with their situation. Examples could be information in relation to metrological or industrial influences, traffic situations (I have to mention stack-up of 189 vehicles on the D1 motorway in March 2008), ecological problems etc. The content of such information can be not only warring but it also could have a soothing character. Special type of information is necessary to distribute for decision makers (members of local authorities, rescue services etc.) irrespective of their localization.

Not all crisis situations can be foreseen but all of them can be managed far more effectively if we understand and practice the best of what is possible. Early warning signals are often announcing the probable occurrence of a crisis situation. If these early warning signals can be picked up and distribute (disseminate) to appropriate subjects on appropriate places, many crises (especially human based crises) can be prevented before they occur. The main enemy of the emergency and risk management as well as the crisis management is denial of emergency. Not only politicians mostly use very wrong and danger idea “It cannot happen to us; therefore, we do not need to spend money to be prepared for crises” with all consequences to their activities.

The Czech law 204/2000 set up the task to build the “Information system for crisis management support” (ISCM). The realisation of this project is authorized by the Ministry of the interior of the Czech Republic – General Directorate of the Fire Rescue Service. In 2005 the National Security Council accepted the proposal for creation of ISCM in three variants [13]:

- complex solution – that covers all user requirements and is operated on optimal technological platform,
- reduced solution - covers majority of user requirements and is operated on reduced technological platform (solves approx. 2/3 of complex solution)
- minimum solution - covers essential of user requirements and is operated on minimized technological platform (solves approx. 1/3 of complex solution)

The Czech government decided on 11.5.2005 (decision 572) to build the cheapest version of ISCM. Integral part of the ISCM – the Unified System of Warning – is also realized in minimized size.

The fundamental task of state executive in the case of crisis situations is to guarantee the functionality of the state. People in such situations need to get information support, instructions a feel of common integrity. It is very simple to conceive of the model situation of information darkness. Government of all levels has to have in hands a scenario how to govern the state in such situations. That means how to disseminate right information to right places. In other case it is opening the scene for thieves and criminal elements.

4. Current ways of information flows in crisis

Nowadays, in the Czech Republic the “Unified System of Warning” falls into the competencies of the Fire Rescue Service (FRS) and of the regional governments of the Czech Republic. Hooters with central controlling set up in large throughout the Czech Republic are rather rarely equipped with voice system capable of apprising the citizens of the reasons of alert and of instructions on what to do next. E.g. in Prague (where is the best situation in the Czech Republic), the warning signal is emitted by 421 sirens, out of which 242 are electrical and are owned by the state. These are only able to generate acoustic signals and cannot transmit verbal one...

The existing structure of speaker hives relies on designing its own intrinsic cellular network of ethereal broadcasters BMIS in the band of 80 or 160 MHz with average radius of 5 km and on complete hardware and software equipment being subject to rigorous homologation of the General Directorate of Fire Rescue Service of the Czech Republic.

Spreading this system throughout the whole area of the Czech Republic means building new, original infrastructure with the total cost in the range of tens billions of CZK. Such extensive financial means are – according to its proclamation – not available for this purpose in the budget of Ministry of Finance and thus, integrated full-area system of really effective crisis notification remains (using current technology and project philosophy) a mere proclamation. No existing electronic medium in the Czech Republic has been prepared to provide adequate crisis communication to the citizens in the case of the hardest terrorist attacks most probably aimed right to the informatics core of the state.

5. Chances for sharing and dissemination of information

The information management in crisis situation is a dynamic special discipline that has to deeply respect theoretical basis of managerial as well as of ICT disciplines. Some of applicable managerial concepts as management reference model and security metrics are described e.g. by Petr Doucek [3]. The main goal of this article is to signify possible and potential technological solution for information distribution in crisis but also in other “special” situations.

The term ‘communication process’ is used deliberately to emphasize that this problem generally involves what is communicated rather than how communication occurs [9]. In most disasters like floods, earthquake, wildfires, terrorist attacks, pig flu etc. are very small chances to use “classical” communication tools - radios, TVs, phones or the Internet. To be certain, in some cases, part of the telephone system may become temporarily inoperative (actually in certain instances the phone company itself may take several exchanges out of service to reduce overloading the total system).

On 7 July 2005 the mobile telephone networks in London did not crash but were heavily congested and users had extreme difficulty making calls. (If the operators had not managed the situation the effects would have been far worse). This made it impossible to establish reliable communications between mobile telephone users which had ramifications throughout the whole of the multi-agency response, and hindered strategic consultation between key London players [14].

The research team of the Technical university of Liberec and broadcasting company Bonus TV under the leadership of JUDr. Milan Brunclík putted in mind to crisis communication at the middle of nineties. With an ideological support and inspiration of the heads of the Czech Radio, namely Mr. Václav Kasík it made at the end of 2007 first analysis for defining core problems of crises personal communication. The research works were crowned by sample of patents defining and describing individual parts and principles of crisis communication chain.

Regardless to applied technical solution, the system of information services for crisis and special situations (under the internal name Radio-Help) has to fulfill following requirements:

- the system has to be accessible to every citizen,
- the system has to be accessible everywhere,
- the system has to be independent on the functionality of mobile networks and internet,
- the system has to be independent on functionality of the electric power network.

This designed system of Radio-Help covers also the solution for crisis communication working even under the circumstances of total collapse of civilization infrastructure. The solution, whose fundamental principles are copyrighted by patent applications, is capable of sustaining the crisis communication even during long-term black-out of supply network system, of radio and TV broadcasting, of mobile and telephone lines, and of the Internet.

6. Technology

Crises are the toughest of all public relations situations. There is no time to do anything but communicate and respond at top speed. The overriding rule in any crisis is to immediately communicate your concern – the injured people, the effect on the environment, whatever. It is important in any crisis to communicate as fast and as accurately as possible [5].

The core task of Radio-Help project was to find appropriate technology for an aimed one-way communication. It other word – it was necessary to define two main components of radio-broadcasting system – sender and receiver based on current transmitting protocols and technologies. Main demands that we defined for a sender are follow:

- one sender has to cover large region (the state),
- sender of special dedicated frequency has to be secure and saved (under the state/military control),
- a sender has to broadcast not only sound, but also identification codes for receivers,
- the content of broadcasting has to be under responsible control.

For the communication is possible to apply well proofed technology of *HD Radio* or *DRM Radio*. Both of these systems have analogous base.

HD Radio technology [12] is a digital radio standard developed by iBiquity Digital and recognized by the U.S. Federal Communications Commission (FCC). HD Radio technology is a system used by to digitally transmit audio and data in conjunction with their analog signals. While it does allow for an all-digital mode, this system currently is used by some AM and FM radio stations to simulcast both digital and analog audio within the same channel (a hybridized digital-analog signal). On the broadcast end, audio is digitally compressed and broadcast by a transmitter designed specifically for HD Radio broadcasting. Audio is also transmitted in its analog form, as usual. The radio station sends out the analog and digital signals on the same broadcast frequency, along with the signals for the digital data. On the listener end, the signals are received and decoded. An HD Radio tuner picks up the digital radio transmission with its accompanying digital signal (mostly text information).

DRM (Digital Radio Mondiale) [10] is a set of digital audio broadcasting technologies designed to work over the bands currently used for AM broadcasting. DRM can deliver FM-comparable sound quality, but on frequencies below 30 MHz (long wave, medium wave and short wave), which allow for very-long-distance signal propagation. DRM is robust against the fading and interference which often plagues conventional broadcasting on these frequency ranges. The encoding and decoding can be performed with digital signal processing, so that a cheap embedded computer with a conventional transmitter and receiver can perform the rather complex encoding and decoding. As a digital medium, DRM can transmit other data besides the audio channels (datacasting) — like RDS-type metadata.

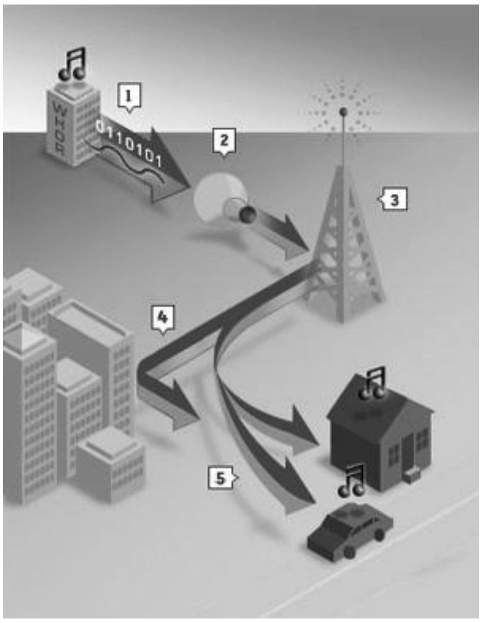

Figure 1. Principles of HD Radio [11]

Principles for HD Radio are described in five steps on Fig. 1:

1 - Instead of sending out one analog signal, stations send out a bundled signal – both analog and digital.

2 - The digital signal layer is compressed.

3 - The combined analog and digital signals are transmitted.

4 - Inevitably, radio signals bounce off objects, causing what is called multipath distortions. This is what causes the static in conventional radio receivers.

5 - signals reach their destination.

With HD-RADIO technology, broadcasters can use the current radio spectrum to transmit free analog simultaneously with new higher quality digital signals. This eliminates the static, hiss, pops and fades associated with today's radio caused by conditions known as multipath, noise and interference.

The crucial point of the system is the receiver - „Personal Communication Terminal" – PCT. On principle it could be HD-RADIO or DRM receiver that is integrated into wide-spread personal equipment – e.g. mobile phone, but is independed and fully separated from its HW and SW. The receiver of crisis communication shares and uses from the mobile-phone just sound-outputs and the power-supply. The PCT could be also replenished with internal or external mechanical boost charger of battery.

The PCT is equipped with GPS (and/or Galileo) system that generates position codes. Sender of HD-RADIO sends digitally an identification code for aimed area (that means position code) and/or a special code of individual PCT. The PCT permanently check the internal and/or position code of the HD-Radio sender and activate itself for receiving the broadcasting just in case of conformity of internal and received identified code. If position and/or internal codes of PCT and broadcasting sequence don't agree, no receiving of sound is activated. In the case of conformity of internal and receiving codes the system is automatically switch on the receiver of crisis information. The whole extension of current mobile phone (with GPS) is based on the addition of one HD-Radio chip with a code comparator.

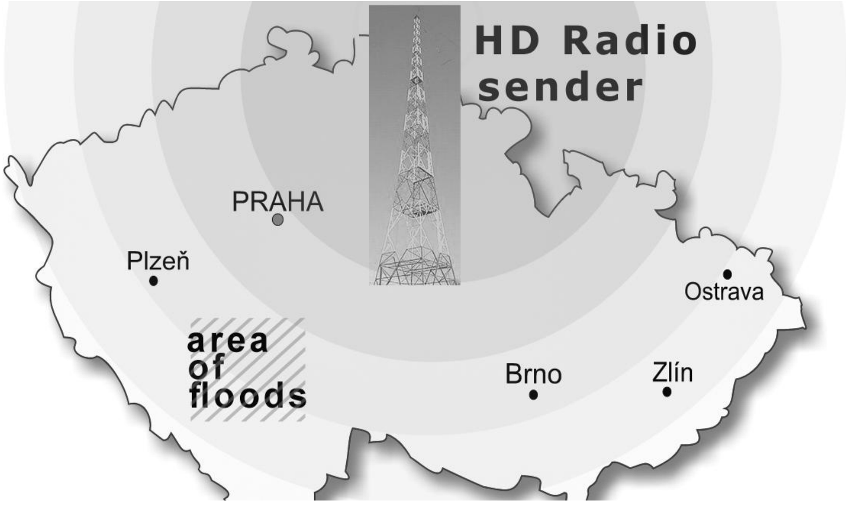

Figure 2. Radio-Help broadcasting for area of floods

The system of Radio-Help is designed not only technologically but also the managerial and program part of the system is worked out. Crisis communication is moderated by mediators – moral and professional competent, well known persons with an ability to lead citizens to self-help rescue of lives, health, assets and elimination of panics. To overtake responsibility for such management is typical task for state-owned radiostations like BBC Czech Radio etc.

7. Vision of dissemination

Crises are the toughest of all public relations situations. There is no time to do anything but respond at top speed. If building a brand platform using regular public relations is a marathon, crisis communications is a sprint. [8]. A badly handled crisis can severely wound, even kill people, companies, society... There are no do overs – you have one chance to get it right. Get it wrong, and if you're lucky, you might restore a reputation in a decade or so.

The dissemination and practical application of services described above could be the idea of European integration viribus unitis [4] – a common European project.

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THE IT SERVICE CONTINUITY MANAGEMENT PRINCIPLES IMPLEMENTATION BY METHOD A2

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Abstract

The framework of ITIL (Information Technology Infrastructure Library) represents the modern and standard approach to management of the ICT services in correspondence with main goals of the whole company. External and internal providers of ICT services should be ready to take care of not only standard situations but also unusual or even critical situations. The increasing dependence of companies on ICT services puts stress on the quality of their deliveries in correspondence with requirements of customers and users. The satisfaction of requirements of both groups and the fulfillment of their expectations are the key determining factors of a quality level of ICT service. One of the partial goals which should lead to the fulfillment of main goals is the improvement of the service availability. Within the scope of ITIL there is a separate process of management entitled IT Service Continuity Management (ITSCM) focused on stable the service supplies. This process is a part of Service Delivery module which represents together with Service Support module the foundation of ITIL framework.

The particular ITSCM implantation is suitable to carry out according of general methodology recommendations (e.g. ITIL framework) where introduced procedures and recommendations are described very generally. Therefore it is necessary to adapt the ITSCM implementation to particular requirements of a real company so-called principle „adopt and adapt“. The authors of the contributions describe their own developed method A2 of IT Service Continuity Management implementation which they implemented in logistic company. General procedures and outputs in this way get a real form which often is not described in methodologies. For this reason the authors developed A2 method which they used by ITSCM implementation in logistic company.

1. IT Service Continuity Management

Management of ICT services consists of many mutually connected processes whose realization determines the success of the whole company. The realization of many processes and activities is not possible without the support and use of ICT services which have become one of the fundamental sources of the company. The increasing dependence of companies on ICT services puts stress on the quality of their deliveries in correspondence with requirements of customers and users. The satisfaction of requirements of both groups and the fulfillment of their expectations are the key determining factors of a quality level of ICT service. This point of view correlates with opinion which was presented by doctor Racek.[5] One of the partial goals which should lead to the fulfillment of main goals is the improvement of the service availability. Within the scope of ITIL there is a separate process of management entitled IT Service Continuity Management (ITSCM) focused on stable the service supplies. This process is a part of Service Delivery module which represents together with Service Support module the foundation of ITIL framework.

1.1. Goal and critical factors of ITSCM success

The goal of ITSCM is the guarantee of technical and program tools which are needed for renewal of ICT services in time which is defined by business processes. The fulfillment of the goal is depended on critical factors of a success which, in the first place, are:

- providing information and support to all employees,
- an update of renewal plans according to changes in the company and its neighborhood,
- regular test of renewal plans,
- effective process of configuration management,
- use of effective tools.[4]

The critical factors of a success of a particular company can be modified according to the situation in which the company is situated. The above described factors should be generally valid for all companies.

1.2. The assets of ITSCM application

Nowadays, companies aim to reduce the risks which can disturb their performance. ITSCM prevents risks which threaten the ICT services delivery to customers and users. Advantages which result from increased company ability "to fight off" risks are mainly indicated in following areas:

- renewal management,
- competitive advantage,
- keep of laws requirements,
- understanding of business needs,
- positive presentation in front of customers,
- increase of company credibility,
- decrease of insurance.[2]

2. ITSCM realization

Within the scope of ITSCM implementation a realization in a company it is necessary to do a number of activities which lead to a development of rules, principles and work procedures. Then they guarantee the prevention and control of non standard situations. A company formulates the design and application of IT infrastructure guarantee elements by the help of IT Service Continuity Plans which are activated in case of a breakdown. ITSCM realization should operate in accord with the whole company strategy securing continuity, so-called Business Continuity and developed Business Continuity Plans. This procedure leads to the activity optimization when there are critical situations with the goal to satisfy best the needs of Core Business Processes in case of breakdown.

The ITSCM process can be divided into the next phases:

- *Initiative* – represents the first phase of ITCSM process focused to the development of work and organization frame including the succession on business standards (ISO 9000, security standards, etc.). Rules of work organization, development of the teamwork and the following way of management comes from principles of project management.
- *Identification of ICT service customer requirements* – this phase is fundamental for the guarantee of quality information base of the whole ITSCM project because there are users requirements in critical situations identified by the help of Business Impact Analyses. Furthermore, there are potential risks and threats of ITC services determined and evaluated.
- *Development of ICT services guarantee strategy* – on base of information sources from the previous phase the basic strategies of ICT service guarantee are designed.
- *Implementation of developed strategies* – this is very extensive phase which implements precautions for guarantee of sufficient deliveries of quality services according to customer's requirements on several levels – from global strategic precautions to ordinary life precautions.
- *Operational management* – within the operational management it is necessary to evaluate the quality of precautions and renewal plans regularly and do their update on the base of changes which are in a company. Then, it is necessary to ensure and keep necessary information knowledge of employees and, in the first place, members of renewal teams and their regular testing.[2]

3. A2 method of ITSCM implementation

The particular ITSCM implantation is suitable to carry out according of general methodology recommendations (e.g. ITIL framework) where introduced procedures and recommendations are described very generally. Therefore it is necessary to adapt the ITSCM implementation to particular requirements of a real company so-called principle „adopt and adapt“ (the name A2 comes from these two words). General procedures and outputs in this way get a real form which often is not described in methodologies. For this reason the authors developed A2 method which they used by ITSCM implementation in logistic company.

In the first place, ITSCM depends on the development of necessary information sources for a determination of relevant ICT services of continuity strategy. Users´ requirements and customers of ICT services are the base for the development of information sources in the area of breakdown and critical situations. It is necessary to evaluate the time in which the operation of service is to be restored – the time frame of continuity and impacts which can appear due to unavailability of service, e.g. company asset.

The live cycle of asset functionalities of company is usually linked with increased financial costs and it is not effective during crash accident operations to restore less important ICT services.

The availability of service itself does not always fully satisfy a customer. In some cases customer needs or requires some specific equipment which enables them to reach expected service profit in accordance with their needs. The part of requirement analyses of a company is identification of required equipment too.

3.1. A2 – solution procedure

The procedure of solution is demonstrated in the Figure 1 and introduces detailed activity sequence whose goal is the development of information base needed for ITSCM realization in a company.

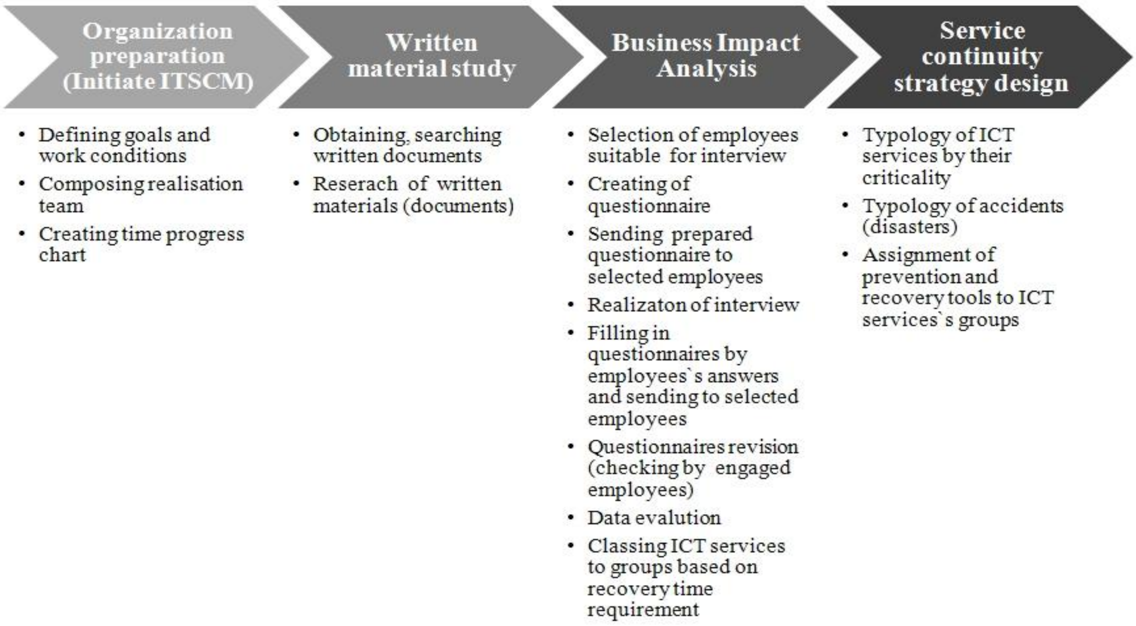


Figure 1 Steps of solution procedure

Single steps can be characterized as follows:

- *Organizational preparations* – forms organizational and work frame which allows the ITSCM realization in company.
- *Written material study* – is focused on introduction with reality of a company and used ICT services.
- *Business Impact Analysis (BIA)* – is focused on the company units which ensure or use ICT services. The information can be obtained only from employees who are carefully informed about the agenda and performance of particular company units.
- *Service Continuity Strategy design* – represents the compile of information which has been obtained by BIA to form of typology of ICT services criticality. The identified critical categories of criticality are prevented by various strategies of ICT service continuity guarantee respective for set by principles, precautions and procedures.

3.2. A2 – scope and form of searched information

The extent of searched information is necessary to select with consideration of the effort to obtain global survey about requirements of particular company units for ICT services in case of crash accidents. Information can be divided into 2 main areas – requirements and impacts.

The choice of the way of information identification influences the quality of identified information. For identification of information we have used the combination of the following methods – interview with paper or electronic questionnaire.

An interview is the most important tool to obtain information. During the interview information is probed in the extent needed for creating the whole picture about the use of ICT services in a certain company unit. Then, the obtained information is processed as responses to questions in a questionnaire and it is convenient to send this filled questionnaire to the employee for a revision. After the validation of the questionnaire and agreement with its content, information is written into a database file of used services including all monitored characteristics.

3.3. A2 – ICT service requirements processing

In this area there is required following information:

- ICT services used within a company unit,
- time requirements for a availability of the ICT renew service when its blackout so-called time frame of continuity which is characterized as time period after its finish it is necessary to restore the service in the extent:
  - *basic* – represents the restoration of application/service in the extent which offers minimal acceptable output for user respective supported process by service,
  - *entire* – extent of quality and quantity of ICT service is equal with defined standard in Service Level Agreement,
- IT equipment used in the context of ICT services,
- information inputs and their forms,
- information outputs and their forms.

3.4. A2 - impacts of ICT services unavailability

This area is focused on impacts which can appear when individual services will be unavailable. To evaluate impacts is suitable to use the verbal description of potential impacts, metrics which contain a numerice range with impact description and in case of financial impacts a sum of money too. Table 1 presents metric which is focused on business impacts of ICT services unavailibility and which one was used in realized practical project. The meaning of services is characterized as a measure of impact of the service failure for a company in areas:

- company processes (business company),
- reputation – external/internal customer,
- financials.

Value	Impact description
1	Process breakdown or its inefficiency causes non or limited impact on company aims reaching or process breakdown which minimally influences the key company process.
2	Process breakdown which inhibites or extends time for reaching the company goal or it causes ineffeciency of key company processes.
3	Process breakdown which inhibites or extend time for the important company goal achievement or it causes serious ineffeciency of the key company processes
4	Serious process breakdown which considerably threatens the key (main) company goal achievement
5	Serious process breakdown which forbids the key (main) company goal achievement

Table 1 Metric for evaluation business impacts

In particular areas the measure of impact in dependency on the failure duration is monitored. The time extent for define relevancy of impact can be determined for example according to British Standards 232:

- failure less than one hour,
- failure in extent 1 – 4 hours,
- failure in extent 5 – 8 hours,
- failure in extent 9 – 24 hours,
- failure in extent 1 – 7 days,
- failure in extent 1 – 4 weeks,
- failure longer than one month.

3.5. A2 – form of information saving (Service Card)

On the base of identified information the application groups according of their time requirements in which their operation should be restored in case of a failure can be defined. A matrix is a suitable form for processing. There, all listed ICT services and them assigned time requirements for restoration are mentioned. In this way the application groups of ICT services which can be use for a design of ICT services continuity strategy are defined.

Data from database file are formalized separately card for every service in “Service Card”. This way of processing of obtained information allows quick orientation in essential information about each service. These cards are usually processed for each company unit separately. Design of the card is presented on next page and it contains following sections:

- *Identification section* - contains information about the name of service, its brief description, a company unit which is a customer and information if this service is used by another company unit.
- *Impacts* – it is focused on information about impact evaluation of service unavailability in defined intervals according to metrics. The form corresponds with metrics and allows quick orientation in time extents of impacts. This section also contains a verbal evaluation of potential and some heavy impacts.
- *Sources* – presents IT equipments or other sources which are need for service realization and their usefulness for user. The requirement is divided into a basic and complete level of the offered service.
- *Information input form* – shows information input forms into a company unit service.
- *Information output form* – presents information output forms which are used by company units.
- *Continuity time frame* – this contains information about time which it is needed to restore availability of service in a basic and complete extent.

Service Card

Service name	
Service describe	
Customer	
Service is used by other customer	Yes ☒☐ No ☒☐

Impacts

	<1 Hour	1-4 Hours	5-8 Hours	9-24 Hours	2-7 Days	> 1 Week	> 1 Month
Business processes	1	1	1	1	1	1	1
Reputation - external customer	1	1	1	1	1	1	1
Reputation - internal customer	1	1	1	1	1	1	1
Financials	1	1	1	1	1	1	1

Describe of potential impacts

Describe of the most serious impact

Sources (IT equipment)

	Basic	Entire
Data	☒☐	☒☐
Server	☒☐	☒☐
WAN	☒☐	☒☐
LAN	☒☐	☒☐
Internet	☒☐	☒☐
Workstation	☒☐	☒☐
Printer	☒☐	☒☐
E-mail	☒☐	☒☐
Doorkeeper/OPS Service	☒☐	☒☐
Scanner	☒☐	☒☐

Information input form

Keyboard	☒☐	☒☐
File	☒☐	☒☐
Scan-barcode	☒☐	☒☐
Scan-document	☒☐	☒☐
Other	☒☐	☒☐

Information output form

Paper	☒☐	☒☐
Internet	☒☐	☒☐
E-mail	☒☐	☒☐
File	☒☐	☒☐
Other	☒☐	☒☐

Continuity time frame

	Time
MAO*	5 days
RTO*	5 days
RPO*	5 days

*ITSCM:

MAO Maximum acceptable outage
Record the maximum acceptable period of time for loss of capability

RTO Recovery timeframe objective
Identify the intended time to recovery of minimum acceptable capability

RPO Recovery Point Objective
Identify the time within which full recovery will be completed

3.6. A2 – ICT services separation according of the restoration time requirements

From the point of breakdown planning the separation of ICT services into categories according to functionality restoration and availability requirements so-called continuity time frame is important.

The customers define time requirements in two levels – basic and entire according to service extent and quality. When there is a crash accident situation it is important to ensure the service performance which is needed for key company processes realization at least on a basic level. On the base of executed activity we define several groups according to maximal allowed time for restoration of minimal level of service. Division of an application into individual groups is one of the main criteria for processing of ICT services continuity strategies according to the meaning and demandingness of services

3.7. A2 – Criticality typology of ICT services and its representation

On the base of identified information by processing the business impact analysis we can divide ICT services not only according to their restoration time requirements but also according to the impact of their unavailability. This evaluation allows determine suitable ways of individual measures (prevention and restoring options) for ICT services.

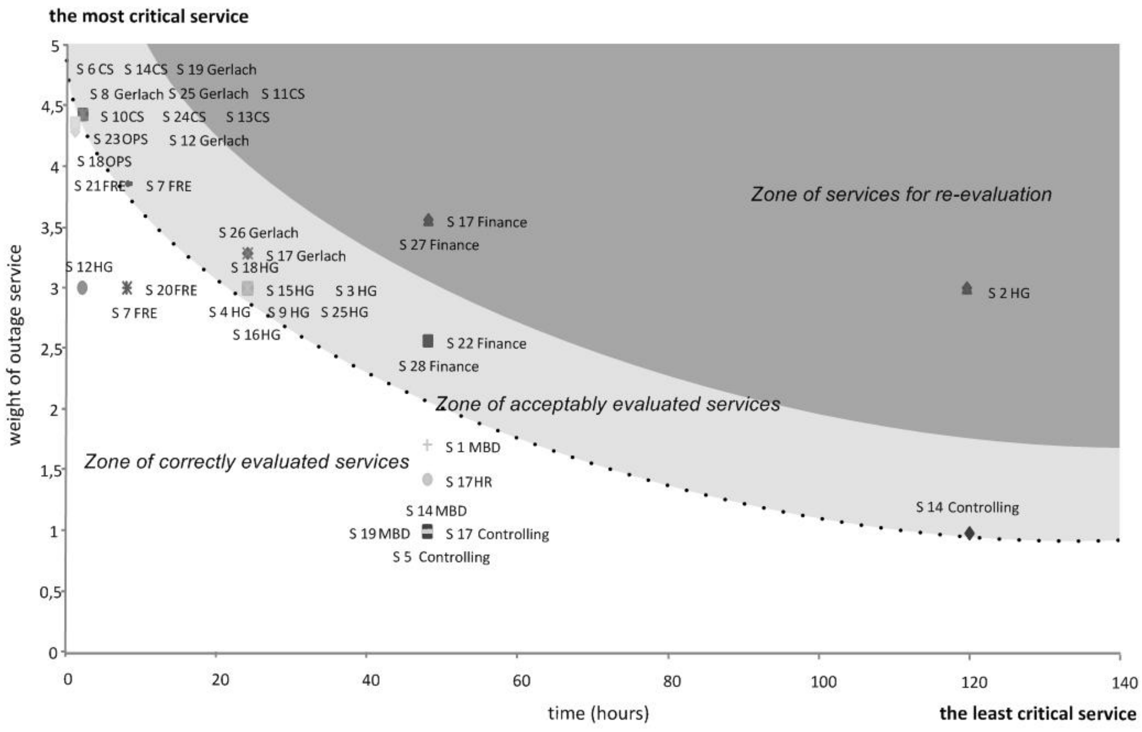
The graph 3.1 contains ICT services and their assignment values from really realized project. The described, presented method was used for realization the project. On the base of information presented by professor Doucek is possible to anticipace the course of curve of criticality ICT services.[1] The graph describes for each ICT service the relationship between requirements for maximal possible length of service unavailability and impact importance level of their unavailability to the company processes and results of their business.

Level of company processes functionality (performance) influences other monitored measures – reputation (external and internal customers) and finance because operating company processes transform inputs to outputs which are delivered to company`s customers and clients should give to adequate consideration, e.g. finance (money). This is a reason why impacts of the IT services failure on company processes are the key indicators.

Impact importance level of ICT services can derive from weighted average of the impact values on company processes. It is also possible to use arithmetic average for evaluate the importance of each ICT service.

There are three particular zones on the graph 1:

- Zone of correctly evaluated services – this zone is presented by white area and services which are located in this area correspond with the rule that with increasing service importance the time of renew (recovery) is shorter.
- Zone of acceptably evaluated services – this zone is presented by light grey area and there are services which approximately correspond with the rule above (with increasing service importance the time of renew (recovery) is shorter). The scope of the zone depends on setup tolerance.
- Zone of services for re-evaluation – the zone has dark grey color and it includes services which do not fit to above described rule and it is essential to re-evaluate the importance of services and recovery times.



Graph 1 Criticality level of ICT services

After decision whether ICT services are correctly evaluated, we are able to create specific critical groups and each ICT service can be assigned to the particular group. So, these groups contain ICT services which have similar or same requirements on recovery time and also their importace for company processes is similar.

For creating criticality typology of ICT services is necessary to define the scope of parameters (rules) for particular groups – time scope and impact importance level scope. The real value depends on conditions and rules, user`s and customer`s requirements and also implementor`s opinion. For example there are defined three groups and the scopes in the Table 2.

Criticality level	Scope of required recovery time	Scope of impact importance level
High	**1 – 12 hours**	**3,7 – 5**
Medium	**12 – 48 hours**	**2,4 – 3,7**
Less	**48 – more hours**	**1 – 2,4**

Table 2 Criticality groups and their parameters

Typology of accidents describes types of possible accidents and threats and risks which can cause them. Possible extents of accidents are examined for each group.

On the base of acquired information throught Business Impact Analysis, creating criticality typology of ICT services and accident typology it is possible to design suitable Service Continuity Strategies for each criticality group. These strategies are composed or contain preventive and recovery options which are optimally balanced for fulfillement of users` and customers` requierements in critical and disaster situations.

4. Conclusion

In recent decades the importance of ICT services has been rising. ICT services which are optimally setup could be instrument of differentiation of companies and they can represent competitive advantage. On the other hand bad quality services can cause cost increasing and performance degradation of company processes. It is necessary to analyze the company requirements on ICT services and the quality of them should be setup on the base of these requirements.

Business Impact Analysis is very important tool for discovering company needs and users` demands. Results of the analysis creates the information base for further steps of ITSCM process and its realization is essential for quality service level management in normal time and also in critical situations

The output of the implementation project of ITSCM in the logistic company was the development quality information sources for formulation of emergency plans. To show the effectiveness of the emergency plans it is necessary to define the basic extend of the systems. The responsible person decides which of the strategy is going to be used to restore the ICT service of the company according to qualified estimations of the breakdown emergency. It is advisable to hierarchically organize all the emergency plans so that the plans for restoration of less serious breakdowns can be electively used for more serious breakdowns.

Experience with A2 method implementation shows its usefulness on organization business activity executing. The members of top and middle management without collaboration with IT managers and using suitable method cannot be able to specify the ICT service breakdowns and their impact on required characteristic of organization business activities.

The strategies can be organized in hierarchical structure of plans and connection with responsibilities, methods and particular work processes enables to create one entity, which can be, in any extend, used in extraordinary situations – from extensive breakdowns where all essential IT equipments are destroyed to minor breakdowns which can be solved within operational management.

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WHAT DOES ARCHITECTURE MEAN AND HOW TO UNDERSTAND IT IN CONTEXT OF BUSINESS AND INFORMATION SYSTEMS?

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Abstract

This article is focused on understanding specific terms associated with architecture. Nowadays both academic and commercial texts use the terms including the word "architecture" frequently. Different meanings of such terms are often misinterpreted, interchanged or sometimes intentionally inaccurate.

Business, system and software architectures are topics of many innovation projects in enterprise management. Lots of high expectations lead to even bigger disillusions and disappointments. It is crucial to make clear what different architecture levels and scopes mean in order to understand these situations.

Definition of abstract meaning of architectures is the first important milestone. It is necessary for further understanding of terms like enterprise architecture, business architecture, system architecture and others. The term of "marchitecture" is combination of marketing and architecture, first used in context of HW producers, but still pretty fitting for software industry too.

At the end of this article author describes relationships between specific "architectures" and uses model of these relationships for evaluating an impact of SOA (as an example) on the company.

1. Introduction

This article attempts to clarify the reasons and background of wrong expectations, which are typical for architecture in context of IS/IT systems. At first the architecture and its different usages will be introduced, put into mutual context and explained on brief example of SOA term analysis.

2. Architecture and its Meanings

2.1. What is Architecture

Architecture as an abstract term is determining for this whole topic. That is why we have to analyze briefly this term. The word architecture comes from Greek word "architektonike" [1]

From its origin this word relates to a building process, especially with designing building and documentation of that design. It was a mixture of craft and art. In later periods the term architecture developed in two basic branches of its meaning, first as "ability or art of making" buildings, second as a sum of characteristics and attributes of the building, architecture as complex and generalizing view on those characteristics (architecture of building).

In modern times the term architecture has been used more and more frequently in other domains than building houses etc. We can make abstraction and replace traditional "building" with "system" and systems architecture is what we get.

2.2. System Architecture

Similarly to preceding text, the system architecture can be understood as ability to design structures and relations of system or system complex characteristic.

We can examine system's architecture on theoretical level and we can categorize such systems according to their architectonic characteristics. The system architecture is most abstract view described in this article.

2.3. Enterprise Architecture

"The term enterprise architecture refers to many things. Like architecture in general, it can refer to a description, a process or a profession." [2]

As quoted before, enterprise architecture can be understood in different ways, but it always refers to an enterprise architectonic structure.

The enterprise architecture defines ways how the company is structured, managed or generally speaking, how the profit is made. Information flow and exchange is an important part of enterprise architecture. Even though it might be affected by IT systems and or may affect them, enterprise architecture is rarely dependant on some specific IT solution. Lot of commercial companies in IS/IT business has used enterprise architecture in their marketing and that is why enterprise architecture is often interchanged for HW/SW architecture on enterprise level (which is not the same).

2.4. Business Architecture

Business as a term has two main meanings in today's IS/IT world. First, traditional, derived from the word "busy", means the processes of a person or an organization which are related to their goals (making profit, healthcare, etc.). In second meaning word business is understood as opposite to technical view.

From the first point of view the business architecture is architecture of company's business, from the second point of view it is "non-IT" approach to the architecture (often information system architecture). This is example of this very common understanding of business architecture: *"the architecture framework introduced in this paper clearly separates the domains of business and IT architecture."* [3][9]

[9] ROHLOFF, MICHAEL. An Integrated View on Business - and IT-Architecture [3]

It is very common that the management understands business architecture in its first meaning (architecture of business) and IT specialists in the second one (non-IT). Different expectations are natural consequence.

2.5. Information Systems Architecture

In a general sense, the term Information System (IS) refers to a system of people, data records and activities that process the data and information in an organization, and it includes the organization's manual and automated processes. [4]

When we talk about IS architecture, we should explain how we understand it. We can start with how Opengroup in its TOGAF™ (The Open Group Architecture Framework) defines following structure of IS architecture:

- *Business Architecture*
    - Business architecture, TOGAF [5] incorporates business architecture (Activity Models, Use-Case Models, Class Models, Node Connectivity Diagram, Information Exchange Matrix). It is example of non-technological approach to IS.
- *Data (or Applications) Architecture* and *Applications (or Data) Architecture*
    - This is the software architecture.
- *Technology Architecture*
    - The technology architecture in TOGAF combines the architecture of hardware and its network topology.

For needs of terms analysis we need a little modified model, where the domains are not separated but overlapping.

For this article, information systems architecture is generalization of software, hardware and communication architecture.

2.6. Non-IT Architecture

If we need to clarify the business architecture, the duality of this term emerges as a problem. In this article we distinguish business architecture as architecture of enterprise's business and non-IT architecture of IS as a sum of process and data architecture abstracted from technological detail. It is something similar to Business architecture in TOGAF.

This architecture has not any direct "physical" representation in real IS, but it serves as an abstraction for better understanding and more flexible thinking about information system.

2.7. Hardware Architecture

In engineering, hardware architecture refers to the identification of a system's physical components and their interrelationships.

Hardware architecture - Wikipedia, the free encyclopedia [6]

Hardware architecture of some computer device refers to its internal structure. Hardware architecture of computer processors deals with semiconductor topics.

Modern information systems are automated by using computer technology. Hardware architecture of information systems define which types, configurations and numbers of computers (and/or other similar electronic devices) and their peripherals.

On the level of information systems, we don't focus on problems which can't be influenced and or has no major impact on systems purpose. For example, there is no need in solving RISC/CISC problem, when workstations for MS Windows are selected.

2.8. Communication Architecture

Because of its special position somewhere between hardware and software we define the networking architecture as its own area.

2.9. Software Architecture

TOGAF's Data and application architecture can be generalized as software architecture. In this article we join these two areas to software architecture.

2.10. Other Scopes

Naturally we can find lots of other "architectures" in context of IS, those architectures are mostly focused on some aspect of IS, for example security architecture, testing architecture, etc. Those scopes might differ in level of abstraction and or its domains.

3. Relations between "Different" Architectures

When the terms of architecture were introduced, let us put them into interrelationship. Following text will describe those relations in way, how we understand it. It is no necessary to accept all this thoughts, but then it is necessary to define your own relationship.

3.1. System Architecture and the Others

As system architecture is most abstract, other "architectures" are focused on some type of system (enterprise, information system, etc.).

3.2. Enterprise Architecture and Its Breakdown

Enterprise architecture is a composition and abstraction of other architectures on enterprise level. One of its parts is business architecture, other is architecture of information system (not IS/IT architecture), we can find others like organizational architecture.

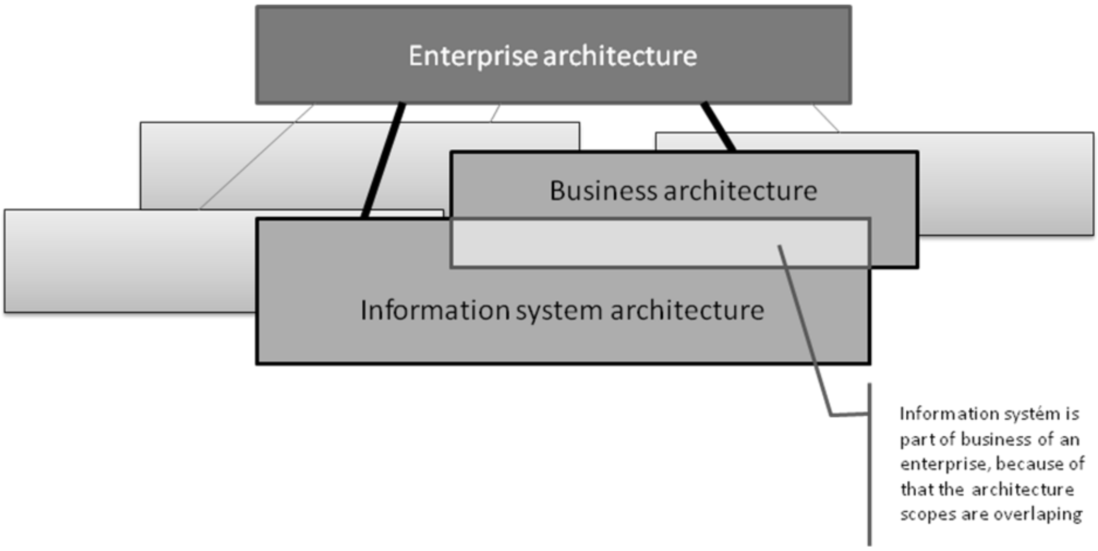

Figure 1 – Enterprise architecture, business architecture and information system architecture and their hierarchy

The information system is understood without close relationship to technology, in abstract theoretical view, but broad usage of this term in context of IT shifted common meaning. It is important to distinguish those two meanings of IS (information system).

In this article we will understand IS architecture as an architecture focused on an complex IT system, nevertheless with contexts of non IT domains (non computing communication processes, informal information flows, etc.).

Within the frame of this article, the information systems architecture is meant as generalization of software, hardware and communication architecture. The non-IT architecture is abstract level of those three areas and its reason is in better understanding of those areas. That is why the non-IT architecture is not being depicted on following scheme.

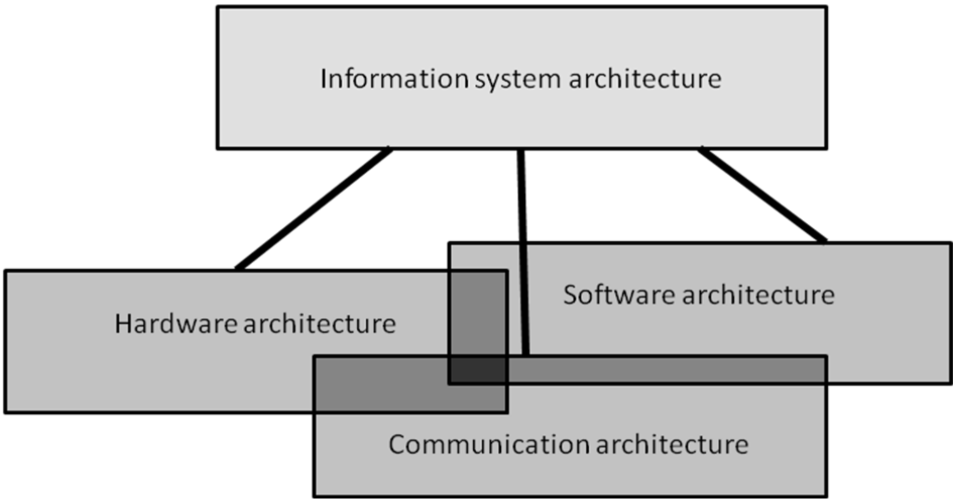

Figure 2 –composition of information system architecture

4. Misinterpretations

The meaning of the terms of “different architectures”, is not precisely defined, as it is usual in IS/IT. That is why I have spent preceding pages on meaning explanations. The fuzzy definitions are one of the reasons why there are so many misinterpretations. Other reasons are exploitation of popular topics by marketing persons in business companies.

Misinterpretation of innovation’s impact of in some IS architecture domain is one of the main reasons why high expectations in IS/IT architecture often turn into big disappointments.

Imaginary situation can serve as an example. The company’s management has made decision to buy software solution, which is presented as a great upward shift in software architecture. The vendor’s salesperson has presented to the management that the shift will have big influence on business agility, reduce costs and enable new business opportunities.

Even if the great upward shift in software architecture was true, the management would be probably disappointed, because the impact of such software innovation will have only partial influence on information system, and it itself only partial impact on business architecture.

Wrong understanding the role of software architecture and or marketing proclamations are two main reasons.

4.1. Marchitecture

A Marchitecture is an architecture produced for marketing reasons, normally by a vendor.

Peter Abrahams - Architecture Marchitecture [7]

Term marchitecture first appeared in context of hardware, where the producers presented new technologies like MMX, 3DNow! and similar as a great improvement to hardware performance. In reality it has only little impact on real usage, but served as a good topic for media.

We can see similar situation in software architecture, where other good sounding abbreviations (SOA, BPM, RUP) help to “seduce” the executive management to buy new products.

In the way how modern marketing works, any good idea which is globally accepted, shall be used to sell almost anything. Perfect example is the SOA, it is so overused, that is already considered as a “buzzword”.

4.2. SOA Term Analysis

Because of SOA popularity lots of vendors added those “three letters” to their product names and or descriptions, and started to sell them on the wave of the SOA hype. It is important thing to understand that Service Oriented Architecture is software architecture concept. Often it is presented as something what dramatically changes the way how the business is done. But SOA is the way,

how the software is done, and how it should be better manageable, understandable, reusable, etc.

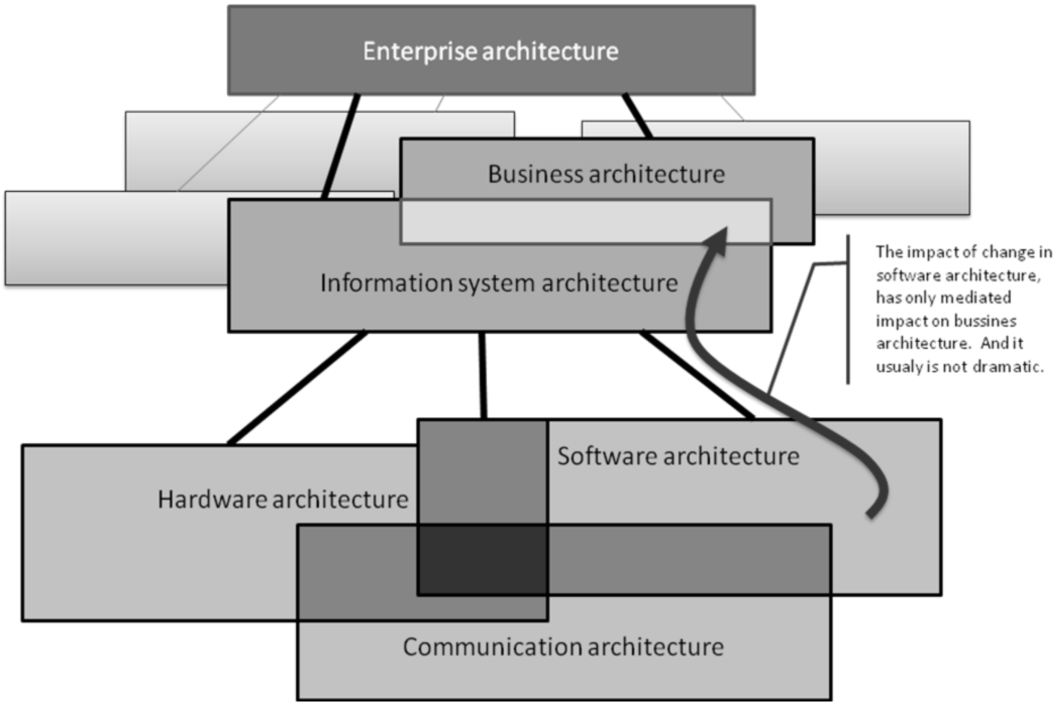

Figure 3 - Impact of change in software architecture

For evaluating impact of SOA or any other software architecture approach, we should consider how big impact IS architecture has as a whole on the enterprises business.

Let's use the SOA as an example. Implementing SOA will change software architecture in proportion which depends on the scope and maturity of SOA principles implementation. Software is only part of IS architecture and lots of its other parts remain untouched. Information systems have only partial impact on enterprises business. There are companies, where the impact is great (those which build their business around IS), or other where it is very low. Almost any business solution can be reached by many SW architecture approaches, it is the time and cost of this solution which makes the difference.

If the impact of business architecture is only partial, the impact of software innovation on business can hardly be dramatic.

5. Conclusions

As it was illustrated in this article, wrong understanding of differences between different "architecture" terms is important factor in wrong expectations in innovations related to software architecture. Most of impact of these innovations is on the side of costs (software development, operating costs, reuse, etc) and or reducing time demands. The innovations of business architecture are almost independent on some specific software architecture. Almost any solution can be reached by many different software architectonic approaches.

Despite all these arguments software architecture is very important and useful activity, which can provide important competitive advantage. However it should be understood in real context, in order to create appropriate expectations.

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TRUST BUILDING ON ELECTRONIC MARKETPLACES IN THE FIELD OF ESCROW SERVICES AND ONLINE DISPUTE RESOLUTION

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Abstract

Globalisation supported by information and communication technologies changes rules of the competitiveness and increases the significance of information, knowledge and networking of companies for the regional economies. The network cooperation resulted in the business-to-business electronic marketplaces. However, as the range as well as the number of companies operates via e-marketplaces, the need for efficient trust-building tools has emerged. The absence of trust building mechanisms and strategies was identified within several studies and it is also the critical factor for the European initiative Digital Ecosystem. This work is focused on effective trust building strategies development for electronic business platforms. Based on trust building mechanism identification, the questionnaire-based analysis of its significance and minimum level was conducted. In the paper, on the base of conducted research, the hypothesis in the field of Escrow services, Online Dispute Resolution and particular mechanisms impact on the strategies were formulated and tested.

1. Introduction

The characteristics of the e-Commerce transactions differ vastly from those conducted in the physical world of business. Personal face-to-face meetings, exchange of information, obtaining references and reputations of various parties from customers and partners and negotiation of contracts have helped the transacting parties to develop some instincts on the relative trustworthiness of the parties in traditional physical world. Legislative framework also helped in developing an agreeable level of risk. The transaction is completed often by the simple act of handshaking, which signals trust. The online environment, where physical contact doesn't exist, where number of potential unknown business partners significantly increases and technology acceptance has significant gaps, opened many new specifics and open issues reflecting trust [4].

In electronic commerce and generally in networked business informatics, trust and security has received significant attention, as it is related to growth in this area of business [5,6]. The Commission of the European Communities noted that, in order to win consumers as well as businesses over to e-commerce, it is necessary to build trust and confidence. In concrete terms, consumers and businesses must feel confident that their transactions will not be intercepted or modified, that both sellers and buyers own the identity they claim, and that the transaction mechanisms are available, secure and legal [7,8].

2. Trust building research

Trust is a complex notion. Current literature on trust tends to be theoretically fragmented and the definitions show a great degree of disparity [1,10]. In the field of B2B relations many studies do not even define trust and those that do refer [1,11] the trust was defined as confidence in the other party's reliability and integrity [12].

On an open consultation on "Trust barriers for B2B e-marketplaces" conducted by the Enterprise DG Expert Group in 2002, several important barriers were identified [9]. From the report we can find that the most important trust barriers are issues regarding the technology (security and protection), trust marks and dispute resolution absence, online payments support, lack of relevant information about partners, products, contract and standardization issues. For the purpose of solving mentioned issues, trust building processes have to be developed and implemented.

There is also a lack of empirical knowledge about how trust in the e-marketplace impacts on buyer-seller trust [3]. As an example, the role and importance of institutional arrangements that B2B e-marketplaces offer in order to build buyer-seller trust and increase liquidity is not known [13,14]. Together, the research on the efficiency/significance of particular trust building mechanism and its impact on participants' behaviour absents [4]. In our research [4] conducted within 6FP IST STREP Seamless project and national complementary project APVV (APVV), the solution based on related research was proposed. In this paper, we will focus on mechanisms related to escrow services for contract condition fulfillment.

3. Methodology

To identify suitable trust building mechanisms and strategies regarding implementation into a various business platforms, a questionnaire survey was carried out.

Type (buyer, seller), size and e-skills of companies and their present level of cross-border collaboration were selected as the factors for results segmentation. According to these factors, results were analyzed esp. in the field of significance and minimum necessity of provision trust building mechanisms. Together, we analyzed the business model regarding fees policy and level of benevolence regarding trust definition. More details on questions and results are accessible from [4].

The research was carried out in 6 EU countries (5 NMS and 1 western EU country). The questionnaires were sent through email and were supported by phone interviews. In order to achieve a greater understanding of the questions, in every block of related questions, the description of related issues was added.

The research was carried out in 6 EU countries (5 NMS and 1 western EU country) with the sample of 149 companies. As the scale of the answers‘ values, 3 level scale was used as follows:

0 – no significance for the trust increase

1 – middle significance for the trust increase

2 – high significance for the trust increase

The scale level was taking into account because of data ordinality and possibilities of non-parametric tests usage.

4. Trust building research

The research was realized in several EU countries and was focused on the trust building issues. The purpose was to identify suitable and efficient trust building strategies and scenarios for electronic marketplaces. Together, the significance of added trust by each mechanism and minimum necessity of presence was analyzed. Within the research, several hypotheses needed for market makers were tested. The hypothesis related to escrow services and online dispute resolution are presented in this paper.

4.1. Personalization/Customization of trust building mechanisms

Hypothesis 1 Significant sample of potential participants will prefer combination of advanced services

The purpose of this hypothesis was the identification of suitable customized set of mechanisms acceptable by some participants. The sense of customization is clear, when we count also with e-skilled companies which can have special requirements and are able to pay for it. For the identification of customization opportunities, association rules were used. On the base of analyses, we were able to identify three suitable customization strategies. For the sample of 15% respondents within our survey, it is suitable to provide combination of all escrow solution from simple (only advisory services where to find the professional service outside the platform), medium (the example of banking services as documentary credits) to advanced solution (services of specialized companies integrated into the platform). It means, as the escrow service is very important for particular part of participants, the marketplace should offer combination of different level of complexity in providing escrow service to be able to justify the requested level vs. fee by companies. Identified second customization strategy was focused on combination of specialized complex database of contractual clauses, its explanation, and automated data flow from negotiation into the clauses supported by possibility of integrated specialized escrow service. This strategy has sense and presents the interest of technology thinking sample, which see the synergy resulting from the combination of mentioned mechanisms. Third strategy was more simple but with higher support by respondents. It is the combination of specialized databases of contractual clauses with explanation and automated data flow from negotiation into the clauses. This strategy is most suitable for initiation phase of e-marketplace development but on the other hand, in the case of high development cost we don’t prefer this strategy as most of participants with lower e-skill level don’t trust so much into the automated data flow and prefer to resubmit the contract data from negotiation into the contract by their own.

The result from our analyze should be supported more in detailed by the analyze on higher sample as in this sample (and it is the general problem) in our sample we was able to obtained only small number of companies with highest level of e-skills esp. with experiences on participation in electronic marketplaces.

4.2. Online dispute resolution vs. Escrow services

Escrow services (ES) should avoid the conflict emerging in business relations by the control of contractual condition fullfilment. It means between online dispute resolution and escrow service is very clear relation from the business point of view. The ESs should integrate ODR elements for improving the efficiency and speed of post-contractual phases. In B2B, this aspect still absents.

In our analyze we proposed to formulate the hypothesis as follows:

Hypothesis 2 Escrow services are positively correlated with ODR services

For the correlation tests, Spearmen Rank Order and Kendall Tau were used. For the analyze we had to conduct tests for all combination of mechanisms (questions), it means combination of all possibilities for ES and for ODR will be tested. The possibilities were identified as follows:

15a Advisory support

15b Technical support

15c Limited ODR (Online Dispute Resolution) – based on basic mediation principle

15d Outsourced specialized ODR

16a Internal ES (Escrow services – simple escrow service internally provided focused on small number of contractual conditions easily controlled)

16b Bank as the ES provider

16c Outsourced specialized ES company.

„*N*“ means the necessity of service provision for the entry on the marketplace.

Spearman Rank Order Correlations MD pairwise deleted Marked correlations are significant at p <.01000				
	15a	**15b**	**15c**	**15d**
16a	0.06	-0.06	0.11	0.06
16b	0.07	0.05	0.10	0.1
16c	**0.29**	0.16	**0.25**	**0.35**

Kendall Tau Correlations MD pairwise deleted Marked correlations are significant at p <.01000				
	15a	**15b**	**15c**	**15d**
16a	0.06	-0.06	0.1	0.05
16b	0.07	0.05	0.09	0.09
16c	**0.27**	**0.14**	**0.23**	**0.32**

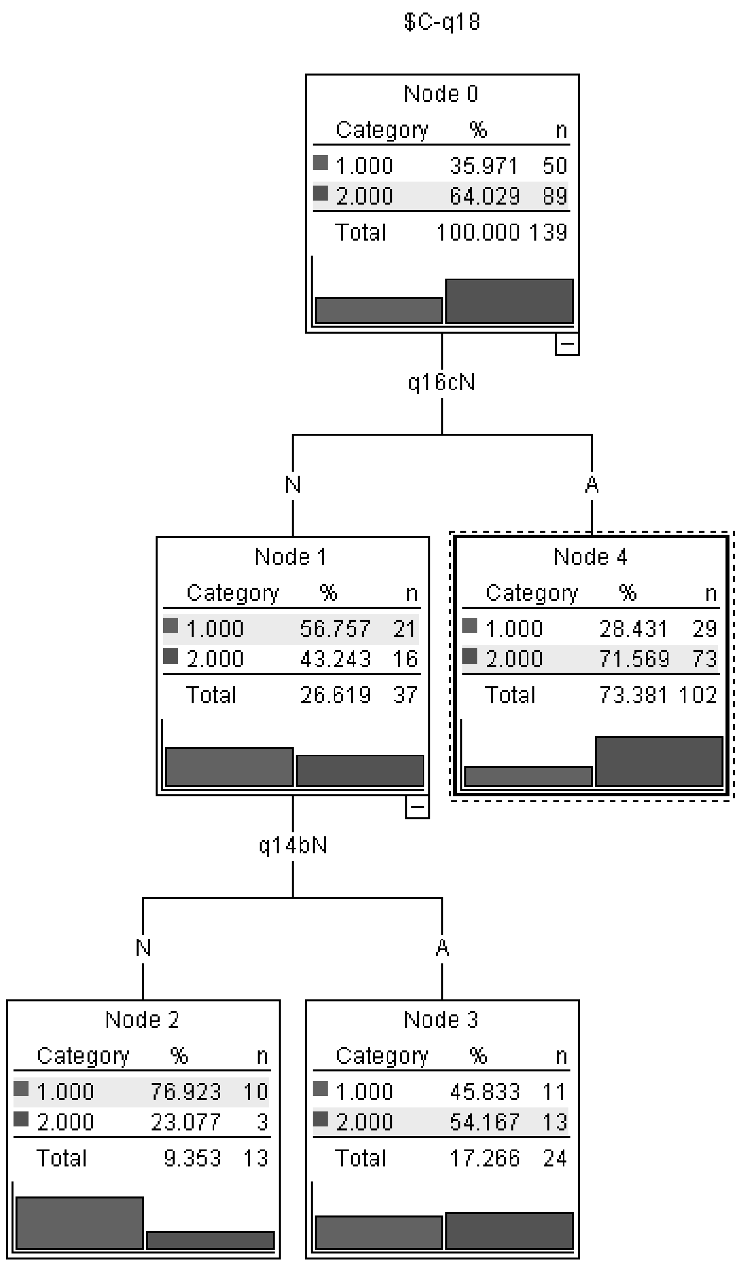
Table 1 - Correlation tests between ODR and ES (*note: Bold number presents statistically significant results)*

On the base of non-parametric correlation tests we see, that esp. attribute 16c – outsourced ES is positively correlated with all ODR possibilities. We have also tested relations for the sample of respondents with some level of e-skills (in the case, that low level skilled companies will have totally different results). The analyze show better results with stronger correlation and was also identified in the case of 16a vs. 15c and 15d. Although, in this test only 16c is correlated with all 15-attributes, in the case, when we analyzed minimum necessity of related mechanisms provision, almost all attributes were semi-strong correlated. It means, the semi-strong correlation between ODR and ES exists. This result is useful for effective implementation such services. Therefore, it is suitable to provide integrated ES and ODR services on particular level.

4.3. Fee policy analysis

From our survey, we identified, that approx. 66% companies prefer model with simple solution without fees against 34% companies which prefer more complex and advanced solutions, although for fee. For the fee policy analysis we used decision tree because of better graphical presentation. As a core question we used the question: Which fee model you accept (the advanced solution for fees against simple solution free of charge)?

When we are looking on the companies, which prefer to pay for advanced solution, we see, that the strongest rule emerged for the relation with minimum necessity of outsourced specialized ES company (16c) – 21 from 50 companies, which prefer to pay for advanced solutions. Together, we see that approx. half of these companies understand the necessity of monitoring and business communication recording for the purpose of ES and ODR. This rule, where 42% companies (15% from whole sample) are willing to pay for the service, we can utilize as a support for hypothesis 1.



Graph 1 Decision tree with target attribute of fee policy acceptation

5. Conclusion

According to several studies, one of the most important barriers for improving networking enterprise is the low level of trust not only into the security issues but especially socio-economic aspects of trust. In the case of globalization and huge networking factors, the large number of unknown companies is the problem, although this number can bring new competitive advantage through finding better and cheaper supplier or business partner. That’s why this paradox should be solved. Providing suitable trust building services can improve trust not only to unknown participants but also to platform as the institution.

On the base of our research we can formulate several recommendations for e-market makers:

- For the initial phase of e-marketplace project, it is needed to start with more simple services with generally high level of trust. According to the sample, it is suitable to provide customization of relevant services according to hypothesis 1.
- It is suitable to integrate ES and ODR services for the synergy effect and speed in post-contractual phase.
- Generally, companies prefer limited trusted services for low fee or free of charge. Acceptance of comprehensive specialized solution for the fee increases by increased e-skills.
- More simple mechanisms in ODR are more trusted than complex ones. The level of increased trust is higher for e-skilled companies.
- Monitoring of business communication provides high level of trust, so it is recommended to provide data recording and allow ODR and ES providers authorized access to these records.
- To provide at least the list of ODR experts with their reputation evaluation.
- Although banks are most trusted institution for ES, we recommend to provide also integration of specialized ES company. As the level of increased trust is higher for e-skilled companies this solution will be still more and more trusted.

According to the survey behind this paper, differences in company responses resulting from different size were small. Furthermore, it revealed interesting variations among different levels of companies’ e-skills. The survey also exposed, that the higher the e-skills of the company, the higher is the trust in more sophisticated mechanisms and acceptance of comprehensive solutions for additional fees (solutions outsourced from specialized companies). However, the results also imply, that not all of the trust-building mechanisms need to be implemented at the initial phase of e-marketplace projects, because many participants entering the marketplaces have usual low e-skills. Nevertheless, after achieving certain skills and experience, the preferences shift to those, similar to e-skilled companies. It means that in a future scenario, it is recommended to use the scenarios with advanced trust building mechanisms or justify the trust building strategy according to the level of e-skills within the relevant sample.

As for the minimum set of trust building mechanisms, the results identified mainly general information with the business status, certificates, references, combination of positive and negative feedbacks, rating, basic contract clauses and explanations, advisory for ODR, technical support, code of conduct and escrow services.

However, some strategies should be examined in greater detail to find the best solution in the near future. The example is ODR or Escrow services. Although an escrow service was identified as a crucial factor, more detailed analyses regarding the business model would be needed. More than 40% of companies request the bank provided ES as a necessity. Yet they would also trust other ES providers. It depends on the range of services, fee policies, levels of automation, implementation costs and others.

Other results and concepts on trust building issues are presented in [4].

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Human Factors in Software Project Management

OVERVIEW OF PRACTICES AND METHODS TO INFLUENCE HUMAN FACTORS IN SOFTWARE PROJECTS

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Abstract

These days the outcome of projects can easily impact the financial well-being of a company. Specifically software projects, due to their nature of being adaptable throughout the development process, have been a lot under investigation. Different aspects have been examined and revealed why projects can fail. The CHOAS report published in 2004 states that only 34 percent of investigated software project have succeeded. Most of the reasons that were stated by this report refer to process issues. Often human issues are really the root cause of process issues. Gerald Weinberg, a well known US software development consultant who has started to study software engineering as human behavior in 1971, is known for saying that "no matter what they tell you, it's always a people problem".Usually people issues lead to emotions in teams.

Cerny explains that emotions of project team members always play a key role in project success. Emotions of project teams are inevitable because of the high dynamic nature of projects. "Individuals and teams in projects need emotional competencies (as part of social competencies) to handle emotions."

How people handle emotions is often influenced by human factors of the organizational environment.

This paper/presentation provides an overview about what human factors and emotions of teams mean to project success. It further introduces a number of practices applied in Agile development methodologies that can help to increase communication, interaction, and collaboration within software project teams. A lot of these practices have shown some real impacts on productivity and quality as they focus more on people and less on complicated use of tools.

1. Human Factors in Projects

Human factors refer to the values, personalities, experiences, culture and beliefs of each individual contributing to a project [8]. If any of these listed items cannot be satisfied for someone, it stays in conflict with these person's value system and mental model [14] Project teams that cannot develop a set of shared values are likely to become dysfunctional. Dysfunctional teams can lead to project failure. Differences in values and beliefs in addition to time pressure and the high amount of interaction due to the dynamic nature of a project create emotions of individuals and teams in projects. Emotions are intensive feelings that require communication [6].

2. Communication in Projects

Communication can be nonverbal (body language), verbal and written. In this paper we focus on verbal and written communication for projects only.

Communication in projects has a number of different roles. Communication is required to build trust between team members so that team members can work together (Team building). Further communication is necessary to clarify a project's scope (content), roles and responsibilities within the project team and work processes. Communication is crucial to exchange formal and informal information.

Formal and informal communication can be differentiated between written and verbal communication. In projects communication can be:

- Formal written
- Formal verbal
- Informal written
- Informal verbal

Formal written communication is required to convey complex matters. It is required when communication occurs over long distances, when complex problems need to be resolved, complex information needs to be communicated such for the project charter or plan.

Formal verbal communication is helpful in projects to present complex content information of the project or work content in presentations.

Informal written communication in projects is used when information is exchanged in e-mails, notes or project memos.

Informal verbal communication is used in meetings and any kind of conversations.

Ineffective project communication can lead to less information exchange, less clarification and increase in emotions. Communication is crucial for project success. Every single information includes four dimensions of information about content, relationship, self-evaluation, and appeal [10]. The increase of interaction in a project leads to more communications between the team members that increase the chance to resolve people issues and improve human factors.

Successful communication in projects depends on the project structure, the definition of when what communication is distributed to whom of the project team and the communications infrastructure (project communication plan). If the infrastructure is insufficient to support the project's communications, most of the project communication cannot take place. Typically the project communication plan includes some of the formal and informal verbal and written communication types as introduced above. Besides the project related information there is information that gets communicated through work processes, work flows and work related methodologies. We are focusing on methods that are applied in these work related methods that include human interaction to increase human factors in software projects.

3. Methods to improve Human Factors in Software Development

There are several general practices that have been applied for a while in the software industry that increase human interaction and therefore have a potential to improve human factors.

Some have been well known in the industry like:

- Business lunch, [2] to discuss project specifics, and build professional relationships.
- Paper prototyping [12] that increase usability through interaction between customer and development to clarify requirements using a prototype made out of paper.
- Analysis and Design (e.g.: Object Oriented modeling and design)
- Review meetings to discuss document and work products.

In recent years there has been the tendency to combine software methods with more communications enablers in software developments. Specifically agile development methodologies include a number of these methods.

Agile development methodologies include several development methodologies like the following:

- Adaptive Software Development (ASD)
- Crystal Methods
- Dynamic Systems Development Model (DSDM)
- Extreme Programming (XP)
- Feature Driven Development (FDD)
- Lean Development (LD)
- Scrum

Agile methodologies have some common characteristics. Most important they are designed to respond to change. They use an iterative/incremental development approach with rapid feedback. Agile focuses on people and interaction foremost and then on processes and tools. People are the most important ingredient of success for a project. Even when a project follows the best processes it will fail in case the players are weak. Agile emphasizes team efforts over individual heroic acts. A company who plans to implement Agile needs to support teamwork and empower teams [9].

3.1. Empowerment

In general Agile development methodologies believe in the empowerment of the development team. This means that the team is responsible for their actions. An empowered team makes its own work related decisions, carries out their work, knows when to ask for help, let others support them without giving up their responsibility for the work that needs to be accomplished [5] . It decides what needs to be accomplished (key result area) when by whom in what order (goal). A self empowered team works only well if the team consists of mature members who are feeling accountable for their work and be able to develop and maintain a respectful environment for all team members. In order that the team is able to perform with self-empowerment it has to go through all stages of team development successfully [17]. Communication and interaction is key for a team in order to get to the performing stage. True evidence of a successful empowered team can be witnessed when a team can resolve its conflicts and can adjust to changes successfully.

3.2. Co-Location

Agile methodologies are based on smaller teams where the team members are co-located. Often the team shares a big enough workspace for their developments which encourages informal communication and problem resolution. The communication barrier is lower if people are sitting next to each other in the room. Questions are often faster resolved and ideas can be evaluated without requiring a formal meeting set up that requires coordination of the member schedules and a conference room. Despite Agile methodologies encourage co-located teams in general there have been experiences made with Scrum to work also in dispersed teams [16].

3.3. Iteration planning

Agile project planning focuses on the planning of one iteration at a time. Iteration planning includes the entire team and takes place at the onset of the next iteration. Agile teams are typically small teams that include the product owner (person who consolidates the prioritized list of requirements from all stakeholder) and the customer besides development Engineers.

After each iteration the project team meets to identify the content (scope) of the next iteration (iteration backlog). *Figure* 1 shows the activities during the iteration planning meeting.

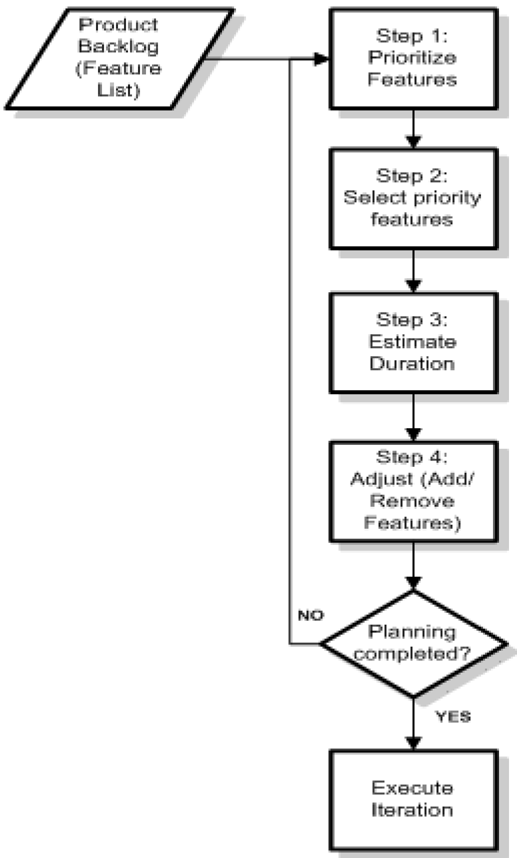

Figure 1: Iteration's planning process

At the beginning of the meeting the team verifies that there is agreement on the list of prioritized requirements (product backlog) and the priority of the listed features. Reprioritization will happen if needed for example when the team is unclear with the current order of features listed in the product backlog (step 1 in Figure 1). After getting more detail on the features from the customer (if needed) the development team chooses features from the product backlog they think can be accomplished within the next iteration (step 2). In step 3 the team identifies the tasks required to implement the chosen features, identifies initial task sequencing, assigns task owners and estimates tasks (time). During step 3 the team might discover that the effort to complete the chosen features is more or less than the time allotted for the iteration. As a result features might be removed or added to the iteration backlog (step 4). When functionality is moved back to the product backlog, it can lead to a reprioritization of the product backlog.

The agile iteration planning approach provides a great baseline for improving human factors within a team. When conducted well the team is empowered to make the selection of features from the list and plan them together. At the meeting they can resolve any concerns and issues that might arise out of the discussion about the scope for the next iteration. Each team member can contribute. No decisions are made above the head of any team members and no team member feels left out of the decision making process related to their work. One Agile development methodology, Extreme Programming, goes so far that the team takes responsibility for the whole developed system, the software is owned by the group, not an individual, and the group is responsible for making it work (Collective Ownership).

As described the planning process is iterative. The team might go through the full planning circle several times. At the same time planning meetings are limited to four hours. The guideline is that the team should not spend more than two meetings to identify the scope and tasks of the next iteration [11]. The idea behind this is that the team learns from its actions and becomes better in estimating over time. After a number of completed iterations the team members can measure their team velocity which is the average time they spent on implementing one feature. When they understand and know their team velocity they can come up faster with their estimates during their planning meetings. Since iterations are short (one to six weeks) uncertainty is limited and estimates are in general quite good [9]. Further the iteration planning process for agile developments makes sure that team members agree to the plan.

3.4. Methaphor

A metaphor is a concept or story that everyone (customer, programmers, and managers) can tell about how the system works. Part of the systems architecture is captured by the metaphor [4]. Finding a metaphor for a software project helps the software project team to relate to the project, explore it as it matures and find new inspiration and motivation from examining the metaphor. Further a metaphor helps to communicate with people of different backgrounds. It can provide a base for communication for a software project team and increase communication amongst the team members.

3.5. Pair programming

It is one of the practices applied in Extreme Programming. For pair programming two software Engineers pair up to program together. Two people program with one keyboard, one mouse, and one monitor. Mostly pairs of programmers are formed based on the required skill set for implementing different pieces of the software. Two people are designing, implementing and reviewing the code together. Pair Programming requires that each team member can work well with other. If one cannot work with a person it is better that each of them tries to pair up with someone else. It is a discipline that allows the Engineers to get to know each other, then perform together and be mutually accountable for the result. “It is a dialog between two people trying to simultaneously program and understand together how to program better. It is a conversation at many levels, assisted by and focused on a computer” [4]. The level of interaction is extremely high. Issues have to be resolved so that progress can be made [4].

4. Conclusion

Projects have a higher tendency for increased emotions due to aggressive deadlines and the high amount of interaction required between people who have not worked together before than regular work. Emotions, if not addressed in time can scarifies human factors and as a result jeopardize the successful outcome of a project. Human factors can be improved in software developments by encouraging the communication between team members. Communication can be formal and informal. This paper introduces a number of practices used in software development methodologies that focus on creating quality work and at the same time improving human factors in software projects. Many of these practices have been developed as part of Agile development software practices and been applied successfully. The main conclusion of this paper is that human factors can be improved in software projects, many practices exist today and have been proven to work in many instances, but have to be carefully selected by the organization and project team. Methods that work for one team or organization might not work the same for another team or organization.

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KNOWLEDGE PROSPECTING DURING THE START UP OF INNOVATION PROCESS IN THE INTERNATIONAL COMPANY

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Abstract

This paper points that in big international company several strategic competencies can be deployed by using information and communication technology and that the knowledge, skills and competencies of managers can be enhanced. Competencies of global managers require skills in various areas. They need to be aware of cultural diversity, demonstrate awareness of their own culture, have proficiency in certain languages and share certain inter and intra personal competencies. As a part of their organizational competence, international managers need to possess a certain level of business and professional expertise which is supplemented by multicultural communication and cooperation. They also have to know how to share knowledge in the working teams, cooperate and communicate with employees, business partners and customers. Information and communication technology (ICT) play important role as a tool for increasing of communication competencies important for marketing strategies. Therefore the author is mapping (by the structured questionnaire and interviews) all possibilities of used learning materials, ways of sharing ideas and information sources in the company. Results of questionnaire and published researches indicate that it is necessary to use all the variety of knowledge together with the information sources and to share them with the colleagues in an intuitive way. Through the alignment of the knowledge management, long term business goals, efficient using of information and communication technology and information sources the efforts help to companies to be successful.

1. Introduction

The current business environment is characterized as highly turbulent, influenced by modern information and communication technologies, globalization, short innovation and production cycles and employees' mobility. It is not easy to compete in such an environment; organizations have to utilize their corporate resources to the greatest possible extent. Such resources include finance, employees, tangible assets, technologies and also knowledge. Especially the unique company resources help to achieve sustainable competitive advantage. This idea is supported by resource – based theory. A company can be understood as a collection of physical capital resources, human capital resources and organizational resources [3]. Resources that can not be easily purchased, that require an extended learning process or a change in the company culture, are more likely to be unique to the enterprise and, therefore, more difficult to imitate by competitors. Therefore one of the most important resources is knowledge especially in today modern business. Why do some entrepreneurs find successful business opportunities while others do not? One of the reasons is that these opportunities are connected with previously gained experience and knowledge of such an entrepreneur.

How are the companies able to reach their business goals? What do they have to do to become innovative? The management has to be looking for the different approach to customer problems, technological substitution and market changes. This involves sustain long term effort for innovation and it often requires a redesign of the business model. Companies have to ask the question what their business is over and over. Due to the shorter product life cycle and intense competition in many industries there has been an increased focus on design activities and other ways of creating unique value and selling propositions through innovative features.

There are two main research approaches in the area of managing innovation. The first approach is based on the assumption that innovation takes place in the beginning of the development process, in the activities that take place before a project is officially launched [16]. The second research approach claims that innovation take place throughout the development process. This assumption is based on the idea that the central process of innovation is design and that the innovation process is managed through the life cycle of the development project. The author’s experiences and the results of the survey indicate that both ways have their place in the today turbulent entrepreneur environment.

The aim of this paper is to map, improve and accelerate the start up of the innovation process and to help the international managers to use and share all the possible information sources in the international company. There is a question where to find the right inspirations ideas during the first exploratory phase of innovation. Therefore the questionnaire has been realized and it is mapping any used information sources by global managers from different department and countries. The results will be used for the improvement and recommendations of this first step innovation processes. It is also necessary to develop several strategic competencies, knowledge and skills using different learning tool including information and communication technologies (ICT) during this first step and also during the whole innovation process. The structure of this paper is following. Second part explains the competencies which are important for today “global managers” of innovation teams in the international companies. Third part represents results of the questionnaire. Discussion and conclusion are in the last section.

2. Competencies of global managers

A number of authors see the competence as the knowledge, skills and attitudes used by employees in the performance of work [20], [21]. Such competencies require individuals or managers who posses capabilities in various areas. Competencies of global managers need to be aware of cultural diversity, demonstrate awareness of their own culture, have proficiency in certain languages and share certain number inter and intra personal competencies. Hinckley and Perl [9] interviewed managers and established an understanding of competencies required by managers. They indentified three areas of competencies: intra personal, interpersonal and organizational competence. As a part of their organizational competence is necessity to share knowledge, to cooperate in the innovation teams and to communicate with employees, partners and customers. ICT play important role as tool for these competencies, communication and marketing activities. Table 1 explains these competencies and the teaching approach.

Competencies	Teaching approach	Selected references
Interpersonal Competence:		
Oral and written communication	International projects	[1], [24]

Qualitative thinking	Video-conferencing	[25], [19], [12]
Intra-personal competence:		
Education and training	Company portal Audio-video, e-learning	[11], [10], [25]
Organizational competence:		
Traditional marketing	Marketing research	[14], [15]
Web marketing	Web-based marketing research	[6], [22]
ICT	Online strategies, web site design	[5], [13]
International business competencies	Project management, groupware applications	[2], [28]

Table 1 - Competencies of managers and the teaching approach (Own source)

When we want to explain the communication we can use classical model of communication. This classical model developed by Shannon [23] and redefined by Weiner [27] shows that message sent to receiver has to be encoded and decoded by language, symbols, artefacts etc. to allow the transmission and that can be distorted by noise. Weiner [27] adds that in the communication the recipient sends a replay (feedback) to the sender and indicates that the success of communication depends not only on the correct use of coding and decoding mechanism but also on the social relationships between sender and recipient. Holá [10] also finds that the results of communication processes depend on the cultural context of both participants.

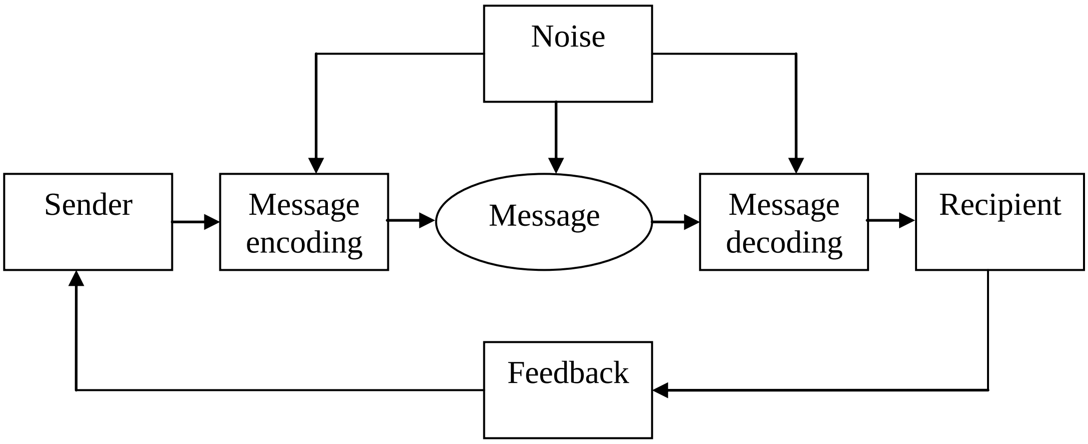

Figure 1 The classical communication model (Source [23],[27])

In the international company much knowledge is created in any development projects and this knowledge has to be absorbed and used in the whole organization. This innovation process is usually very well structured and documented. The process has three stages:

- exploratory (generation of ideas),
- development (feasibility study),
- industrialization (project authorization).

All stages are supported by project management methods. Much effort is directed towards the second and the third stages. The first step where it is possible to introduce new ideas is left out. This early stage is often terminated before leaning opportunities have been fully explored. Therefore the aim of this paper is focused especially on this early step. Usually the first idea starts in local countries and later is considering and sharing in headquarter. Every innovation activity is supported by the team of experts from different countries. It is established the international team of managers who are from different departments (sales, development, production, marketing, R & D) and they are cooperating together during the whole innovation process. Every innovation team has his leader. The following activities are used for sharing knowledge inside the company:

- different training activities (e-learning, audio-video tools),
- company and some other conferences,
- e-mail,
- internet,
- company's intranet.

3. Data collection, methodology and results

The pre project activities are fuzzy and require a lot of inspiration. New concepts and ideas need to be selected, diffused, cultivated, combined and applied in new context. These activities are not supported by software project management application. Therefore mapping and considering of any possible information resources can help to improve this innovation process and can help better share some inspiration and new ideas. The structured questionnaire has been realized between the 40 managers from different departments (sale, production, marketing, R & D) from different countries, all of them are from one big international company. Results of the survey indicate that the most used inspirations of innovation teams are the experience and discussion with customers, internet and intranet sources, exhibitions and benchmarking activities. Therefore it is necessary to develop and improve these most used activities, especially to motivate the customers to share their experiences and ideas. On the other hand the cooperation with universities and other external institutes are missed out. But the benefits of relationships with external institutes are evident in the maximized productivity of R&D. Therefore the company can develop a broader knowledge base and monitor its using by the staff.

Von Zedtwitz [28] asked 14 international companies about the greatest challenges and issues for the managers involved in innovation processes. A content analysis of the 50 documented answers reveals that the two most cited issues are: implementation problems, knowledge exchange and ICT skills and knowledge. Perks and Jeffery findings also suggest that though a successful innovation network configuration theoretically involves recognizing where the innovation value resides in the network and developing capabilities and mechanism to understand and access value, practically, this effort is problematic for companies embedded in their own base of knowledge and relationship patterns. Thus, the underutilization of international innovation teams still prevails, even though companies invested in ICT. This situation points to structural problems that impede the leveraging of expertise. Beuijerse [4] introduced nine possible knowledge streams within the organization:

1. determine the knowledge necessary,
2. determine the knowledge available,
3. determine the knowledge gap,
4. knowledge development,
5. knowledge acquisition,
6. knowledge lock,
7. knowledge sharing,
8. knowledge utilization,
9. evaluation of utilized knowledge.

Darroch J. and McNaughton, P. [7] identified three knowledge management components:

- knowledge acquisition,
- knowledge dissemination,
- responsiveness to knowledge.

In this paper these 9 above mentioned streams have been divided into 3 steps:

- exploratory/generation of ideas (1st – 3rd phases): market research, customers satisfaction study, cooperation with customers for obtaining customer information,
- development - feasibility study (4th – 7th phases),
- industrialization - project authorization (8th - 9th phases).

Much effort is directed towards the second and the third stages of innovation process. These stages are supported by project management methods and software applications supported team cooperation. The first step where is possible to introduce new ideas is left out. This early stage is often terminated before leaning opportunities have been fully explored. The questionnaire has been focused on the competencies of the individuals who play important role in knowledge processes in big international company and on what is the relationship between individual knowledge sourcing, activities and performances. 40 respondents are from seven countries: Czech Republic, France, Italy, Hungary, Poland, Romania and China. In table 2 are the main results of the questionnaire.

Used information sources during exploratory	Tools and methods	in %
1. Internet	Web pages of competitors, news and others	100
2. Communication with customers	Meetings, e-mails, field researches	80
3. Fairs and exhibitions	Face to face meetings, internet	78
4. Company database	Internet, project management application	75
5. Specialized databases	Internet	74
6. Company meetings	Face to face meetings, video conferences, Intranet	73
7. Cooperation with universities or research institutions	Project management	52
8. Discussion with other managers about possibilities (feedback)	Groupware applications, Intranet	45

Table 2 Results of questionnaire (Own source)

Results of questionnaire indicate that some of information sources are not used quite often. The most frequent information source is communication with customers. Therefore the company should pay attention to customer relationship management through the whole company. Also we can see from results that using external sources and external cooperation are not use quite often. These sources and possibilities could be increased. The using of groupware application is not sufficient and this can be one of the reason that improvement and innovations are invented slowly just in one country and the same innovations are used successfully in other countries for long time. The reason is that information are not entered into company intranet.

4. Conclusion

Allowing access of the right information, at the right time in the right information sources is the important assumption of the start up of innovation process. There are a number of methods that are currently being utilized by business research, analyze, map and forecast technological innovation. The companies that are active in these techniques have an advantage in comparison with the companies that are not active. They are able to follow relevant technologies and plan for possibilities of the actual market. These procedures must be communicated and continually developed. Modern management has shown that especially continues efficient improvement, increased innovation and optimization lead to sustainable competitive advantage. Managers and their members of innovation teams must be trained to share the information sources with the appropriate colleagues in the company. Through the alignment of the knowledge management, long term business goals, efficient using of information and communication technology and information sources the efforts help to companies to be successful.

In the international company especially where the managers are spread in different countries it is necessary to share some common knowledge platform. At the moment the managers use just company's structured database of all products, but have no possibility to share together the unstructured data as some experience, remarks, suggestion or the knowledge. Therefore it is recommended to use for instance internal Wikipedia which support individual and organizational knowledge sharing, learning and where the employees' contributions and using could be monitored. The big advantage of this system in comparison with database is that individuals can add, change and delete the content in a collaborative fashion. Further author's research will be also focused on using data mining techniques during mapping process of searching and sharing information in start up phase what can help better and deep analyze of different approaches in searching information during the innovation processes.

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MODELS IN INFORMATICS

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Abstract

Human factor is the most important and the most critical factor for successful software development and also for non-problem day to day operation. A lot of project managers look for the best way how to present all important information inside the project among the team members. One of the ways how to manage and share information is to use the model and visualization of the system.

This paper deals with basic characteristics of model and their basic classification – mainly well known piece of knowledge (but now in human factor point of view). The main conclusion is to emphasis that SW models are not only UML and BPM but also custom model designing for a particular occasion often with non IT specification.

1. Introduction

Nobody, who has ever cooperated in a software development team, doubts of the importance of models to the SW development. A lot of us frequently use models' languages like UML, DFD or BPM. And we may think it is enough – we create satisfactory models of the whole system. These models are understandable, accurate and perfect. But sometimes the business side appears blank spaces in the communication. The development team has put a lot of time and effort in getting perfect model but the business does not understand this graphical representation of the system.

This paper is focused on introducing the role of models during the software development. The aim of this article is to show that the design of the model should correspond to its users and also to the reasons for its existence. Following research tasks result from this basic aim:

- To present the basic models' classifications.
- To make a proposal of the basic models' characteristics based on this classification.

The current state of discussion about the models in the literature is divided into two groups. The first group deals with standardized models – their creation, design, improvement, implementation, methodologies.[2], [10] Large number of articles, books and also some contributions by academic researchers have been devoted to finding the best techniques, languages, methodologies or tools for models in each SW development phases (especially analysis, design and programming). The basic characteristics of these models are described in the section 4.1.

The second group is focused on the positive and negative characteristics of the models and try to show alternatives, eventually points to the applicability of use. [9], [1] There are more and more articles published that describe problems with traditional modelling techniques as a support on business side.

My research is based on a review of the "SW modelling" literature and also on my own experience. There were classical methods for working applied; such as induction and deduction, analysis of collected data and information; construction hypotheses; consult and discuss practical experience; abstraction; synthesis towards a generalization of results and contribution.

In this paper I deal with the presumption that there are two related subjects - huge non-IT customer with its requirements to information system and the supplier. The supplier is a SW company with many projects. In the SW development team are involved people from customer's and supplier's side (IT and also non-IT educated). And there are also the managements of the both companies that should understand information about the project and requirements to the new information system. But they are not directly members of the project.

2. Human factors in SW project

The main factor, resource, benefit but also a critical point during the software life cycle is a human factor. As all project managers know not only people but people with their knowledge, experience and skills are one of the resources of each project (obviously with HW, SW, data, funding and time). [4] or [7] The human factor are primarily represented by the roles.

You can find these typical roles involved in each project (depends on the size of the project): a customer (as a group of different roles), project manager, analyst, developer, architect, programmer, tester, support. These roles are often modified or concentrated, e.g. an architect in small companies is usually not a separated role.

As said above there are lot of roles in the project's team. We can find various classifications – each classification points out different criteria and categorize roles into different groups. In [7] there is published basic classification with all essential roles of project, in [5] the classification is created for statistical purpose. Almost in all different classifications can be found following two basic groups of roles:

- The IT group consisting of analyst, programmer, architect, tester, commonly also project manager – all these are primarily included in the SW project.
- Managers and another roles who are not in IT and do not take part in creating the SW project sometimes.

These two groups create the SW project and also other outputs. Communication inside the developing team is usually simple – they speak the same language, the same dialect, they have similar knowledge base and they are headed to the same goal.

But what about customer's or supplier's (top-) management? These people are not in the centre of the team; they aren't in the same wave. In big companies there is a very long way from the IT department and IT project to the management of the company. The strategy and goal of the business should be the same but there are a lot of small substeps to achieve the goal and each substep can have a little different direction. The top management does not deal with IT routine issues and is not familiar with the IT language as well, which creates a discrepancy – there is primarily missing marketing knowledge and simple issue explanation ability. We can find a similarity in a situation when you want to sell something to someone who does not completely understand all the aspects concerning the subject of sale. You should persuade him and also explain the aspects. It is a marketing skill. And design sells.

One of the ways how to present a complicated problem is to use graphical and visual expression like modelling.

3. Basic characteristics of model

A model can be used as a reflection of the reality but also as a medium of information and data transformation among members of the team. A model is an explicit formulation of a human idea, conceptions and seeing the world. It is a human construct in which the important characteristics of the world around are mainly captured. It is up to the author to choose the main and most significant aspects. [8]

The model is created to use one of the model functions:

- to define hypothesis and its storage;
- to present reality through basic characteristics;
- to present conceptions and proposal;
- to create one component of the development cycle – used for generating source code or documentation;
- to record contemporary phase of the project or system;
- to describe changes in system.

The process from creating to using a model (the lifecycle of a model) can be described by seven basic steps.

- To define the purpose and aim of the model.
- To analyze the real situation (analyze system, creator's knowledge and user's prospective capability).
- To create methodology for the model (choose from existing common methods or creating new modified methods for a certain type of a model).
- To collect information about reality (in second step we analyze situation then, based on this analysis, we create methodology and knowing the details regarding the methodology we can explore the reality).
- To create the model.
- To use the model.
- To update the model.

The system development life cycle (SDLC) is the basic life cycle. A lot of detailed life cycles are based on this. The basic phases are planning, analysis, design, implementation, maintenance. [11] My suggested model lifecycle is based on SDLC too.

Basic characteristics of the model affect each of these steps. The answer what these characteristics are can be found in the following questions:

- What is the purpose of the model existence?
- What reality or system is designed by the model?

- Who creates the model?
- Which tools, instruments and knowledge are used?
- Who will use the model? What are the user's skills and knowledge?
- How often and in which range will the model be actualized?

All these characteristics of the model together with two basic groups of users indicate existing two big groups of models – standardized models and customs model.

4. Standardized and custom type of the model

As said above there are two big groups of users – more IT and more business. And from the chapter 3 it seems that there are two big groups of models – for IT focused people these are models with standardized structure "standardized models" and for business people "custom models".

4.1. Models with standardized structure

Models with standardized structure like UML or BPM are usually used during the SW development. Detailed information about UML can be found in [1]. Řepa describe a lot of characteristics, methodologies and tools for business process modelling in [10]. There is also standards and techniques presented in wider context in the chapter 6. The basic characteristic of these models is that their basic graphic presentation is always defined ahead. And most of them are only half understandable without knowledge of particular methodology.

On the other side with these strict rules you can model a lot of situations, signify a lot of characteristics. This makes your model understandable all over the world. But creators and also users have to know the principles of the methodology.

Many software tools are using one or more of these visualization languages (in common we don't speak about methodology). But every software adjusts the model to own environment. (You know very well UML but if you want to model with help of some UML support software you must also know the possibilities and boundaries of this tool and sometimes you must modify your technique because of software limits.) Such these ideas can be seen in the research published in [6] and [3].

Dobing and Parsons published their research about using UML components in [6]. The conclusions of this survey are: "The results suggest that more extensive educational programs are needed, both to increase the number of analysts familiar with UML and provide ongoing support to help them make fuller use of its capabilities. This suggests that UML should not be considered exclusively as a language for software professionals, and that a greater understanding of UML diagrams and their roles in building systems is needed throughout organizations. Standardization of UML has made a major contribution toward this goal; standardization of usage guidelines is needed as well. The complexity of UML is a concern, suggesting more programs are needed to help IS professionals and their clients learn the language and how to use it more effectively." [6]

In research [3] has shown that standardized language UML is from the perspective of understanding relatively too complex technique (also for the IT professionals). The usage UML requires a good knowledge and understanding of technique and also tools.

The big advantage is that these models are well-know and this is the best condition for using. Thanks to using and working with them they are developed and constantly improved. The basic characteristics of the models with standardized structure are presented on Figure 1.

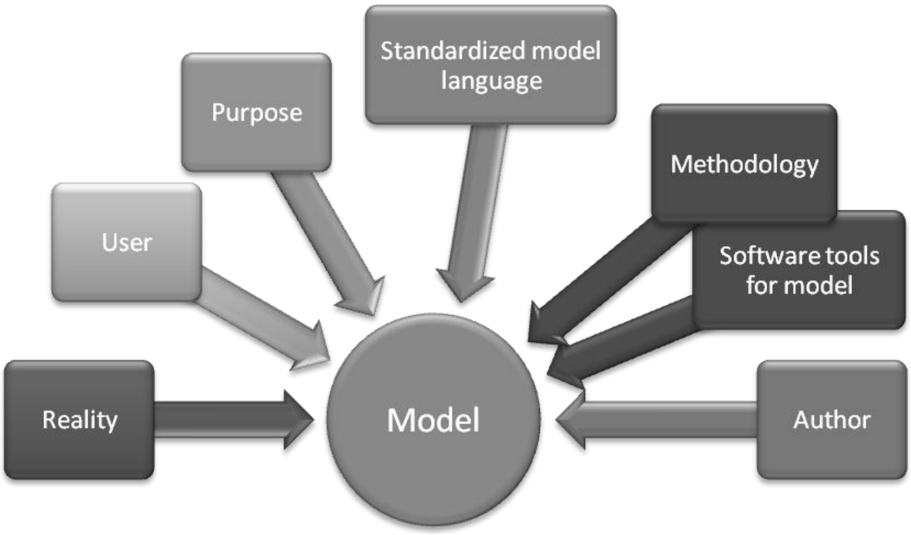

Figure 1 Attributes of model with standardized structure

4.2. Custom models

Custom models are models that are created for a particular situation, customer and purpose. These models can not be used worldwide. Their power is in their customization and business management friendly.

These types of models are created for management and as opposite the standardized technical models when their users do not have to be familiar with particular technical language. These models are based on simple graphics which is understandable for non IT customer. Special knowledge is not demanded on the user's side. The purpose of these models is very different from models with standardized structure. Custom models are not designed for source code generating or for detailed technical system documentation. Custom models are designed for business and basic business documentation. These models are created for quick and easy understanding, the reality is very simplified and the design should be attractive and also user friendly, easily operated.

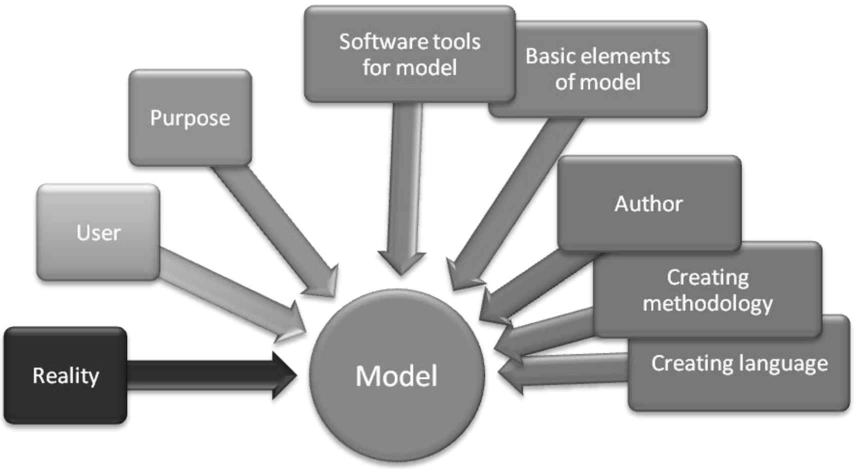

Figure 2 Attributes of custom model

Most important characteristics of custom models are shown on the Figure 2. Custom model differs from the previous one. The new language and methodology are even created, not only used as in standardized model. Basic difference is the design phase of the models. Custom models are not based on existing methodology and are not created using specialized software tool. The author has to create new methodology and new language on the basis of custom needs. Of course in some cases we can take an existing methodology and existing language and customize them. Based on defined model language we can choose the specialized software and prepare the basic elements for our new model.

The models with standardized structure are understandable worldwide. Users have to know the standardized language. On the other side the custom models are very specific and have purpose only in the given situation. But custom models are in this situation easily understandable. These models are customized for real situations, for specified users and their knowledge.

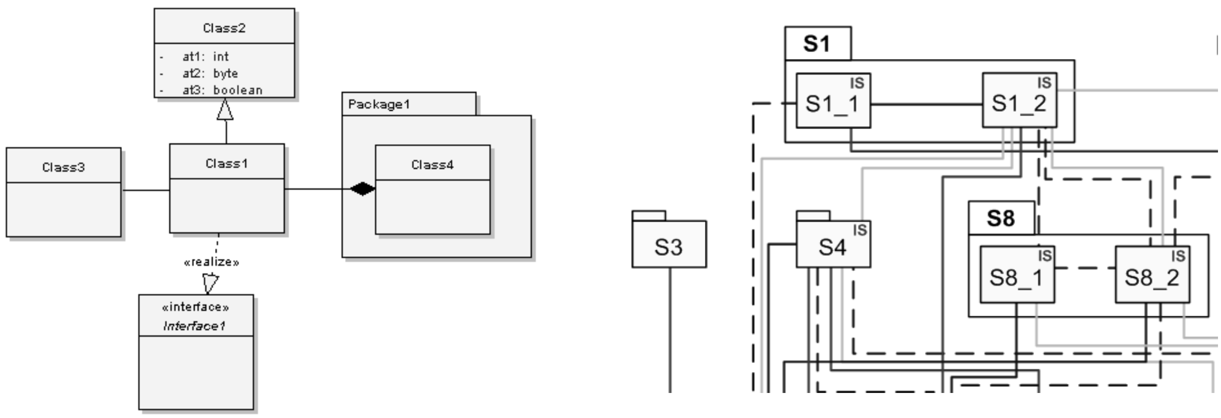

Figure 3 Example of standardized and custom model design

5. Conclusion

Models in software development project are well known UML and BPM. But besides them there are also custom models – models for business and management. The language is simpler, the methodology can be simple but the importance is great.

The aim purpose of the paper was to contribute to the topic of SW project's models, to discuss the characteristic of these models and to bring new piece of knowledge and new point of view to classifications of models. I have explained the purpose of existing the models with standardized structure "standardized models" and the "custom models". Using each type of models require consideration of their basic characteristics. The defined characteristics of standardized models are: reality, users, purpose, standardized model language, methodology, software tools and author. The different characteristics for the custom models are: software tools for model and basic elements of model; author creating methodology and language.

The outcomes of the paper could be used in research about usage of modelling and also the outcomes can be the base for consideration of modelling techniques. The outputs can be also used in process of model education. Teaching software modelling is about methodology, based on technique knowledge, about software modelling tools, about asking and answering; but also about creativity, design and maybe art.

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A SURVEY TO EXAMINE THE IMPACT OF NON-CONFORMANCE COSTS ON OVERALL QUALITY COSTS IN SOFTWARE INDUSTRY

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Abstract

Most organization's main goal is to produce and maintain high quality goods or services. With a comprehensive understanding of the costs related to quality, this goal can be achieved. In recent years organizations have been focusing much attention on quality management. There are many different aspects of quality management. This paper focuses on the impact of non-conformance costs on overall quality costs of software projects. For this, a survey was conducted. A questionnaire was developed for defining measures, collecting data against those measures and analyzing the collected data through different techniques. On the basis of the collected data and results, we have uncovered some of major non-conformance costs parameters. Our finding indicates that design changes, corrective actions, motivation, customer complaints, etc have significant impact on overall Quality Costs (QC).

1. Introduction

For the last two decades, the computer software industry has emerged as one of the major industries worldwide. In most of the organizations, project management practices like costs and schedules estimations are largely unpredictable, and the quality of the software is often poor [4][6]. This gives emphasis to the need to study both the quality of the software products and the software engineering practices in the development and maintenance of the products. Increasing and overestimated expenditure in software has caught the attention of researchers, towards the identification of productivity and quality parameters in research [13]. Researchers have adopted both experimental and hypothetical approaches to better understand the process of software development and maintenance. Due to the increased role of software in everyday life and the competition in the software industry, issues regarding software costs have become an important question in the research [12].

The quality of software has been studied by considering defect analysis and software maintenance issues. Empirical research has analyzed tradeoffs between software quality and maintenance, and examined drivers of software maintenance costs [1]. Almost 75% software projects were delayed due cost overruns and poor scheduling [15]. Based on these facts and figures, practitioners in the software industry are still faced with the challenge of understanding the key tradeoffs in a software project in order to deliver quality products to customers on time and without cost overruns. This emphasizes the need to study the various factors that influence the software costs and its quality.

Thus in this research, we propose to undertake research on some of the critical parameters which are considered to be important for the quality cost of the software.

Cost of Quality (COQ) and Quality Cost (QC) are two different definition tags, but more or less used in the same meaning. With the passage of time, ideas of what constitutes quality costs have been changing. In early 1980s, the costs of quality were perceived as the cost of running the quality assurance department, plus scrap, rectification, rework, testing, warranty costs etc. But, with time, this idea has changed and now it is widely accepted that cost incurred in design, implementation, operation and maintenance of an organization's quality management system, the cost of organization resources for the improvement of process, costs of system, products and services failures and non value added activities are all different forms of Quality Costs [3][5].

In this survey, our goal was to identify and find out the impact of non-conformance costs on overall QC. We identified some parameters and evaluated their significance among the rest of other parameters. This work is organized as follows. Section 2 describes quality, quality with respect to software, its importance of measurement, and different types of quality costs. Section 3 explains the industry outlook, data collection, and an overview of an software organization including the survey details. Section 4 describes the survey results. Conclusions are discussed in section 5 and section 6 is about future areas of research.

2. Quality

The term quality is among the most ambiguous words in the English language and is ambiguous in all other natural languages too. ISO 9000 explain quality as to fulfil the requirements. Moreover, it also explains that a product may be considered to have quality even if the requirements specification is inappropriate [17].

The American Heritage Dictionary defines quality as "a characteristic or attribute of something." As an attribute of an item, quality refers to measurable characteristics – things we are able to compare to known standards such as length, color, electrical properties, and malleability and so on. However, software, largely an intellectual entity, is more challenging to characterize than physical objects. Qualitative aspects are hard to define objectively, so we have defined proxies to measure them [9][14].

2.1. Software Quality

There could be many different aspects on which behalf quality of software could be evaluated. It varies case to case as per priority.

Caper Jones [10] recommended paying particular attention to the following six quality factors:

- Low levels of defects when deployed, ideally approaching zero.
- High reliability or the capability of running without crashes or strange results.
- A majority of clients with high user-satisfaction when surveyed.
- A structure that can minimize "bad fixes" or insertion of new defects during repairs.
- Effective customer support when problems do occur.
- Rapid repairs for defects, especially for high-severity defects.

It does not bother what definition is used for quality, it is necessary to be optimistic rather than pessimistic. The important thing is that, what sort of problems, user is facing? Why his experience categories it as a failure on part of software?

2.2. Quality Cost (QC)

Quality costs (QC) are the portion of the operating costs brought about by providing a product or service that does not conform to performance standards. Quality costs are also the costs associated with the acuity of poor quality [12].

2.3. Importance of Measurement of Quality Cost

QC is treated as business parameter with other parameters like marketing, research, sales, production etc. This measurement focuses on those areas which have high expenditures, wastages, potential problems. Further more, this measurement helps to reduce costs and brings improvements in the error prone areas. QC measurement is an important and effective effort with a lot of advantages [5].

The cost of quality can be a highly significant element of the profit-and-loss statement, particularly in the long term. It is the cost of achieving quality goals [3]. By adopting proper means of cost of quality, evaluation of effectiveness, establishment and improvements of different procedures and programs is possible. It is very important to adopt a mechanism which evaluates monitors and reports such things on a regular basis. There are also some other cost measurements, like sales, turnover and added value etc. These measures help to evaluate the capability and effectiveness of the quality management system. They also help to identify those specific areas which require more attention.

2.4. Types of Quality Cost

In real terms, the quality cost is the sum of the cost of conformance and the cost of non-conformance, where the cost of conformance is prevention costs plus appraisal costs and the cost of non-conformance is internal failure costs plus external failure costs. Using quality cost, a manager can determine the usefulness of investing in a process, changing a standard operating procedure, or revising a product or service design [7]. QC can be categorized into two major classifications as follows:

- Conformance costs.
- Non-conformance costs.

Conformance costs are regarding preventive and appraisal measures. Planning, administration, quality education, product evaluation, inspection etc are some of the major conformance costs. These are the costs which are mostly considered important in the software industry.

Non-conformance costs (failure costs), our research area, covers the price paid by not having quality systems or a quality product. Sometimes, accounting procedures are unable to pickup such costs. Some important examples of non-conformance costs are rework, scrap, downtime etc.

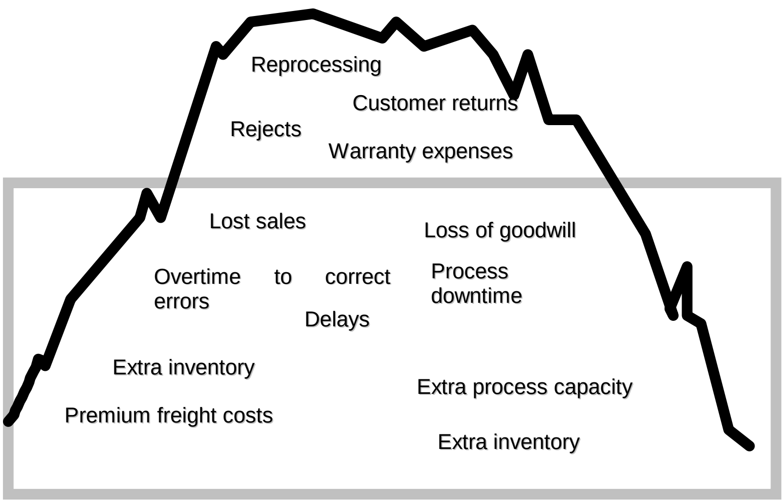

Figure: 1 Iceberg of Quality Cost, Modified from: Adapted from Principles of Quality costs, Ed. J. Campanella, ASQC Quality Press. [5]

There are two major categories of non-conformance costs, as described below:

2.4.1. Internal Failure Costs

Internal failure costs are those costs coupled with product nonconformities or service failure found before the product is shipped or the service is provided to the customer. Internal failure costs are the costs of correcting the situation. Examples of internal failure cost are rework, scrap, corrective actions [8] etc.

2.4.2. External Failure Costs

External failure costs are the costs that occur when a nonconforming product or service reaches the customer. External failure costs include the costs associated with customer returns and complaints, warranty claims, or product recalls. As the impact of external failure cost is very high, it must be reduced to zero. Because they are highly visible, external costs often receive the most attention. Unfortunately, internal failure costs may be seen as necessary evils in the process of providing good quality products to the consumer. Nothing could be more false. Doing the work twice, through rework or scrap, is not a successful strategy for operating in today's economic environment. Examples of external failure cost are returned goods, corrective actions, liability costs [8] etc.

2.5. Human factors and Quality

[16][17] has discussed in detail about the importance of human factors in quality. No doubt, both software quality and software failure have a great interaction with human factors. Quality with respect to user is based on the performance of the software system. It could be measured how effectively a user is getting its specified goal, what's the efficiency of system and how high the level of satisfaction a user have? There are different metrics like ISO/IEC 9126-2 used to define the role of human factors at different level in software quality [17]. Moreover, different process improvement models like ISO 9000 and CMMI (Capability Maturity Model Integration) also describe certain aspects of human maturity in an organization.

3. Industry Outlook

The research is conducted to find out the impact of conformance costs on the overall QC of software project. Research sites are some of the leading software organizations that develop various commercial applications.

3.1. Data Collection

In order to get information about those critical non-conformance parameters, which are to be considered important in QC, a survey was conducted. For the data collection, a questionnaire was designed by considering standard rules of questionnaire research [2]. In the questionnaire, questions about designation, experience in software industry and department were asked. All questions in the questionnaire were subjective. An ordinal scale was formulated to answer for data collection. The respondent has to answer in numerical values. The scale has 5 choices, from 1 to 5 (from least towards highest), first scale is one and rest are in equal interval of one. The number has an interval, mean how much weightage is given to that specific non-conformance cost in the overall QC.

The selected organizations for survey are from different geographical regions across the world. The questionnaire was floated amongst 25 organizations located in Asia, Europe, Australia and USA. There were 22 responses. All respondents are project directors, project managers or team leads. Information summery of data collected from different organizations is given in Table 1.

Data of Organizations under study	
Total Number of Organization	18
Average Organization Size	28 Employees
Average Team size	8
Data of Organizations under study	
Number of Project considered	22
Organization Maturity Level	CMM Certified: 4
	ISO Certified: 9
	5 Organizations did not specify any of above maturity identification platform
Development Type	New Development: 17
	Enhancement: 4
	Re-development: 1
Business Area Type	Banking and Finance: 3
	e-Commerce: 5
	Communication: 3
	Sale and Manufacturing: 7
	Insurance: 1
	Government Public Admin: 3
Respondents:	Project Director: 4
	Project Manager: 11
	Team Lead: 7
Respondents Average Experience	> 1year: 2
	between 1 - 3 years: 6
	between 3 - 5 years: 9
	between 5 - 7 years: 4
	> 7 years: 1

Table 1: Summary of Data, collected from different Organizations

4. Survey Results

This section describes the results of analysis applied on the data.

4.1. Internal Failure Cost

In case of internal failure cost, we have taken 10 parameters into consideration. These parameters are rework, repair, material failure reviews, design changes, scrap, inefficiency, injuries and accidents, overtime, corrective actions and motivation.

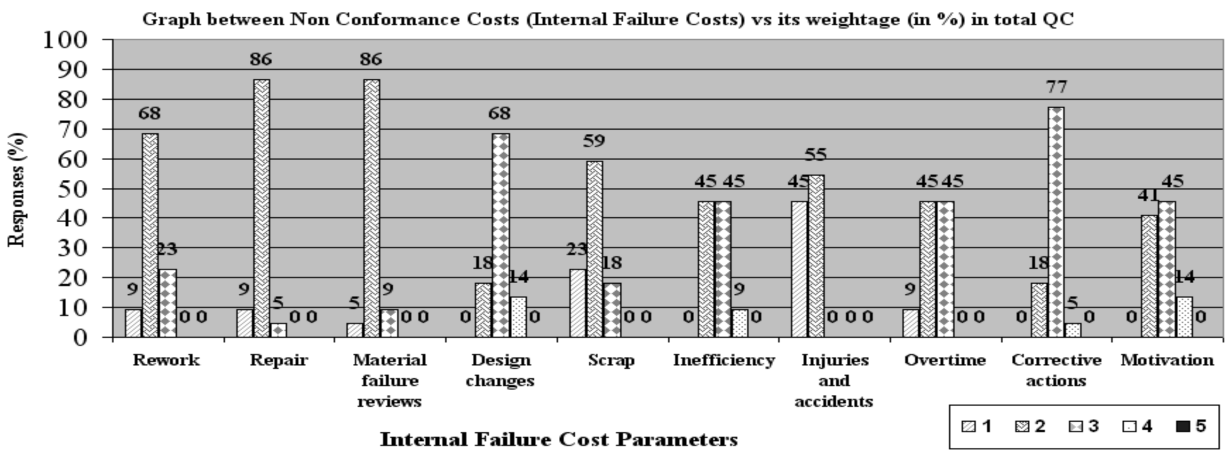

Figure 2: Graph between Non-conformance Costs (Internal Failure Costs) vs its weightage (in %) in total QC

As per collected data, in case of rework, 68% respondents said that their consideration is below average, while 23% said this parameter has average impact on the overall QC. In case of repair, almost all respondents kept this parameter below average. Same is in case of material failure review. Design changes and motivation is the parameter to whom, almost 70 to 80% respondents considered its significance above average in QC. Moreover, overtime, scraps have average impact on overall QC.

4.2. External Failure Cost

In case of external failure cost, we have taken six parameters for analysis. These parameters are returned goods, warranty costs, customer complaints, liability costs, cost overrun and penalties.

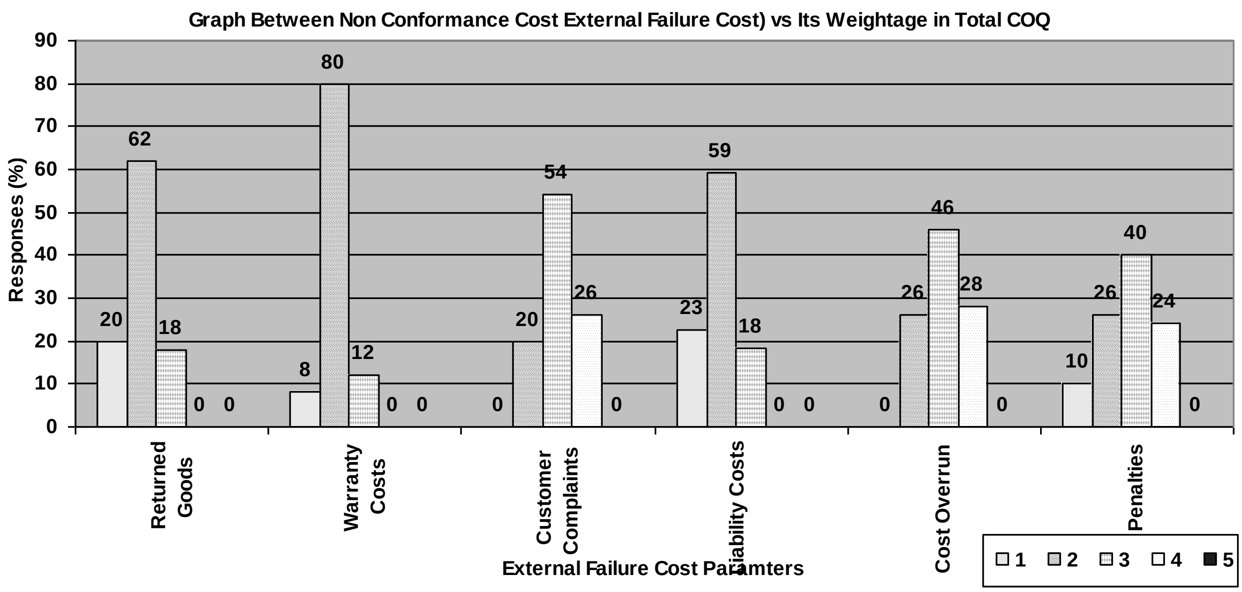

Figure 3: Graph between Non-conformance Costs (External Failure Costs) vs its weightage (in %) in total QC

In case of external failure cost, we have seen that most of the parameters play an important role in the significance of overall QC. Results show that customer complaints, cost overruns and penalties are among those external failure cost parameters, which have high impact, as compare to returned goods, liability cost and warranty costs.

5. Conclusion

In this paper, we have reported the results of a survey by studying the impact of various non-conformance cost parameters (internal and external failure cost) that contribute more or less significantly towards overall QC. A total of 16 parameters were considered for the survey. Results have shown that out of 16 parameters, six parameters had high influence on QC. These parameters include design changes, corrective actions, motivation (from internal failure parameters), customer complaints, cost overruns and penalties (from External Failure parameters). Improvements in these parameters can significantly reduce the QC. None of the other ten parameters has shown any negative affect on the overall QC.

6. Future Areas of Research

The area of QC is a vast one. Throughout the world good initiatives have been taken and researches have been done. However to study with respect to different domain and software industries, this research can be expanded. Further studies in this area can be done from following aspects:

- Increase the sample size to include a larger pool of organizations.
- Study similar but more mature industry models.
- Distinction in QC parameters based on the particular domains (e.g. MIS, System software etc.) in which an organization deals can also be studied.

- Study of those organizations which are following specific process improvement models like ISO, CMMI etc.
- Respondents experience and domain expertise should be considered as a human factor
- Offshore/local client models can be treated separately and with more detail.

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Social Responsibility for Information by Informal Systems Thinking

INFORMAL SYSTEMS THINKING BY SOCIAL RESPONSIBILITY CONCERNING INFORMATION

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Abstract

Informal systemic thinking/behavior has been applied for millennia by successful persons attaining requisite holism/wholeness without existence of systems theory. Narrow specialists tend to neglect it rather than to practice interdisciplinary creative cooperation to attain it. The current crisis of 2008- results from it and from the related lack of requisite wholeness of information as a basis of behavior. Prevention of errors in information systems is therefore crucial. (Corporate) social responsibility that requires honest behavior of influential people and organizations toward their coworkers, other business partners, broader community/society, and natural preconditions of survival of the current civilization of humankind, can support information processes to attain requisite holism/wholeness. It can also receive support from them.

1. The selected problem and viewpoint of dealing with it in this contribution

A good decade ago we presented at IDIMT our findings that informal systemic thinking, i.e. requisitely holistic behavior, can exist [30], not only a formal systems theory, of which there are many now [18]. Our experience has proven that we were right: for millennia with no formal systems theory there have been successful people; they were obviously much more holistic – broad and deep, most probably in an interdisciplinary creative cooperation of mutually different specialists, than the less successful ones. A short time after our publication and with no link with it, of course, European Union published its document on promotion of corporate social responsibility (SR) [16]. We presented some of our research on SR (without limitation to organizations, because they are human tools) at IDIMT 2008 [32]. Now, we will link SR and (informal) systems thinking and apply it/them to the issue of information.

2. Systems theory versus systems thinking and informal systems thinking/behavior

Systems theory was established to fight over-specialization by creation of a worldview of holism of human behavior (i.e. monitoring, perception, thinking, decision making, and action) aimed at wholeness of human insight and outcome, and methodology supporting this world view ([3], p. VII, and later pages). Decades have shown that the concept has been right in principle, but in practice no total, i.e. real holism/wholeness is possible, but a requisite one. It is up to humans to choose how many and which viewpoints and which synergies of them will be considered, while others are left aside, although they still exist and impact reality. Humans make their dialectical systems and take responsibility for their resulting holism/wholeness. See Figure 1.

←---→		
Fictitious holism/realism (inside a single viewpoint)	Requisite holism/realism (a dialectical system of all essential viewpoints)	Total = real holism/realism (a system of totally all viewpoints)
Dangerous due to causing oversights along with partial insights based on specialization	Attainable, but depending on human choice of the essential viewpoints/professions, not all possible ones, and their synergies	Ideal, but impossible to attain due to huge complexity of reality reaching beyond human capability

Figure 1: The selected level of holism and realism of consideration of the selected topic between the fictitious, requisite, and total holism and realism

The dialectical-systems approach is supposed to enable people to attain the requisite holism of their behavior that results in the requisite wholeness of their outcomes by their habit to think/behave along the lines of the left column in Figure 2. The point lies in prevention of oversights and resulting mistakes, including World Wars and World Economic Crises, the climate change problem, etc., but also other mistakes, such as bankruptcies, car crashes, etc., by requisite holism.

No	Systems / Systemic / Requisitely Holistic Thinking	Un-systemic / Traditional Thinking (limited to a single selected viewpoint)
1	Interdependences, Relations, Openness, Interconnectedness, Dialectical Systém	Independence, Dependence, Closeness, A single viewpoint/system
2	Complexity (& Complicatedness)	Simplicity, or Complicatedness alone
3	Attractors	No influential force/s, but isolation
4	Emergence	No process of making new attributes
5	Synergy, System, Synthesis	No new attributes resulting from relations
6	Whole, Holism, Big Picture, Holon	Parts and partial attributes only
7	Networking, Interaction, Interplay	No mutual influences

Figure 2: The Seven Interdependent Basic Sets of Terms of Systems / Systemic / Holistic vs. Un-systemic Thinking/Behavior

Behavior in line with the left column in Figure 2 may be practiced without the language of the systems theory. Then we speak of the informal systems/requisitely holistic thinking/behavior.

SR is such a case.

3. Social Responsibility – an Attempt to Promote Informal Systemic Behavior

SR can be viewed as a rather new international attempt to promote informal requisitely holistic behavior. It is aimed to reach beyond charity to diminish or prevent power-holders' abuses/misuses of their co-workers, other business partners, broader society, and natural environment, beyond official requirements on a voluntary basis [16]. SR is also viewed as an upgrading of total quality management and similar methods supporting innovation and requisite holism of e.g. business behavior, or even as a method aimed at world peace (for an overview see: [21]). In another wording – moral sentiments – Adam Smith presupposed SR as the author of liberal economics theory, but the Chicago school of neo-liberal economics erased two crucial preconditions of Smith's liberalism – total transparency of businesses and no division of rights and duties of owners and managers of enterprises, e.g. by shareholding and limited liability enterprises [46]. The Friedman's neoliberalism caused socio-economic conditions to appear which liberalism and USA had been created against, i.e. against 'feudal capitalism' [19].

SR is no longer limited to charity and 'doing good in order to do well' to your co-workers, customers and other partners in business and social life, and to your natural environment, because 'this is nice'; it has become a part of the unavoidable good business ([11], [23], [24], [25], [38, [39], [45], [47]). Thus, SR is becoming a way of informal systems behavior/thinking, because all crucial viewpoints are involved, and they are so in synergy and need working on an interdisciplinary basis.

Let us take a case of a lack of SR that has also been supported by a lack of requisitely holistic behavior of information providers. From Annie Leonard (www.storyofstuff.com) we can quote some interesting (backed with quotes) data about the current consumers' world, such as ([28], p. 4 – 5):

- In recent three decades 33% of natural resources were consumed.
- In USA only less than 4 % of the original natural forest has remained.
- In USA 40 percent of water resources have become undrinkable.
- In USA there is 5 % of world's population, but they consume 30 % of resources and produce 30 % of waste of the entire world.
- If everybody consumed on the USA level, we would need 3 – 5 planets.
- Today more than 100,000 synthetic chemicals are used.
- Only a few of these chemicals were tested for impacts over health and none for their synergetic impacts over health.
- USA industry admits it emits more than 1.8 million ton of toxic emissions per year.
- An average consumer in USA consumes now double more than 50 years ago.
- Now, all of us see more advertisements in one year than people did in their entire lives 50 years ago.
- In USA, according to investigation, there was the biggest number of happy people around 1950.
- In USA, they use 3 – 4 times more time for shopping than consumers in Europe.
- In USA, the average apartment size doubled after 1970.
- Every person in USA generates about 2 kilos of garbage a day, which is double more than 30 years ago.
- Every garbage-can to be taken away from your home is backed by 70 garbage-cans generated in the production process for products the leftovers of which are now in your garbage can.

All these efforts and methods apply and produce data and messages aimed at being information, i.e. influential basis of action. Thus, SR concerning information may have a crucial role for humankind to survive, for business to flourish, for humans to be happy, etc. If information is not requisitely holistic, it might be misleading causing failure rather than success and happiness. Many applications of IT can support requisite holism and wholeness. But the contents of information as influential inputs into behavior are at least equally crucial.

4. Contents of Requisitely Holistic Information Support in Business Management

Globalization of the world economy puts competitive pressure over the businesses, requiring their high quality business operation, which can be significantly improved by management innovation. Management, either innovated or outdated, determines the quality of the entire business. Business management uses information presenting important characteristics of the field/industry dealt with, and its own and co-workers' knowledge, i.e. long-term information (from the content and methodological aspects).

Information differs from data. Available data tend to be too many to become informative (= influential). Selection of date enables informing, which cannot be fully holistic, but requisitely holistic, hopefully. This requires an information-management innovation. It results in the requisite information. In business, it surfaces in, and influences, the basic business and other processes supporting the entire business.

Both non-economic and general economic information on business operation dealt with are needed in the business managers’ economics-oriented decision making, and can be quantitative and/or qualitative. To run one's business operation well one, namely, needs all / requisite various information with which quantity, value, and quality (or any other important) attributes of business are presented. Making and using information opens a variety of content and methodology issues making it adequate (= requisitely holistic, realistic, applicable, and influential).

The business operation can be found adequate, when it is successful (efficient and effective in economic terms), respected (from the aspect of business behavior), and ethical (morally adequate from the aspect of a responsible attitude towards the social and natural environment). To be so, the business-operation managers need general information, too.

The majority of general information can have a direct or indirect impact on economics of business operation. For this reason, this information can be also a part of the economic information in the broadest sense of the word. Beside, there is also information that can be called non-economic information for business (such as law, technology, sociology, political trends, local, national, professional, and other cultures, values, ethics, norms, education, demographic trend, etc.). These include messages, data, or information that is not directly related to the business operation, or is not included in the management of the business operation dealt with, but of its environment. Because of its impact over economics of business operation this “non-economic” information can be called indirect economic information. Under an open-system approach to business management it is included in requisite information and knowledge.

With all the briefed diversity, the problem of the theory and practice of business informatics, since its beginning, has lied in the target orientation aimed at requisite economic information. In the past, information support to management was very often limited to the financial aspect of the economics business operation alone. Financial information does present an important subsystem of information, but nothing more. The modern business information focuses on providing more / requisitely holistic information necessary for the business operation management. This is an important trend in information management innovation.

Herein we find the increased importance of the indirect economic information. It is difficult to treat because its definition is problematic. Its content can be objective and subjective: defined by events and by observers and decision makers.

The information is called objective, if it can be well defined and, therefore, well investigated on the basis of different quantitative units (i.e.: quantity, weight, value). Under equal conditions it is repeatable. But conditions can be subjectively selected, depending on the selected system of viewpoints (per professions, interests, etc.), and so can “objective” information. It tends to lack holism, which is precondition of total objectivity, for natural reasons: (1) Nature has enormously many attributes, (2) There is no information without observer/s’ perception and/or expression, and (3) Humans are neither able to know everything, nor to think of everything at the same time.

Reductionism is consequence of this limited human capacity, and it allows for depth and hinders holism. Therefore objectivity of reality is not limited, but objectivity of data, messages, and information is.

On the other hand, information that cannot be exactly defined is called subjective. As a rule, it is collected and examined by the application of various qualitative units, or even by application of descriptive criteria only, which cannot be measured in quantitative units. Reductionism results again, allowing for depth and hindering holism. But now its presence is clear and admitted.

Thus, the information capacity of collected data and messages depends of the level of holism of the selected system of viewpoints of both the data providers and data collectors and processors. If holism/wholeness is not attained, misinformation and/or disinformation can results.

Therefore, in attempts to increase holism of information, we face two aspects of data suitability, i.e.: (1) An adequately target-oriented type of information; and (2) A suitable level of generalization of information, resulting from data and messages.

For the needs of the individual business operation (different kinds, types, and forms) and business operation in the individual areas of work (e.g. per business functions, or per projects), we need the information that is suitably conceived and created in accordance with the set goals of our work. On the other hand, we need different general information for each business operation, for business participants to both set goals and to realize them.

Information can be created on different levels of generalization resulting from requirements of the business management. The level of generalization can be in the interval between entirely general information and completely specific information. This fact brings us again to the issue of background of attainment of a selected level of holism. It is essential for information to be reliable rather than misinformation or disinformation.

Creation of requisitely holistic information provides content, which serves as a starting point for the consideration of the informational support to business. Though, such information provides only for the basic, but not for the sufficient precondition for the informational support to business to be requisitely holistic. The other basic precondition of understanding and application of information consists of creation and use of a suitable information infrastructure as a component of the requisitely holistic business intelligence.

Hence, as a part of the issue of the information infrastructure the role and importance of entanglement in creation of a holistic information support for business will be briefly discussed now.

5. Entanglement of Requisitely Holistic Information Support e.g. for Business

Let us now spend a few minutes with the issue of entanglement.

The concepts of entanglement are not always precisely defined, on one hand. On the other hand, there also appears the question how to manage / master entangled phenomena as economically as possible and, at the same time, successfully - effectively and efficiently.

What are both theoretical and practical issues of entanglement? We are more interested in the process than in the structure, and more in holism of consideration than in its partiality (one-sidedness).

The entanglement has been increasing/changing since the existence of life on earth. However, one also knows of the need for a more detailed consideration of entanglement. If one does not consider both synergies and details, one takes the risk of an oversimplification and of making many important oversights, as a result, which may cause entangled consequences.

We can hardly choose between levels of entanglement of reality. The choice we have is rather either the entanglement of consideration / investigation / management of reality or the entanglement of their consequences, and related information. It is probably logical to find if more beneficial to devote most of our attention to the phenomena of entanglement in order to avoid complicated and/or complex consequences:

- When the objects of our discussion are the details with respect to an individual component of an entity under investigation, then we can talk about the entanglement of the type complicatedness. It can also be defined as the entanglement based of the characteristics of the components and present a part of the real characteristics of phenomena, which have different components / parts. The greater is the variety of components, the higher is also the level of complicatedness and vice versa, both of facts and information. Synergies do not count.
- In the case of our concentration on the characteristics, which results from mutual influences between the components of an entity (and their background - basically their interdependence) we deal with the entanglement called complexity. It shows the characteristics of phenomena, which have different structures and synergies than their components alone do. Their structure is formed by a number of different types, varieties and forms of relations between the components inside the features at stake and with their environment. The greater is the variety of relations, the higher is also the level of complexity and vice versa, both of facts and information. Synergies are central and critical. Details are found less important.

The two entanglements exist in reality, of course. There can, therefore, be a number of their various contents. A similar conclusion holds of the variants with regard to the level of entanglement of both types which is, very often, bigger in reality than in a usual consideration (also in a scientific one in which systems are modeled – Figure 3). When examining the phenomena, the following level of wholeness of consideration of characteristics of phenomena can be achieved, hence:

- (in one extreme) totality,
- (in the other extreme) zero-level, or
- (between both extremes): a requisite level.

It all depends on our selection of a viewpoint / viewpoints / system or network of viewpoints / dialectical system of all essential and only essential viewpoints.

Level of realism of consideration of the selected topic	Level of simplification of consideration	Viewpoints of consideration taken in account	Components taken in account in consideration	Relations taken in account in consideration
Existing object to be dealt with	None	All existing	All existing	All existing
Dialectical system	Small - requisite	All essential	All essential	All essential
One-viewpoint system	Big due to specialization	Single – selected by specialization	Selected inside the boundaries set by the selected viewpoint	
Model of the one-viewpoint system	Big due to specialization and modelling aimed at clear presentation	Single – selected by specialization and simplified to be clear	Selected inside the boundaries set by the selected viewpoint and shown in a simplified - modelled way	

Figure 3: Relation between reality and holism/realism of human consideration of it

In the consideration of entanglement, we additionally encounter the problems of how to define a requisite entanglement of our examination, both of facts and information. But this issue exceeds frameworks of this contribution.

How do these findings impact consideration of reliability of information in the case of business information? Unreliable information is namely a misinformation and it is therefore dangerous.

6. Reliability of Information as a Case of (Corporate) Social Responsibility

Failure to inform depends on more complex processes than the ones offered as their first and, of course, simplified approximation quoted by Eli B. Cohen [9], and aimed at provoking our thinking by his book. His two figures (4 and 5) say so:

Data → Processing of data → Information

Figure 4: The simple three-stage framework of information delivery

Reality → Data recording → Processing of selected data → Decision maker ← context Error types: I. Data recording, II. Process Stage, III. Decision Making

Figure 5: Expanded Framework on information delivery

We see an essential part of complexity to be added in the following facts, at least:

- Which part of attributes of reality does one consider? In a business case, the same business reality can provide basis for different pictures of reality, if it is watched from the viewpoints of e.g. book keeping, marketing, sales, supplies, technology for the daily routine, technology research, development, innovation (which can be of many kinds – from technology to culture and management style etc.), human resources, organizational culture, private relations along with the official ones inside the company or with its business, social or natural environments, legal situation (which again can be of many kinds – from business and employment contracts to punishable actions), etc.
- Which part of possible data does one record? In a business case, they can have to do with all the above realities or some of them; they can depict their past, present, or future situations, their local, regional, national, or international situation, their situation in terms of the stage in their process of unfolding, their situation in terms of availability and eligibility of qualitative and/or quantitative data, their situation in terms of computer support to recording or another technology, etc.

- Which contents can the processing of selected data have? In a business case, they can have to do with all the above realities and possible recording types, and add to them very different levels of e.g. depth and/or breadth of insight; further routine processing or creative processing can be added, all the way to innovation, or perhaps to manipulation leading to misinformation or disinformation, which can tackle coworkers, managers, owners, or competitors, government, etc.
- Who is the decision maker? In a business case, these may be managers and/or owners. But it is not realistic enough, if one thinks of them only: everybody makes his or her decision every moment (including decisions such as: »I am going to have a cigarette now / later«, or »I am going to toilet now / later«, »It is time to go home«, »It is time to work harder«, »I will read / not read this message / I may read it later«, »I will make a / no suggestion«, »I will be passive / active the about company problems«, etc.).
- Do decision makers acknowledge that complexity of business has grown and most attributes of the life reality in business have changed, while the need to make good decisions has not changed? A simplified, e.g. quantified, model of reality can hardly be realistic enough for good, i.e. requisitely holistic and realistic decisions, and resulting actions.
- Do decision makers admit that problems are to reality what atoms are to tables, and we experience tables, not atoms? Problems are abstracted or exatracted from experience by analysis. We do not experience individual problems, but complete systems (= complex entities) of those that are strongly interacting. Ackoff calls them messes. Defining them is the first step of real problem solving.
- How do decision makers deal with the old proverb “What you see depends on where you sit in an organization”, i.e. the multiple and diverse viewpoints and resulting insights into the same fact, causing (very) different assessments of fact resulting in (very) different conclusions? (“Everyone’s eyes have their own painter”, an old proverb says.)
- How do decision makers deal with the experience that the “information asymmetry” makes you know a part of reality better than your counterparts do, while making you blind for another part / many other parts (your business partners, including your staff, many distrust you and fail to disclose their information to you).
- How do decision makers perceive, understand and assess context of their decision-making / thinking / action? All the above varieties may enter the scene, and make a long set of very different synergies. Very different information may result.
- How do decision makers consider the fact that totally holistic information (i.e. knowing everything) is impossible, and they must base their decisions on assumption about reality and its future? How do they use imagination to make realistic strategies? How do they select the essential from the less essential data / viewpoints / information / insights / knowledge?
- How do decision makers tackle the fact that managing today includes a lot of innovation / transformation of e.g. way of interaction with customers, way of formulation of problems internally, way of imaging the future – in order to make a difference, hence to survive in globalized competition? How is informing adapted to this rather new fact?

We do not say that Cohen's figures (4, 5) are not O.K. We are just following his suggestion to think more deeply about errors in informing systems to add to his quoted three pointed-out topics: (1) Reality and captured data are not the same, (2) Decision-making takes place within a context, and (3) Only the selected data are processed.

He is right: »decision-making is only indirectly influenced by reality; there are many steps that separate reality from the decision-making process«. On this basis he wants to apply »this framework as a means to organize the types of errors that lead [information] systems to misinform their clients«.

We want to contribute by thinking in another direction: how can one tackle the data-to-information-to-decision process in order to diminish the number and weight of errors. Data recording errors follow earlier errors – data selection, and data selection basis and errors in it.

We will follow the concept depicted in Figure 6.

Errors to be detected, classified, and prevented or removed for reliable/responsible information	
Essential errors (with critical consequences)	Non-essential errors (with unimportant consequences)
↓↑	↓↑
An over-biased / too one-sided / partial / too poorly holistic approach; no requisite holism reaching sufficient holism of decision makers in any step of the entire process from setting criteria for watching reality and collecting data all way to the final (business) decision and action – caused by a crucial lack of specialists' interdisciplinary co-operation	No biased / one-sided / partial / too poorly holistic approach; reaching requisite holism of decision makers in any step of the entire process from setting criteria for watching reality and collecting data all way to the final (business) decision and action – caused by no crucial lack of specialists' interdisciplinary co-operation
↑↓	↑↓
Selection and application of subjective starting points not following the Dialectical Systems Theory – the left column in Figure 2, but a one-sided / single-disciplinary approach	Selection and application of subjective starting points following the Dialectical Systems Theory – the left column in Figure 2 and middle column in Figure 1
No social responsibility concerning information provision and application	Requisite social responsibility concerning information provision and application

Figure 6: Dependence of reliability of information on the decision-makers' approach – with SR or without it

Humans and their organizations, which practice (C)SR use requisite holism by (informal) systemic behavior and hence provide a reliable information throughout the entire process of making and using information. This helps them succeed both in a shorter and longer term because reliability has become a basis of their excellence by becoming their values-culture-ethic-norms ([36], [8] etc.).

Let us take a case of current processes resulting from a lack of systemic behavior and social responsibility due to which information has become misinformation resulting in a world-wide crisis.

The 2008- crisis as a current case of a failure due to a lack of systemic behavior and requisite wholeness of information

There is much publishing, i.e. providing of data, messages, information, and misinformation about the so called financial crisis of 2008 and later in the daily press. It shows a very shallow approach to the problem in the background of this crisis. One of the missing elements is the clear link of (1) the neo-liberal economics of Friedman and his followers in the Chicago School of Economics who have reigned in the world-wide economic literature and political practice for many decades, with (2) e.g. the hot problem of the humankind's natural environment as the central preconditions for humankind to survive ([6], [7] and references in them). Halimi [22] quotes the Nobel laureate Gary Becker to clearly and briefly show this oversight. Becker was very far from requisite holism, and he was actually providing a misinformation, when saying what Halimi quotes: "In the most advanced countries they exaggerate with the right to work and environmental care. The free trade will destroy some of these extremes, because it forces everybody to remain competitive when importing from developing countries." Becker mixed up value and price, and forgot about the longer-term and broader effects [40], [41]. In other words, the Chicago school of economics produced misinformation by calling a socioeconomic order pure market, which actually has been a feudal market reigned by big multinationals as monopolistic and oligopolistic masters over information changing it – by information asymmetry – in misinformation to mislead and abuse the entire global world economy and society.

Several other respected authors – economists are also trapped inside their own specialization. So are politicians, as reported about in the daily press: they criticise and require solutions rather than provide them according to their role in society. Ackoff and Rovin [1] have obviously not been listened to, neither have been Whittaker and Cole [48] or even Davidson [12] or Mulej et al. ([33], and earlier, since 1974). We neither have room to quote here many contributions in conferences and journals on cybernetics and systems theories concerning approaches and solution to the selected problem. We only can summarize that it is very dangerous, if very influential authors are biased and one-sided rather than requisitely holistic (e.g. [2], [5], [10], [13], [15], [27], [29], [34], [35], [31], [37], [42], [43], [44], [46] etc.). Fujimoto [17] is right: economics is superficial; he namely found that there are two kinds of sources of competitiveness – the deep ones come from technology and organizations, the superficial ones from economics; both are important, but there is anyway a crucial difference. Take a look at Fig. 5 again.

But other disciplines/professions are no less narrowly specialized and therefore no less fictitiously rather than requisitely holistic. This is the fate of specialists who do not practice interdisciplinary creative cooperation: they are and remain poorly informed, which makes them lose control over their own lives, while they may imagine the opposite. The current crisis proves they are wrong.

The common denominator behind this scene can be called the lack of possibility for any professional to have the totally complete information. This brings us to the issue of the relation between SR and requisite wholeness of information. As we have tried to demonstrate in IDIMT 2008, solving the technological problems of the data/message/information processes is important, but far from enough, or even everything important, once one thinks of the content of information, too, which one must think of. A dialectical system is more helpful.

The essence of the concept of the dialectical system and related law of requisite holism/realism (Figure 1 here) is well expressed by Wilby ([49]: 388), although she leaves open the question of viewpoints selected and thereby determining the boundaries of study: "The goal of holistic study is not to look at 'everything'. Instead it is to make a decision about what is relevant to the study and what is not and to know and understand why those choices were made. The biases and interests affect the choice of what is likely to be included and excluded (i.e. what is in the system as opposed to what is relegated in the environment of the system)." What Wilby calls holistic, we call requisitely holistic. It has an essential impact over what is information rather than misinformation.

7. Conclusions

From the viewpoints of Mulej's law of two-generation cycles of the prevailing values-culture-ethics-norms the period of the neo-liberal economics (that might be called 'feudal economics') is ending right these years with the crisis of 2008- (e.g. [19], Mulej, in [33]; [36]). The same is true of the rapid changes inside this cycle depicted in Figure 7. The time is coming for what we have called at IDIMT 2008 [32] the need for the 5th phase, or the next two-generation cycle as the one in which the honest business behaviour, including the application of the SR and informal systemic thinking to information as a crucial basis of behaviour will prevail. The alternative might be very dangerous, perhaps even the end of the current civilization of humankind [14].

De-cade	Market & Social Requirements	Enterprise's Ways To Meet Requirements	Type of Enterprise
1945 -	Covering of post-war conditions of scarcity, rebuilding, etc.	Supply anything; supply does not yet exceed demand	Supplying Enterprise
1960 -	Suitable price (as judged by customers)	Internal efficiency, i.e. cost management	Efficient Enterprise
1970 -	Suitable price X[10] quality (as judged by customers)	Efficiency X technical & commercial quality management	Quality Enterprise
1980 -	Suitable price X quality X range (as judged by customers)	Efficiency X technical & commercial quality X flexibility management	Flexible Enterprise
1990 -	Suitable price X quality X range X uniqueness (as judged by customers)	Efficiency X technical & commercial quality X flexibility X innovativeness management	Innovative Enterprise
2000 -	Suitable price X quality X range X uniqueness X contribution to sustainable development (as judged by customers)	Efficiency X technical & commercial quality X flexibility X innovativeness X sustainable development	Sustainable Enterprise
2010 -	Suitable price X quality X range X uniqueness X contribution to sustainable development X (corporate) social responsibility (as judged by customers)	Efficiency X technical & commercial quality X flexibility X innovativeness X sustainable development X honest behavior toward coworkers, other business partners, broader community/society and natural preconditions of survival of the current civilization of humans	Socially responsible enterprise

Figure 7: From a supplying to a sustainable enterprise – and a new definition of the concrete contents of requisite holism of enterprises' behavior

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[10] X denotes interdependence. No attribute is avoidable any longer for a longer-term success/requisite holism. The original table (Bolwijn, Kumpe, 1990) did not contain X, but +. The sign + denotes no interdependencies and resulting synergies; elements are only summed up in a set, not a system. Summation only is an oversimplification. The original did not contain the decades of 1950, 2000, and 2010 either.

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THE MULTI-CRITERIA ASSESSMENT OF (CORPORATE) SOCIAL RESPONSIBILITY

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Abstract

Assessment of (corporate) social responsibility ((C)SR) requires a hierarchy / network of requisitely holistic factors and indicators. The paper discusses them from the viewpoints of the European Union's understanding of SR, the understanding of the current crisis as a social crisis, and the need to replace and complete them up by the ones of well-being and happiness. Special attention is given to the synthesis of the local alternatives' values into the (C)SR measures as the aggregate values. The paper introduces some possible solutions for considering synergic effects in the aggregate values; we delineate how to complete the additive model into the multiplicative one by considering synergic elements. By using the multi-criteria decision-making methods, we can assess the level of (C)SR – the aggregate value of (C)SR measure, benchmark the SR performance of enterprises, determine the key success and failure factors and benefit from good examples.

1. Introduction: The Critical Questions Addressed

Since the current so called financial crisis has its roots in the lack of requisitely holistic human values, culture, ethics and norms, and behavior (for details see [25, 26, 27]), greater emphasis should be given to monitoring and measuring (corporate) social responsibility (C)SR. Assessment of (C)SR requires a hierarchy /network of relevant requisitely holistic factors and indicators. The paper discusses them from the viewpoints of the European Union's (EU) understanding of SR [12, 13], the understanding of the current crisis as a social crisis [25, 26, 27], the need to replace and complete them up by the ones of well-being and happiness [10, 27] and the need to obtain the measures as the aggregate values.

Multi-criteria decision-making (MCDM) methods that have already turned out to be very applicable in business practice (for an overview see [9]) support requisite holism by applying systems theory in an informal style [9]. These decision analysis approaches are worth to develop because

- They enable a complex, integrated and logical framework that allows for interaction and interdependence among factors, structured hierarchically or like a network to deal with dependence and feedback, and
- They enable consideration of all dimensions of the so-called sustainable performance: economic, environmental, ethical and social dimensions (see [6, 21]); moreover,
- They enable the creation of requisitely holistic information, and

- They enable consideration of the contents of social responsibility: honest behavior of influential people and organizations toward their coworkers, other business partners, broader society, and natural environment, beyond official requirements on a voluntary basis (see [12, 13, 25]).

If the criteria can interact with each other, not only the weights on each criterion (i.e. the criterion on the lowest hierarchy level) but also weighing on subsets of criteria should be considered (see e.g. [24, 31]). Marichal [23] defines and describes three kinds of interaction among criteria that could exist in the decision-making problem: correlation, complementary, and preferential dependency[11]. When such complex interactions exist among criteria, several authors [23, 24, 31] recommend the use of a well-defined weighting function on a subset of criteria rather than single criterion during global evaluation. For example, fuzzy logic has some suitable tools to solve MCDM problems by aggregating criteria; since fuzzy integrals (e.g. Choquet integral) are able to model the interaction among criteria in a flexible way[12] [18], they have already been made use of as a tool for criteria aggregation [18, 23, 24, 31].

Dealing with interacting criteria is s kind of difficult issue [24]; an overview of the most preferred and commonly used leading decision-analysis literature (see e.g. [1, 2, 16, 34]) can let us report that decision-analysis theorists and practitioners tend to avoid the problem by constructing independent (or supposed to be so) criteria. We have already presented the frame procedure for multi-criteria decision-making by using the group of methods, based on assigning weights [9]. The described frame procedure can be adapted to the problem's particularities. In synthesis, the additive model is used where the reciprocal preferential independence of criteria is assumed [4, 34]. We have already demonstrated how the Dialectical Systems Theory's (DST's) guidelines defining the subjective starting points (values and emotions, knowledge on contents, and knowledge on methods, as a dialectical system) can be followed when approaching MCDM problems step-by-step, as well as the DST's guidelines concerning implementation of starting points [8]. However, the synthesis by the additive model may hide synergies (e.g. when assessing the (C)SR). To complete the frame procedure for multi-criteria decision making with interactions among criteria, we recommend the up-grade of the currently used methods by considering the synergic effects: besides establishing the criteria's importance in order to define the weights of the criteria, the importance of the group of criteria should be expressed in order to assess the importance of the synergic effects of the considered group; we delineate how to complete the additive model into the multiplicative one to consider synergic elements.

Finally, some alternative (non)traditional multi-criteria methods for preference programming that can be well used in the (C)SR assessment are introduced.

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[11] Positive correlation can be overcome by using a weight on a subset of criteria, and the sub-additive feature overcomes the overestimate during the criteria evaluation; when negative correlation occurs, the weight on a subset of criteria will be super-additive. In a complementary type of interaction, one criterion can replace the effect of multiple criteria – the importance of the criteria pair is close to the importance of having a single criterion. In preferential dependence, the decision maker's preference for selecting an alternative is given by a logical comparison [31].

[12] Grabisch and Labreuche [18] pointed out that an important feature of fuzzy integral is the ability of representing a range of interaction among criteria: form redundancy to synergy, which allows for considering both negative and positive interactions among different criteria.

2. Factors of (Corporate) Social Responsibility

The main factors of SR can be defined by following the EU understanding of it [12]; EU mentions officially four contents of SR (of enterprises): it is aimed to reach beyond charity to diminish or prevent power-holders' abuses/misuses of their co-workers, other business partners, broader society, and natural environment, beyond official requirements on a voluntary basis [13]. In the literature on business excellence one requires more – upgrading of its measures with SR[13] (for overview see [17]) [25].

In 2001, Margolis and Walsh [22] reported that SR was measured in 27 different data bases which cover 11 different performance fields: corporate programs, disclosures, political donations, donations for charity, investments in society, natural environment, human rights, human resources, products, competitiveness, and global fields. According to Drašček [11], the most frequently used criterion for measuring SR was environmental performance. According to Vila [33], the main fields of SR are as follows: Product quality and safety, Marketing practice, Education and stimulations for employees, Philanthropy, (Natural) Environmental performance, External relationships, Relationships with employees, Diminishing discrimination, and General and health security of employees. Each of these fields includes many elements – indicators.

Assessment of (C)SR requires a hierarchy / network of relevant factors and indicators to overcome the separate assessment by single (although several) attributes. The main fields of SR can be considered as the first level criteria, and indicators can be considered as attributes – criteria on the lowest hierarchy level. When structuring them into a hierarchy / network, the law of requisite holism should be considered. The understanding of social responsibility as a way leading out of the current socio-economic crisis [26] recommends us to replace some economic (material) factors and indicators by psychological, sociological, etc. ones and complete them up by the ones of well-being and happiness. According to Diener and Seligman [10], well-being can be measured by positive and negative feelings; unselfishness, reasonableness and importance; optimism and confidence, as well as happiness. Mulej et al. [27] recommend us to review the subjective well-being, which support the willingness for creative work and cooperation, which (can) lead to the increasing (objective) social and personal well-being.

Many organizations review and track their performance in the area of CSR, and provide the results to their managers and to broader society via web-pages; these reports include several factors and CSR performance indicators[14]. However, although the CSR is reviewed with respect to several, but single factors and indicators, the CSR measures as the aggregate values with respect to all considered criteria (factors) and sub-criteria (indicators) should be obtained[15].

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[13] For example, Sun [32] used the Global Reporting Initiative (GRI) guidelines in compiling their CSR report in the following fields: Economic performance, Environmental, Labor Practices & Decent Work, Human Rights, Society, and Product Responsibility. For the indicators that describe each field see [32].

[14] For example, Cisco Systems [3] focus on three main areas: Employees (workplace and diversity), Environment, and Social Impact,.for the indicators that describe each field; see [3].

[15] Drašček [11] investigated the SR indices, as well: the KLD (Kinder, Lydenberg, Domini) Index is based on the Likert scale (from -2 to +2) in "positive" fields (relationships with society, diversity on working place, relationships with employees, natural environment, and product quality and safety) and in negative fields (connection with nuclear industry and with army or defense industry). The cases of the SR Exchange indices are FTSE4U, calculated by Royal Exchange, and Dow Jones Sustainability Index (DJSI). Drašček [11] points the problem of their unclearness out.

3. How to Obtain the (Corporate) Social Responsibility Measure with Respect to Multiple Criteria

We have already developed and presented the frame procedure for multi-criteria decision-making (by using the group of methods, based on assigning weights) that complements intuition and helps us to master interdisciplinary cooperation on formal and informal principles [9]. We concluded that the problems should be approached step-by-step [9]: Problem definition, Elimination of unacceptable alternatives, Problem structuring, Measuring local alternatives' values, Criteria's weighing, Synthesis and Ranging, and Sensitivity analysis. It has been demonstrated that the above mentioned frame procedure supports decision-making on the bases of not only theoretical findings and empirical research, but also (and first of all) the requisite holism by interdisciplinary co-operation, hierarchy of complexity, creative thinking and openness; it follows intuition, theory and experience and it supports informal systemic thinking [9].

In the Multi Attribute Value (or Utility) Theory (MAVT or MAUT) and the methodologies that were developed on its bases (e.g. Simple Multi Attribute Rating Approach – SMART [20], the Analytic Hierarchy Process – AHP [29]), the additive model is usually used when obtaining the aggregate alternatives' values in synthesis as the sum of the products of weights by corresponding local alternatives' values:

$$v(A_i) = \sum_{j=1}^{m} w_j v_j (A_i)\text{, for each } i = 1, 2, \ldots, n, \qquad (1)$$

where $v(A_i)$ is the value of the i^{th} alternative, w_j is the weight of the j^{th} attribute and $v_j(A_i)$ is the local value of the i^{th} alternative with respect to the j^{th} attribute.

The use of the additive model (1) is not appropriate when there is an interaction among the attributes. In order to apply the model we need to assume that mutual preferential independence exists among the attributes (see e.g. [4, 16, 34]). The first attribute is preferentially independent of the second attribute if we prefer the alternative that is more suitable with respect to the first attribute, irrespective of the values of the second attribute[16]. If we also found that the second attribute is preferentially independent of the first attribute, then we could say that the two attributes are mutually preferential independent [16]. If mutual preferential independence does not exist, decision makers or evaluators usually return to the hierarchy (value tree) and redefine the attributes so that the attributes which are mutually preferential independent can be identified. In the occasional problems where this is not possible, other models are available which can handle the interactions among the attributes that express synergy. According to Goodwin and Wright [16], the most well known of these is the multiplicative model. Let us suppose that (C)SR is assessed with respect to two attributes only[17]; the value of the i^{th} alternative $v(A_i)$ (which can be the measure of the CSR performance) is

$$\mathrm{v(A_i) = w_1v_1(A_i) + w_2v_2(A_i) + w_{12}v_1(A_i)v_2(A_i)}\text{, for each } i = 1, 2, \ldots, n, \qquad (2)$$

[16] However, both alternatives have to have equal values with respect to the second attribute.

[17] This simplification is made to explain the bases of multiplicative models.

where w_1 is the weight of the first and w_2 is the weight of the second attribute, $v_1(A_i)$ is the local value of the i^{th} alternative with respect to the first and $v_2(A_i)$ is the local value of the i^{th} alternative with respect to the second attribute[18]. The last expression in the above sum (2), which involves multiplying the local alternatives' values and the weight of the synergy between the first and the second attribute w_{12}, represents the interaction between the first and the second attribute that expresses the synergy between these attributes.

The sum of the weights in (1) equals one, and so does it in (2), as well. In order to complete the additive model (1) into the multiplicative one (2), one has to determine the weight of the synergy between the first and the second attribute w_{12}, and then recalculate the weights of initial factors – attributes, obtained in (1), so that the sum of the weights of initial factors and the one of the synergy between them equals one in (2).

If the local values of alternatives with respect to each attribute are normalized (which is usual in using the computer supported multi-criteria decision making methods), (2) can be used when there is a (positive) synergic interaction between the attributes. However, there are also negative interactions between the attributes (e.g. redundancy interactions [24]). To consider both positive and negative interactions in (2), we recommend the following procedure. To simplify the assessment of the (C)SR, the above mentioned recalculation of the weights of initial factors – attributes, obtained in (1), is not needed. Let us assume that a synergic element is an "added value" to the aggregate value, obtained by an additive model (1). When there is a positive interaction between the attributes (i.e. synergy), the product of the local alternatives' values and the weight of the synergy between the first and the second attribute can be added to the sum (1). When there is a negative interaction between the attributes, the product of the local alternatives' values and the weight of the synergy between the first and the second attribute can be deducted from the sum (1). It should be pointed out that the last mentioned recommendation has not been theoretically proved yet. However, such simplification might allow decision makers to use the most preferred computer supported multi-criteria methods, based on the additive model, to obtain the (C)SR values, improved for positive and negative interactions between attributes.

In practice, the criteria's weighing is an exacting step of the frame procedure for multi-criteria decision making (by using the group of methods, based on assigning weights), although it is supported by several computer supported methods, based on ordinal (e.g. SMARTER), interval (e.g. SMART, SWING) [20] and ratio scale (e.g. AHP) [14, 29]. Professionals of several fields that are capable of interdisciplinary co-operation should be involved in this step. Their co-operation may lead from systematic to systemic approach, if making synergies, or better: add systemic to systematic viewpoints. Group priorities' establishing is well supported by the group-decision making upgrades of computer programs that have been most preferred for individual MCDM in the last – almost three - decades [7]. Because very often the decision makers are not aware of the relationships among different factors taken into account for the goal fulfillment, intuition comes into forefront when establishing the judgments on importance. Further, since decision makers are often inconsistent in criteria's weighing and in measuring the local alternatives' values (which means that the importance allocated to the considered criterion or the value allocated to the considered alternative is over- or undervalued), they are recommended to use the procedure for the improvement of the decision makers' consistency [5]. Studying the corrected intensity levels, they

[18] (2) is written by following an example in [16].

can improve their understanding of the relationships among the criteria, and of the criteria's meaning and importance as well.

Studying and comparing the additive model (1) and the multiplicative one (2) it can be concluded that the multiplicative model (2) does not require additional effort when measuring the local alternatives' values with respect to each attribute. The local alternatives' values, measured by making pair-wise comparisons or by using value functions [4], can be used in both models[19].

However, the judgments' expression about the importance of the synergies among factors requires additional efforts for decision makers to determine the appropriate weights. Since systematic procedures can not compensate for the lack of knowledge or limited abilities of decision makers, an important task is given to the requisitely holistic use of decision logic, heuristic principles, information and practical experience – the main characteristics of informal systems thinking.

4. Concluding Remarks

Some of the traditional multi-criteria methods based on assigning weights allow for consideration of both tangible and intangible factors. They allow for consideration of both general economic and "non-economic" (indirectly economic) factors and information (see [25]). Moreover, in the last years the methods for the approximate specification of preferences have been gaining favor in enterprises. Theoretical work has been done to extend methods, such as AHP, and value tree analysis; the decision maker thus can express her approximate preference statements through interval judgments [7]. Preference programming [30] also involves approaches like PAIRS (Preference Assessment by Imprecise Ratio Statements)[20], SPAIRS (Simple PAIRS)[21], PRIME (Preference Ratios in Multi-attribute Evaluation)[22] and RICH (Rank Inclusion in Criteria Hierarchies)[23]. Easy-to-use software has been developed to support the methods for the approximate specification of preferences [19]. They can be helpful in group decision making, too. They can be of special value when assessing corporate social responsibility.

Assessors of (Corporate) Social Responsibility have to select viewpoints to be considered – from many available – and networked, including relations in networks to be considered, and to develop, choose, and verify possible solutions in order to e.g. assess the level of (C)SR – the final value of (C)SR measure, to benchmark their performance – (C)SR, to determine the key success and failure factors and to benefit from good examples, including their synergies (in a best-case scenario). They can do so by several methods, among which we emphasize the multi-criteria decision-making ones

[19] In this step, professionals of several fields should be involved; namely, skills in their own professions as well as the ability of interdisciplinary co-operation are of great importance when making pair-wise comparisons or defining value functions.

[20] In PAIRS, the alternatives' characteristics are modeled through ranges of scores on the lowest twig-level attributes. It is assumed that the ratio statements are consistent with each other and consistency bounds are used to help the decision maker to avoid inconsistency [30].

[21] This approach describes interval versions of the SMART and SWING procedures [28, 30].

[22] In PRIME, the decision maker evaluates ratios of value differences. The weighting procedure explicitly uses the attribute ranges [30].

[23] In RICH, the decision maker is allowed to associate a set of rankings with a given set of attributes [30].

supported with appropriate computer programs [6, 7]. They can well support their requisite holism, i.e. diminish their danger of making oversights, as well as their danger of being overwhelmed by data and hence losing their focus and requisite holism.

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LOSS OF PUBLIC SPACE AS A REASON FOR LACK OF SOCIAL RESPONSIBILITY

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Abstract

In this article I would like to identify the situation which results from the disrespect to social values and principles. I consider the decrement of public space to be a reason for the ignorance towards social responsibility. In the final version of my paper I will show the public space in wider context and will also demonstrate its more detailed relations to social responsibility. Possible solutions will be suggested more explicitly.

How I understand the concept of public space can be seen from the considerations of H. Arendt.

1. Public space

In The Human Condition Hannah Arendt conceives of the public realm as a space produced by particular forms of citizen interaction. Where citizens are willing to engage in the risk and unpredictability of mutual self-disclosure, they benefit from the self-discovery that comes through interaction with previously unknown others, and solidify the bonds between citizens that produce and sustain a space for this public form of interaction.

"Public space" is the space where individuals see and are seen by others as they engage in public affairs. It is, thus, the space of the town hall meeting, the legislative assembly or any of the other venues where public business is done. People become public through speech and labour in the creative sense of the word.

2. Social responsibility

Social responsibility is considered to mean actions and decisions that enhance the benefits of society. It is also often related to ethics. It can mean either refraining from an action or responsibility to act. Businesses are getting more and more control over the resources and finance and influence the life of many people tremendously. Even the state authorities are very often dominated by private entities and their interests. That is why the social responsibility of businesses is very important.

However there are opinions that businesses and their owner shouldn't be involved in the social actions as they shouldn't bear the costs for the whole society. The liberals say there is nothing as common social interests or benefits. If anything like that appears it is an instrument hiding the private interests of anybody. The other option is that it is a sign of an effort to regulate the society based on rational plan which may try to help people but cannot know their real interests. That’s why the liberals are against any kind of intervention into the free market relations.

Unfortunately the liberalistic concept leads into the dissolution of the society into private interests which don’t respect anything common and don’t see anything the people can have in common and could share. The ideas of altruism, solidarity, respect to others slowly disappear. This type of logic supports the concept of homo economicus. The reasons for that can be found in the loss of the public space.

Both the result and reason of the social respect disregard (as the relations are mutual) is the loss of the public space. People lose the sense for communities and common interests.

3. Public space endangered

Drawing on the Aristotelian distinction of the oikos (the private realm of the household) from the polis (the public realm of the political community), Arendt argues that matters of labour, economy and the like properly belong to the former, not the latter. The emergence of necessary labour, the private concerns of the oikos, into the public sphere (what Arendt calls 'the rise of the social') has for her the effect of destroying the properly political by subordinating the public realm of human freedom to the concerns of mere animal necessity. The prioritization of the economic which has attended the rise of capitalism has for Arendt all but eclipsed the possibilities of meaningful political agency and the pursuit of higher ends which should be the proper concern of public life.

The Greek household was the sphere of labour, exchange and the family. Greek men were allowed to enter the public world of the polis only if they had the status of the head of a household. The polis was the sphere of discussion, but also of collective action, which took the form of war or competitive sports.

H. Arendt says that market transactions and hunt for living belong to private life and its affairs. The public or political life consists in something else, in discussions, pursuing higher ends, respect, honour etc. If humans concentrate on immediate perceptions only and ways how to satisfy them they are losing their human nature and become closer to animals.

I’d like to say that if personalization and openness are taken in the commercial sense of the world then the public space is in danger.

4. The Fall of the Public Man

R. Sennet says in his book Verfall und Ende des öffentlichen Lebens that private life like being a father or mother or to be a friend used to be natural capacities whereas to deal with foreigners in a satisfying way and keeping distance from them used to be results of human and societal activities and ways how to make a social being out of human-animal. The economical situation in the 19th century with its pressure on individual ownership and shocks caused big uncertainty regarding ownership and economical stability which caused fear and people were trying to find some asylum in the family and drew back from public life. Another aspect was mass production which unified the social levels and allowed people to hide their identity from the public sphere. And the material goods became mysteries endowed with human features and people were not satisfied till they got the goods to learn its mystery – an important role played advertising showing how personal satisfaction is connected to material things. People were more oriented on goods than on relations with others and believed goods are endowed with psychological qualities.

But capitalism was not the only reason for the social change. The secularity of the 19th century which was based on the evolving subjectivism put into the centre of human affairs the immanence. The immediate perception, the feeling, the fact was the feature of reality. Everything was important and could lead to explication of the present fact. (The biggest expansion for this principle came with S. Freud and his emphasis on unconsciousness ideas.)

Personalization and openness are results of this decay of public sphere. The result of the process is that consumers don't want to convey any information about them because they consider everything to be their private issues. Companies want to know everything about their consumers and don't respect any limits.

Personalization means also renunciation. Customers want to satisfy their needs and don't take into consideration any public aspects and respect for others. The world diminishes into the limited small area of the subject and his needs. The companies on the other hand want to know as much as possible about their customers and try to collect all possible information. They also follow the idea of immanence that everything is potentially important and may lead to deeper explanation. They are interested in the consumer because they want to know his deep thoughts to enforce him to buy its products. It can be seen on the schizophrenic attitude one person is in as customer and as employee. As employee he has only very small rights and has to fulfill all the wishes of the customer. As customer he wants to be satisfied and no shows no respect.

And customers are afraid of their privacy which is threatened on the market and companies want to exploit it. Customers are through the goods fetishism attracted by the companies through the idea that they would be able to satisfy their private aspirations on the market and through consumption. This is only an illusion however. The market is quite severe and cruel and people are disappointed in their expectations. The bought goods don't grant the satisfaction they were promised to grant. That is one of the important reasons why people close in their families and forgo the public life.

Another trend resulting from the disrespect to societal values and loss of the public space combined with the modern technologies is the attention economy. It shows where the individualism may lead. There is no social responsibility in the attention society, only attempts to gain attention which provides means for existence.

5. Attention economy

M. Goldhaber suggests an idea of attention economy where openness and effort to draw other's attention would be the most important and most desired factor of life. He sees already in today's society some indications of this future development. E.g. the movie stars are can attract the most of attention and that gives them the possibility to have almost everything. The money paid for advertisement and PR promotion on the competitive market are significant, too. The company which will be most deeply rooted in the conscientiousness of people will have the biggest profit. And as profit is the only aim at which companies nowdays aim the correctness of their message is inferior. The internet and its expansion help this transition, too. It is very easy to publish any kind of material on the web page, so not information, but attention is scarce. I think the difference between money lies only in the fact that money are immaterial and don't have any meaning themselves whereas attention is more concrete and bound to the person. Originally money was also a concrete thing like gold or diamonds which could have been exchanged for anything. Money had some value in itself. The question is how can this move affect the relationships like friendship and love and it can affect the public life.

It is interesting how both the public and the private life have changed in the last century. People struggle for authenticity and self-realization which means their subject is at the centre of their life. This is true since R. Descartes published his works and subject pushes through more and more powerfully.

Without respect to public space the social responsibility cannot be reconstructed.

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INFORMAL SYSTEMS THINKING: SUSTAINABLE DEVELOPMENT AND SOCIAL RESPONSIBILITY

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Abstract

The crisis of 2008 results from one-sided rather than requisitely holistic behavior of the influential peoples. For humankind to survive, values, culture, ethics and norms must be innovated, not technology only. Sustainable development and social responsibility concepts might help. Information about them and about alternatives – riots, strikes, known must be provided for people to find sustainable development and social responsibility more efficient and cheaper than the alternatives.

1. Introduction

Humankind is facing a very serious global crisis in 2008 and later. The most innovative parts of the world became the richest over the recent century, but the crisis surfaced in their areas first; thus, many of their invention-innovation-diffusion processes yield fictitious rather than real innovation. Other areas/nations depend on USA etc. as global masters too much to be saved of crisis. Messages from press on the world-wide political and other conferences and schools of economics say that the most influential persons and organizations of the world keep trying to solve the problem with means that have caused the problem to surface [17], [3]. We belong to others who deem a new solution needed – sustainable future and socially responsible enterprise based on creativity, ethics of interdependence, creative cooperation, shorter work-week, and green investment.

2. Requisite holism by Sustainable development/Future and Social Responsibility

Members of modern enterprises are facing a basic question: How should they define their new development and future business? Some possible answers are: Sustainable development (SD) principle ([15], [17] etc.) and social Responsibility (SR) principle ([6], [4], [5] etc). Enterprises exist and develop best, if their behavior is requisitely holistic attaining requisite wholeness of their actions. However, in both theory and practice, we detected no holistic model of business that provides a requisite wholeness in a harmonized and goal-oriented development. SR and SD in synergy may be a new way out from the crisis.

3. Sustainable Development

The SD concept offers a possible solution, at least, to achieve a sustainable orientation of human activities ([17], [13], [16] etc.). And what is sustainable enterprise (SE)? On the basis of theoretical cognitions and our own experiences in business practice, one can define SE, in the most general sense, as an enterprise attaining a synergetic whole of economic, ecological, social, and ethical dimensions (e.g. goals) of its business.

Table 1 shows the basic aspects and resulting criteria of what are SEs, and possible means of implementing market and social requirements as imperatives in and beyond law about the modern environment (See: [24], [20], [15], [1], [22], [2], [7], [23], [17], [8], [16] etc.).

Humans namely live on four basic levels to be considered in SD, therefore by sustainable values, culture, ethics, and norms (VCEN): Individual; Enterprise (e.g. corporate); Closer environment (e.g. natural, social, and ethical); and broader (i.e. global) environmental levels. On all four of them four the main criteria make the dialectical system to be considered as in Table 1.

Aspect	**General Criteria**
Economic imperative	Competitiveness
Ecological imperative	Habitability
Social imperative	Community
Ethical imperative	Legitimacy
All aspects	Combined criteria

Table 1: Sustainable enterprise's basic aspects and main criteria of its quality level

These needs require sustainable enterprises to conceive, formulate, and use requisitely holistic criteria, and to evaluate their business critically with them. Table 2 summarizes some basic criteria for evaluation of SEs' business from some critical viewpoints.

Criteria ____________ Aspects	Individual Performance Criterion	Corporate Performance Criterion	Societal Performance Criterion	Global Performance Criterion
Economic Imperative	Individual prosperity	Corporate profitability	Societal wealth	Global wealth
Ecological Imperative	Individual eco-efficiency	Corporate eco-efficiency	Societal eco-efficiency	Global eco-efficiency
Social Imperative	Individual quality of life	Corporate reputation	Societal quality Of life	Global quality of life
Ethical Imperative	Individual VCEN	Corporate VCEN	Societal VCEN	Humankind VCEN
All aspects in synergy	Individual sustainable life index	Corporate sustainable behavior index	Societal susta-inable develop-ment index	Global sustainable development index

Table 2: Basic criteria for evaluation of sustainable enterprise – a suggestion

Hence, a SE attains the highest level of requisite holism and destroys the human condition for survival the least of all enterprises. A SE does not only command with the most modern and comprehensive knowledge, but uses VCEN such as sustainable VCEN resulting from SD principles. This leads to sustainable future (Ećimović et al, 2007).

4. Social Responsibility

SD is mostly understood as a relation to natural environment, which is not enough. SR includes SD and adds the VCEN - interest of enterprises to do more than the law requires officially because it helps them out-compete the others by more requisite holism of their approach and wholeness of their outcomes [6].

SR can and must reach far beyond charity toward the end of abuse of power/influence of the influential persons/organizations in their relations with their co-workers, other business and personal partners, broader society, and natural environment as the unavoidable and terribly endangered precondition of human survival, at least in terms of the current civilization. SR supports innovation also by upgrading criteria of business excellence, by supporting requisitely holistic behavior [10], [11].

SR may help humans innovate society by including social efficiency, social justice and similar VCEN that, among other references, lie at the core of all social teaching called religions, philosophy of moral and ethical behavior, etc. ([4], [5] etc). One must pay attention to no allow power-holders to abuse these teachings.

Technology supports rather than creates future and development into it, and can be used with SR or abused/misused with detrimental consequences. The choice depends on the most influential people and their definition of their self-interest as a background of the new economy - of affluence of 15% and poverty of 85% of humankind [12] - and humankind's future. Innovation of VCEN is unavoidable for the current civilization to survive. So far, the neo-liberal school of economics of Friedman and others in Chicago school of economics has been based on the VCEN replacing both the state-run centralism and Adam Smith's liberalism – by calling something that has not been free, but oligopolized or even monopolized by multinationals – the free market. They were wrong because the transparency of business, limitation to local markets/businesses, and clear ownership of businesses with no divorce of duties and rights by shareholding and limited liability companies used to be presupposed by Adam Smith [21]. This transparency and limitation no longer exists. Thus, the current VCEN and resulting circumstances are no free market, but renewing the pre-capitalist times against which the free market had been established [8]. One may speak of the 'feudal capitalism', which has become detrimental for humankind, including the rich ones, e.g.:

- The natural preconditions of humankind's survival are destroyed for all.
- The poorer people's dissatisfaction results in riots all way from strikes to international terrorism.

These and other similar consequences of one-sidedness of the greedy ones may cost much more than a requisitely holistic practice of SR by individuals, organizations, and governments.

5. Four or Five Economic-development Phases of Humankind?

There is an interesting view of economic development phases that stresses the notions that are summarized in keynote contribution (see [11]; see also [14]). Porter sees four phases: (1) the factors phase of competitiveness means that a nation or region lives on natural resources and cheap labor, providing for a rather poor life for millennia; (2) the investment phase means that a nation or region lives on foreign investment into its economic development and can hardly compete; (3) the innovation phase means that a nation or region lives on its own progress and attains a better and better standard of living; (4) the affluence phase means that people have finally become rich, which makes them happy, but also lose ambition.

Thus, the phase 4 is not the highest development phase only, but also the phase of growing problems of employment, supporting everybody etc. The crisis of 2008- seems to reflect it, although 85% of humankind lived on less than six USD a day even before it [12]. Conclusion: one must attain and keep capacity of a requisitely holistic approach in order to enter the innovation phase quickly and remain in it as long as possible, or may return to it from phase 4, probably via phases 1 and 2, like history has already shown. A fifth phase might be the necessary innovation [18]. Marketing speaks in some versions in the same direction, but not requisitely holistically [19], other disciplines of economic and business sciences do even less so; hence, information is poorly provided for impact over people to be attained [9].

6. SD, SR and Information

Information must be provided to help politicians, business persons, and everybody else understand, accept and practice innovation of VCEN as a precondition for the 5th phase rather than a long-term crisis.

Its basis might lie in the question: what is easier to handle and cheaper: SR, including SD; or riots, strikes etc. all way to international terrorism (which is reaction to behavior with no/poor SD and holism of the most influential people and peoples of the world).

7. Some Conclusions

The crisis of 2008- can be viewed as a visible end of the 2-generation cycle marked with the neo-liberal rather than real liberal VCEN and resulting economy and society taking one-sidedness to its extreme rather than promoting VCEN of interdependence of specialists – both as humans and as professionals. Application of the law of requisite holism in the form of sustainable future and SR under leadership of SR/SD enterprises may pave the current civilization of humans' way to the 5th phase rather than to destruction. Effects of the measures visible in early 2009 denote that using means that have caused the current crisis – unnecessary consumption that 85% of humankind cannot afford anyway, while the others do not join it as rational beings – does not work. Synergy of creativity, social responsibility, VCEN of interdependence and requisite holism in a shorter working time and in a creativity-based leisure time may be a better solution. Natural resources, investment and innovation remain necessary, but neither self-sufficient nor helping power-holders only. Investment and innovation should be aimed at sustainable future based on SR/SD. They can shorten the working week and life, and make room for creativity of all kinds in the working and leisure time.

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KNOWING AND (IN PLACE OF) INFORMATION (INFORMAL SYSTEMS THINKING, PARADIGM SHIFT AND REALITY)

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Abstract

Nature of the global world changes in an unprecedented way which cannot be understood by means of traditional familiarity. And human doing produce greater or lesser problems of their sources are often obscure while are impeached or minimized formerly. Despite of an awareness of impended hazard strengthens and activates reflections on our responsibility. This paper points out the nature and problem of our human (athropic/social created) knowledge that does not allow for reality practically. Our dealing with information supported by information and communication appropriate troubles multiply henceforth. Our actual (responsible) doing depend result from a meaning (of information) emerging from (spontaneous) fruition of individual knowledge. The circumstances are corroborated through contemporary economical crisis and emerging distinction between virtual (financial) ad real economy (of everyday life).

Where is the Life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?
Thomas Stearns Eliot

1. Introduction

Musing on systems thinking we lay emphasis rather on some aspects of systems paradigm than thinking itself. However it plays an essential role – let us reminder constructivism which is prevailing stream of thought in systems community. For example Klir [14] notes expressively:

... systems do not exist in the real world independent on the human mind. They are created by the acts of making distinctions in the real world or, possibly, in the world of ideas. Every act must be made of some agent, and, of course, the agent is in this case the human mind, with its perceptual and mental capabilities.

... some abstraction distinguished on the objects that reflect the way in which the objects are interacted with.

However many authors (from these cited in this paper Hayek [13] and Boulding [6]) point out the problems resulting from such distinctions. They caution against a simplification and ignorance of spontaneous order similarly as basic trends of recent systems science. This one emphasizes self-organization, recursion… and also human thinking and it patterns. We can recall misjudged aspects of modeling intruded into Simon's question [29] *"How can a simulation ever tell us anything that we do not already know"*?. However we can also remember an account that Senge [26] ascribes to mental models or concept of archetypes in systems dynamics [18]. Nevertheless advanced cybernetics constitutes a grand benefit in this area: It points on the nature of human *knowing* [16] which bears on our thinking a doing. In this we should give much greater consideration to such concepts as *knowledge, information, information processes*. The (dramatically enhanced) influence of (digital) information technology (and internet namely) is connected with an increasing virtuality of our doing and/or emergence of a cyberspace. Gibbson (who firstly used this concept in sci-fi novel Neuromancer) describes it appositely [9]:

Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity…

Perhaps such opinion seems to be exorbitant and it is undoubtedly a fancy hyperbole but the complexity of an actual global world embodies similar aspects.

2. Warning reality

Just "dissipation of reality" resulting from our (mental) and pragmatically (rationally) constituted models in framework of shared culture [5] and/or social reality [29]. To agree with the sentence presented by Maturana and Varela [16] "All knowing is doing and all doing is knowing" we can also see a necessitates of our re-thinking of our knowing and cohering responsibility for our doing. Earnestness of these results from two reasons being typical for (problems of) global world:

- Forever increasing consumption of energy that makes possible unprecedented changes of (material) reality. Many traditionally presented (but newly considered) ecological problems including changing environment.
- Escalating amount of communicated knowledge/information that produces new aspects of society. Its complexity changes and/or advances:
    - On the one side an amount of fluctuations is growing due to individual interpretation of crescent quantity of shared data… (see later);
    - On the second side we increasingly depend upon jointly (more or less apparently) constituted and used knowledge (Giddesn [10] talk about "shared expertise") that are often opposite and sometime also risky [3].

This knowledge (expertise) bears on various patterns of culturally formed cognition and/or shared social reality mentioned above [3]. This (feeling of) reality emerges from social interaction of its (most?) notable form is communication (of information). Some authors such reality title „intersubjectivity" that must not be commuted for "objectivity" in the sense reality being consequent on spontaneous processes. Just these differences play considerable problems of our contemporary life including socio-economical changes and problems.

We face the world economic crisis comparable with great depression of 1930's which resulted in the Second World War. Let's hope in better future this time, however optimistic forecasts presented namely from economics quarters are based rather on sporadic indicators and idle wishes than serious analyses. Moreover an impact on future seems to be evident and to consist not only of an immense indebtedness, but also to require important significant social changes. Some dramatically advert fall of capitalism (without saying what capitalism is) while others talk about cathartic bath…

Reportedly over hundred thousands of employees lost their jobs during September 2008 when the crisis has surfaced fully (or better outwardly) in Wall Street. Many of them graduated from prestigious university; they generated sophisticated models and/or played with them and used top information technology. Many questions emerge: Where was the mistake hidden? Who is responsible? And which solutions will be appropriate? The answers are not simple, since various views and opinions exist. The most widespread of them blames the bankers (or managers in general). Others stress a role of media and strange distribution of (distress) information. Also decision of Clinton's administration which made easy an acquisition of own house (via mortgage) for poorer people is often mentioned. Roots of contemporary crisis are also (often) connected with fault of a reliance on financial deposit and/or bank (capital) institutions. Although all these explanations are something to it systemic approach refers to more complex problems and different concepts of economy on principle. Let us remind three distinguisher economists being considerable persons of their thought agrees with systems theory: Fridrich August von Hayek [13, 14] Herbert Simon [28] and Kenneth Boulding[24] [6]. All point out a spontaneous (ecological) of economic system someway and also a consideration of information, knowledge and/or (human) thinking. Unfortunately commonly used models are simplified (reduced), quantitatively based and too abstract – i.e. far from changing reality of information society and/or global world.

The roots of contemporary economics crisis lies in financial area but it outgrew into daily life. Some authorities refer to two economics and denote the first "virtual economy" and the second "real economy". Although both are closely coupled, real economy embodying everyday (and personal) life has an essential meaning. To promote this effect we should notice Bouding's idea [6] "*There is no such thing as economics, only social science applied to economic problems."*

However, such common separate accounting does not cover the whole or global situation and/or problem; for this we must apply systems thinking in the *informal* way. Using this term I would like emphasize its emergence from awareness of complexity and reflecting inherent (and reduced) nature of human cognition. Appropriate systemic approach gives us understanding of pivotal problem – scilicet distinction between real systems and their models (results of our cognition). Virtual economy is based on just abstract models – being consequent on symbolic merits of money. This quite differs from real economy of everyday life. Such systemic thinking naturally covers mental models that tackle the distinction: "…*between things determining what we use for an explanation, and our satisfaction with the mental model we use to determine our satisfaction with the explanation we build on it"* [1].

This knowledge (expertise) bears on various patterns of culturally formed cognition and/or shared social reality mentioned above [4]. This (feeling) reality emerges from social interaction of its (most?) notable form is communication (of information). Some authors such reality title „inter-subjectivity" that must not be commuted for "objectivity" in the sense reality being consequent on spontaneous processes. Just these differences play considerable problems of our contemporary life including socio-economical changes and problems.

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24 Let us briefly remember a few facts: Hayek and Simon were Nobel laureates in economy and Boulding was (only) noinated at different times. While Simon and Boulding are prominent exponents of systems science the fact that Hayek participated in cybernetic (Macys) conference. Finally can be applicable to point out personality of K. Boulding – he was (first) president of more scientific societies: General Systems Research (today ISSS), American Economic Association, American Association for the Advancement of Science and others…

3. Systemic point of view

Using the *system* or *systems approach* many practitioners avoid the real complexity and/or spontaneous order of complex systems. System's complexity results in unpredictability and uncontrollability and/or poor chance to control it. Perhaps we should have it in mind when we talk about *management* (incl. information/knowledge management) – this process is quite different from *control*.

Just systems accept complexity distinguishing *systematic* and systemic thinking as well as the concept of system itself. We should strongly differentiate two concepts of systems: While the first is real system (*system per se*) the second concept of systems is model resulting from our cognition that depends on our worldview (paradigm). In this sense system *is defined* in International Encyclopedia of Systems and Cybernetics [8] as *...man-created general conceptual model for coherent, complex and more or less indentificable and permanently observed real world entity.*

The systemic thinking transcends the common worldview (and related insight) as a result of *everyday* experiences and commonplace education. It corresponds to concepts of folk *philosophy* or *naive realism*. From our point of view we can define the first expression as the common-sense conceptual framework that we, as human beings, employ to understand, predict, and explain the outer (objective) world. The second term is defined as follows [19]: *Naive realism holds that the view of the world that we derive from our senses is to be taken at face value: there are objects out there in the world, and those objects have the properties that they appear to us to have.* We can refer to more and different concepts of similar frameworks of thinking, for example Mingers [19] alludes (in similar sense) to empiricism and conventionalism and adverts to *critical realism*. We should mention logical positivism or rationalism which results from 'scientific approaches'. It impresses traditional (first order) cybernetics and it resides in the background of computer information processing.

However, emergence of science pointed out the incorrect nature of human cognition. We can remember the human (observer) which daily perceives motion of the sun on the sky [24]. From his repetitive experiences he deduces (during process of abstraction) conclusions that the sub (Sun) circles round the ground (Earth). Although such notion is faulty, it was justified through communication with other people having similar knowledge. Science is representing process that forms 'veritable' human knowledge as scientific theories that are used as deductive background of thinking.

Let's leave aside the problem of conservative science (paradigm) that fails when facing complexity and let's point out the right/correct (consistent) theory that should satisfy following requirements:

- System of fairly defined concepts (categories) in mutual relations;
- Axiomatic foundation (postulates) on which the theory rests;
- A set of implicit or explicit formations or transformations;
- Theorems as sets of proposition which enable us to conclude on outcomes (results);
- A set of applications that causes implications of theory.

The old school concept of scientific theory connects it with algorithmic nature and/or with deterministic laws; systems theory can 'only' form basic principles that constitute (and maintain) changeable real word. Together with advanced (2nd order) cybernetics emphasizes human (observer) and his knowing (rather than completed knowledge). It also gives the path to understanding (explanations) before routine performance resulting from inadequate knowledge. Theory in this sense represents consistent a knowingly constituted meta-knowledge and/or background of our everyday thinking and doing. Moreover such theory reflects or refers to general world-view as well as a cognitive force of natural language. Let us yet to replenish abstract nature of used models as well as of symbols (words of natural language primarily) used in speech acts (utterance) that immediately bears on (interpretation of) information.

4. Systemic thinking and its difficulties

The actual and consistent systemic thinking considerably differs from conventional (usual) thoughts – much more than the logical positivism mentioned above. Normal thinking is narrowly tied to (natural) language and meaning of lingual message deeply rooted in (1) our everyday experience, as well as in (2) culture which forms and justifies common framework of our behavior. However, culture – as a system of mutually constructed senses and values – emerges from mutual communication… in order to affect individual understanding backwardly. The cognitive function of the (natural) language remains strange or underrated, usually. In a sketched way language (with symbols) makes an inherent interface between human knowing and doing on the one hand and the real – or better: reflected – world on the other hand. Similar interface is absent in the case of formalized language namely in use of calculus that is based on (totally) abstract symbols and set of rules that determine a manipulation with them. However, calculus is an essence of computer information processing.

It immediately results from two basic aspects of human cognition which is (i) intentional and (ii) abstract. Distinguished entities are defined through a set of attributes being ascribed to all elements of the same type (pattern) and are coupled with the name (noun) of entity. However the set of appropriate properties characterizes (symbolizes) quality and/or nature of entity which remains equal. These matters (of fact) are incompatible with systemic thinking which explains and accentuates aspects such as (i) dynamic nature of the world, (2) distinction between signs (names) and designated entities etc. Ossimitz [22] indicates these affairs similarly when he characterizes basic features of systems thinking: (1) *thinking in models,* (2) *interrelated thinking,* (3) *dynamic thinking,* and (4*) steering systems*.

common thinking	systemic thinking
entity	system
static	dynamic
relationships	interaction
(use in) environment	(interaction in) meta-system
linear causality	circular causality
input(s) / output	interaction in environment
stability	dynamics equilibrium
states	patterns
(use in) environs (environment)	(interaction in) meta-system
type of entities (patterns)	structures (fluctuations)
type of entities (patterns)	structures (fluctuations)
no distinction between reality and model	distinction between reality and model

Table 1 Comparison of common and systemic thinking

Nevertheless, the indicated aspects of systems thinking are interpreted in the common sense of used words, for example (or typically)

- time is understood in Newtonian sense, while (possible) changes and circularity play an important role (systems behavior depends not only on actual input but also on previous evolutions);
- dynamic equilibrium of real system is pattern while actual structure fluctuates around it;

To remind you of problems of systemic thinking we can present a set of concepts (principles) forming framework of systemic thinking and compare them with common-sense (see above).

In this sense systemic thinking represents actual paradigm shift and difficulties related to it apposite result from the nature of human knowing, which explains the advanced cybernetics. Gregory Bateson [2] comments it suitably when he characterizes cybernetics as

Biggest bite out of the fruit of the Tree of Knowledge … But most of such bites out of the apple have proven to be rather indigestible - usually for cybernetic reasons.

In other words: our familiar thinking – more or less approach naive realism – stems from empirical principles and does not impeach generalization and abstraction that is its natural ingredient. Constituted theories are deprecated (as too abstract) from this point of view and remain often inadequately understood or misinterpreted. Particularly premises of their relevance are unknown obscure or ignored. Just frequent references to Shannon's theory of information can be used as an expressive example. The name of famous book [27] is "*A mathematical theory of Communication*" and Shannon in the second paragraph of his article[25] enunciates: "*Frequently the messages have meaning… These semantic aspects of communication are irrelevant to the engineering problems*". Systems science and cybernetics are truly abstract, however both (namely 2nd order cybernetics) refer to the abstraction and explains its nature (difference from reality) as well as its benefits and dangerous [24, 30]. The calculus (incl. mathematic and formal logic) is specific case and problems of appropriate (mathematical) models do not lie in their (created) consistency but in correct (real) interpretations of their meaning. Nevertheless their use - supported unprecedented possibilities of computers and advanced software – influence our doing. Boulding [6] which alleges "*We make our tools, and then they shape"* is right and we should give higher consideration to our knowledge as well as meaning of information which is derived from them.

5. Meaningful information

Systemic point of view also provides new notion of information being consistent with unified theory of information. We shall distinguish two kind of information – physical and semantic. The first consist in diversity of the material world, while the other is presented via signs and symbols the meaning of which is interpreted by individuals (people, receivers, user, observes).

Namely, Stonier famed the concept of physical information [31], but his view remains stationary. Dynamic conception of our understanding is explained by Bateson [2] who defines *information* as "*a difference that makes a difference*. This sentence can be explained in other words: Information is a way of interaction between a form (variety) of physical entities (systems) which affects changes of interacting system:

[25] Mentioned book cover two items – along indicated Shannon's article also the second in which Weaver criticizes concepts of information that ignores meaning.

- Physical activity (i.e. observable);
- Mental activity including thinking as re-creation of implicit knowledge; and
- Making of new information presented through symbolic structure (differences).

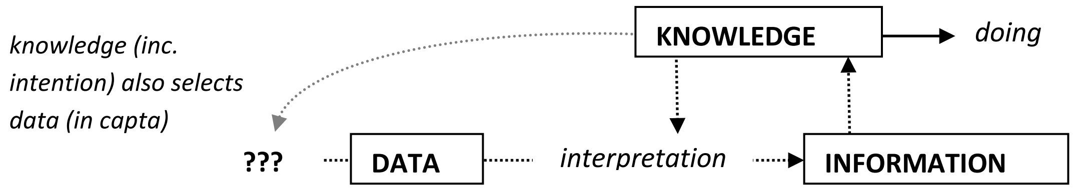

Figure 1 Circle explaining real relations among data, information and knowledge

Meaning of information is derived from the form (diversity) of (abstract) symbols – in other words from input data, or better, data structures (words are put together). Such data are input-stimulus for nervous system; its response (interpretation) depends on previous evolution and has the nature of knowing (e.g. implicit knowledge). However the meaningful information also changes structures of nervous systems and/or re-creates knowledge. The appropriate dynamic concept makes commonly and hourly related good for real circular process which comports with concept of hermeneutic circle (inc. pre-understanding).

6. Meaning (and responsibility) result from knowledge

Probably the nature of interpretation – process which attributes meaning to the data and conception of meaningful information which changes original knowledge – is a heart of the change paradigm and also of the informal systemic thinking. Nevertheless, this conception changes considerably our understanding of computer information-processing, which produces 'only' data interpreted by individual people. Their implicit knowledge (or rather knowing) – plays a crucial role. Probably three misty understood and often equated phenomena from the Figure 1 deserve a brief outline herein.

Let us firstly adduce a nature of data that are empirically distinguishable entities having physical substantiality. Their form determined through set of rules (syntax) diversifies them (from my point of view at least) from similar concept of signals (that have general character). In contrast to information they have not meaning; it is ascribed in cognitive process of particular receiver (user?) in which his knowledge play grand role.

The concept of knowledge is customarily understood as a static thing (typically explained as declarative and/or procedural) that is moreover truthfulness. However systemic paradigm refers to dynamic nature of the universe including (implicit) knowledge or knowing emerging from individual's interaction within an environment. In this sense also Nonaka and Takeuchi [21] enunciate: *We consider knowledge as a dynamic human process of justifying personal belief toward the "truth".* Such knowledge is applied in actual (unique) moment and context.

To accept it we should respect two important natures of (actually applied) knowledge: (1) It has an intentional nature and (2) it is individual. Let us firstly sketch the concept of the intentionality that bears on human naturalness to define (discriminate and denominate) entities as (distinguished) patterns. Due to known attributes we adopt posture and do intentionally (pragmatically). Individual nature of knowledge emerges from subjective interaction within an environment incl. communication (of information) in social environment. The first process is described as learning (from individual experiences) while the second practice is representing teaching that presents pooling of socially created (and static) knowledge. Teaching transcends conventional concept of education but covers also other form mediated information dramatically affected by "information and communication technology" that change actual information processes. ICT deal with data or manipulate with symbols in fact. Actual doing depends on a personal knowledge (or meaning of individually interpreted) information, though it is influenced socially through process of communication.

To accept presented matters (of fact) we can better understood some aspects of global reality and its changing complexity (mentioned above) in which information and knowledge play an important role. The limitations of our knowledge seems to be evident and should make for our responsibility. However different knowledge frameworks – being inherited from a vision of welfare – are firmed up pragmatically and ignore (any) definitions as well as the pertinent accountability. Conformable knowledge removes us from reality of real complex and spontaneous processes but understanding them may explain meaningful risks and practically accept the requisite (human) responsibility.

7. Economy, information and knowledge

Now we can try to illustrate problem of amended (social-economic) complexity, difference of virtual and real economics in point of knowledge information and advanced way of their sharing through ICT. The consideration of information in economics seems to be well known but its meaning and/or connecting with knowledge (of receiver) stands aloof usually (if we pass over general confabulation related to "knowledge economy"). Let us therefore remind estimation of distinguished economists mentioned above.

The ideas of F. A. Hayek bearing on (information and) knowledge are noted enough; especially his famous article from 1945[13]. However some ideas of knowledge - impossibility of total knowledge and/or knowledge diffused in society - refer to its meaning in market economy. To accept them we can muse on changing character of market in contemporary information society, i.e. society unprecedentedly sharing information through ICT. Quarter of century later but long before an emergence of internet give notice to changing situation Herbert Simon [28]:

"...in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it".

Corresponding thought appears to be relevant, however is far from economic mainstreams as well for technologically oriented professionals from ICT (is free filed interesting for system scientists?). Moreover quantitative approaches (and models) connected information with money and capital without an appreciation their substantiality. Actually the money are (only) general symbol of worth (value) and as such they bear information (indicate benefit of economic subject in market place) of its meaning depend on knowledge (of receiver, that has not *total knowledge*). Kennet Boulding supports similar idea by his quote [6]:

What the economist calls "capital" is nothing more than human knowledge imposed on the material world. Knowledge and the growth of knowledge, therefore, is the essential key to economic development. Investment, financial systems and economic organizations and institutions are in a sense only the machinery by which a knowledge process is created and expressed."

Phenomenal economic grow (of industrial era) is derived performance of such institutions and their financial activities. These are based on abstract character of money which can be used more times as though tanks to knowledge and trust (incl. risk) that are coupled with them. They are originally derived from practical activities of economic subjects (individuals, companies…) and their activities the one side and enable to put into practice other activities (only some of them are materialized). Multiple used of such finances adverts to two forms of money – cash (in wider sense of word) and virtual[26] of their value and operation is based only on inter-subjective knowledge.

Reference of money to reality was guaranteed through golden standards until recently and banks from time to time materialized through a movement of goldbricks. The financial transactions are today put into life through transfer of (digitally coded) symbols. While gold (goldbrick) is also only symbol it has materialized nature and is also marketable commodity. Moreover banks and other financial institution that create advantageous and mutually confused portfolios realize business through computer networks… Unprecedented and unthinkable complexity emerges. Its virtual nature is derived from beliefs in progress and economics grow[27] rather from real (rational) knowledge.

People's trust was shaken and we try to solve critical situation. But do we have a better knowledge? It is rather (culturally formed) belief (embodied idea of money), which can simply produce money again and again. Do we (people) accept the fact that perpetual motion cannot exist in real world?

Perhaps mentioned opinion seems to be much too pessimistic, but it rather corresponds with critical thinking [11] that is rather skeptical. While pessimistic denote negative (intentional) stance, skepticism stands for a deference of rose-colored glasses (of delusion). Skepticism is representing an insight and acceptance of changeable reality as well as nature of (human) knowledge.

Take a skeptic stand to create responsible (optimist).

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ATTAINMENT OF SOCIAL RESPONSIBILITY BY ENTERPRISE ETHICS PLANNING

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Abstract

Social responsibility of enterprises, other organizations, and countries, depends on humans and their ethics, which can be viewed as information – impact of influential persons over others and their internalization of received information about the "correct" ethics. Social responsibility can be attained by planning of ethics.

1. Introduction

Enterprise ethics is a both broad and a specific topic. As such, it also concerns the wider public, not solely enterprises and entrepreneurs, which is clearly demonstrated by recent occurrences of various enterprises' fraud and manipulation of their functioning. Such behaviour usually causes dissatisfaction of the parties involved, scandals, and may even lead to the enterprise's bankruptcy (for historical review of business ethics research see [52]). Unacceptable behaviour of influential persons and organizations, especially enterprises, has obviously grown so big and crucial, that e.g. European Union (EU 2001) has found it necessary to pass an official document of corporate social responsibility. The latter is defined as a voluntary honest rather than abusing attitude and action of enterprises toward their co-workers, business partners, broader society, and natural environment. Thus, it is about ethics.

2. Ethical behaviour in enterprise functioning

Several discussions and researches support the importance of considering the ethical behaviour in enterprise functioning. Some authors even argue the linkage between ethics and world financial crisis in 2008 as a consequence of the neoliberal neglecting of the requisitely holistic behaviour concerning innovation [45]. The above mentioned crisis can be therefore considered as a reason for innovation of planning and management within (corporate) social responsibility and requisite holism of human behaviour [46], therefore the innovative planning, necessity and complexity of creative cooperation aimed at innovation can be considered as a way out from the 2008- crisis [47], [48]. Enterprises are part of our lives and economies in which they co-create the circumstances of the economic, social-political, ecological, technical-technological, legal, cultural, supply and sale markets, and personal environment. This is the reason why they are increasingly obliged to incorporate ethical orientation of their functioning. Business ethics is also taught at many faculties and universities, although we cannot refer to the existence of universal business ethics [36]. Consequently, authors we closely studied [60], [64], [28], [36] who focus on problems of business ethics, have different opinions and comprehension of the fundamental instruments and levels (micro, mezzo, macro) at which enterprises should be guided towards ethical functioning and towards the awareness of such functioning as one of the most important factors of the long-term success of an enterprise. By ethical behaviour only the enterprise can obtain the status of a credible and a trustworthy partner, which in a long-run ensures the enterprise's success. Credibility [5], [6] is also that very fundamental characteristics of an enterprise without which the enterprise can not introduce and realize the business ethics.

Since we cannot refer to one model which would uniformly embrace the topic of enterprise ethics, it is even more difficult for academics as well as practitioners to clearly define whose responsibility enterprise ethics actually is, and to what extent. This also raises relevant questions: Do owners (shareholders) and top management of an enterprise really have to consider the interests of other enterprise stakeholders (see also [38])? Can an enterprise be successful in the long run if its only goal is profit? What is the role of society and the broader environment in enterprise functioning and vice versa?

In this paper we argue the importance of the role of the enterprise key stakeholders (that is owners and top management) in the business ethics planning and implementation. The main argument we make is: when the key stakeholders of an enterprise have positive attitude towards the ethical core values they will importantly influence the planning of such type of enterprise culture and climate that will support and enable the planning and implementation informal as well as formal implementation measures of business ethics. Therefore, enterprise ethical behaviour demands conscious and positive attitude towards the planning of enterprise core values, culture and climate in a way that stimulates the desired achievement of business ethics. Based on this argument the concept of the holistic planning of constitutional elements as well as measures for the implementation of enterprise ethics is proposed and presented in the paper.

3. Enterprise core values

In society, values help to define people's "core" thinking: what they love, hate, or are just indifferent to [29]. In an enterprise, values serve to convey a sense of identity to its members, enhance the stability of its social system, direct a manager's attention to important issues, guide subsequent decisions by managers, and facilitate commitment to something larger than self [14]. We believe that values of society influence enterprise values and the other way around.

Hood [30] argues that ethical orientation of an enterprise is revealed through the formal and explicit activities of business life on a daily basis. The basis of these activities is outlined by enterprise's accepted procedures and policies. A formal statement of the enterprise's ethical stance is a means through which the values and ethical orientation of the enterprise are transmitted to employees. In authors' opinion values are the point at which the individual intersects with society (see also [20]). Hood (ibid) classifies values in terminal values (desirable end-states of existence) and instrumental values (modes of behaviour or means of achieving the desirable end-states). He divides terminal values further into social and personal values, where on the other side instrumental values further into morality-based and competency-based values. Social values include items as freedom, equality, and world at peace and morality-based values include items as politeness, helpfulness, affection, and forgiveness. Personal values include factors as self-respect, broadmindness, and courage and competency-base values include items as logic and competence. The author defends the opinion that enterprise success can be controlled and focused by maintaining and examining the enterprise's ethical orientation through creating the underlying enterprise's values. Further, Hemingway and

Maclagan [21] prove that enterprises' ethical behaviour depends on formal adoption and implementation of enterprises' ethical programmes, which can be considered as the result of and is associated with the changing values of individual managers.

In a context of enterprise ethics, it is very important that organizations provide a moral environment for employees. Various authors [37], [41], [44] developed the term ethical leadership, where development of a specific value or set of values is important for enterprise's success as integrity, prudence, courage, temperance, and justice. Morris [43] argues that core values of every organization need to reflect their ethical content. Thommen [63] proposed the categorization into three dimensions of an enterprise's credibility (responsible, communicative, and innovative behaviour) considered as the "highest" value. Marrewijk [29] is of an opinion that for the enterprise's success the enterprise's core values as order, success, community and synergy are of relevant meaning. These four core value systems have further strong relation with enterprise culture and enterprise climate. About ethical leadership and organizations read [40].

Garciá-Marzá [17] argues that there are interests common to all stakeholders, which in order to be satisfied demand a specific orientation in management decisions and actions. Considering this, the author proposes basic or core values that represent the corporate constitutional framework, responsible for establishing the basic rules for subsequent definition of relationships and strategies among various groups (enterprise stakeholders). In his opinion, if we eliminate any of these values, a dialogue will no longer represent a process of reaching agreement but will become a mere strategy or compromise, where the final outcome is decided by the more powerful side. So-called ethical core values ([17], [29]) help to establish and maintain the standards that delineate the "right" things to do and the things "worth doing". Such ethical values influence individual's choices and lead to actions which every organization supports. Some authors ([17], [29], [10]) believe that when the ethical values of an enterprise are widely shared among its members, the enterprise's success will be enhanced.

4. Enterprise culture

Enterprise/corporate culture is a multifaceted construct, and is defined by various authors differently. Goffman (in: ibid) focused on the observed behavioural regularities in people's interactions, Homans (in: [31]) discussed the norms that evolve in working groups, Ouchi [51] stressed the philosophy that influences organizational policy, and Van Maaren (in: [31]) emphasized the rules for good understanding in an organization. More recently, enterprise/corporate culture has been defined as encompassing the assumptions, beliefs, goals, knowledge, and values that are shared by organizational members ([5], [14], [31], [51], [55], [56], [57], [58]).

Various types of enterprise/corporate cultures have been identified – related to the dynamic nature of the industry concerned [18] and to the size of the organization [19]. Several classifications have been proposed, the most often cited being those of [58], [14], [24], [25], [26], [27], [55], [56], [57], [54], and [11]. [23] proposed that enterprise culture could be classified by comparing the degree of individualism versus collectivism, the apparent power-distance metric, the tendency towards uncertainty avoidance, and the bias between masculinity and femininity. Kets De Vries (in: [31]), on the other hand, opted to derive his classification from characteristics of the prevailing mentality: a paranoid culture (a persecutory theme), an avoidance culture (a pervasive sense of futility), a charismatic culture (everything evolves around the leader), a bureaucratic culture (depersonalized and rigid), politicized culture (leadership responsibility is abdicated).

In the Thommen's [63] opinion, an enterprise should emphasize its culture to the level where it comes into accordance with the enterprise's vision and strategy. Thommen [62] differentiates between strong and weak enterprise cultures. An enterprise with a strong culture is one with a high level of values and high norms anchoring, a high level of agreement, as well as high system and environment compatibility.

5. Ethical climate

Ethical climate concepts remain popular as a means of understanding the right-brain-based ethical atmosphere in enterprises. For the purpose of our discussion, we will use ethical climates as identified by Victor and Cullen [65]. In their opinion, an institutional normative system can be considered as an element of culture, although enterprise culture is more comprehensive and includes the patterns of behaviour, artefacts, ceremonies, and special language. Observers of organizational ethical climate discuss only those organizational norms that concern practices and procedures with ethical consequences in only a segment of their organizational culture.

Victor and Cullen [65] describe the enterprise climate as perceptions that "are psychologically meaningful molar descriptions that people can agree characterize a system's practices and procedures". Further on, the authors argue that the prevailing perceptions of typical organizational practices and procedures that have ethical content constitute the ethical work climate. In their opinion, ethical climate is conceptualized as a general and pervasive characteristic of an organization, affecting a broad range of decisions. Ethical climate therefore "informs"/influences members of the organization what one can do and what one ought to do regarding the treatment of others. The authors believe that climate types represent perceived norms of an organization or group with an ethical basis. The critical role of leadership on ethical climate and employee behaviour is argued in a research made by Mulki, Jaramillo and Locander [49]. The importance of enterprise ethical climate and the change of ethical climate over the enterprise life cycle stage is argued in a research made by Belak and Mulej [4].

6. Informal and formal measures of business ethics implementation

Informal measures play an important role in the socialization process, in which "other employees" or people, co-workers, etc. play a major role as "sources of, or references for ways of thinking, feeling, perceiving, and evaluating, and as an audience which may be physically present or absent in any interaction, but towards which an actor orientates their conduct [12]. Mechanisms of informal control may include a social dimension through which superiors regulate the behaviour of subordinates, or employees regulate the behaviour of their peers through daily interaction in compliance with the enterprise's norms or values. Adam and Moore [1] argue that informal measures such as the social norms of the enterprise may reflect the enterprise's values and rules of ethics. Enterprise members may be coerced by other members of the group, peers or superiors, to conform to the social norms. If not, they risk disapproval, or even rejection. In such a way, the social group exerts pressure on the individual to conform to the norms – but only to a limit. Different relationships (e.g. between co-workers, superior vs. team, superiors and subordinates, etc.) may develop in the frame of non-formal meetings such as coffee breaks, lunches, sport, etc. We can see that informal social norms play a crucial role in forming the social order in an enterprise [1].

On the other hand, managers have a strong impact on the behaviour of their employees. This informal measure is labelled "the example set by the manager", which is part of the formation of manager-subordinate relationships. The example set by the manager may be the tool advocated by the philosophy of the enterprise. "The role model" is also one of the roles that managers are expected to perform, since they can set the example for "proper and desirable behaviour" for the employee to imitate. Some of the informal measures of enterprise ethics implementation are presented in Figure 1.

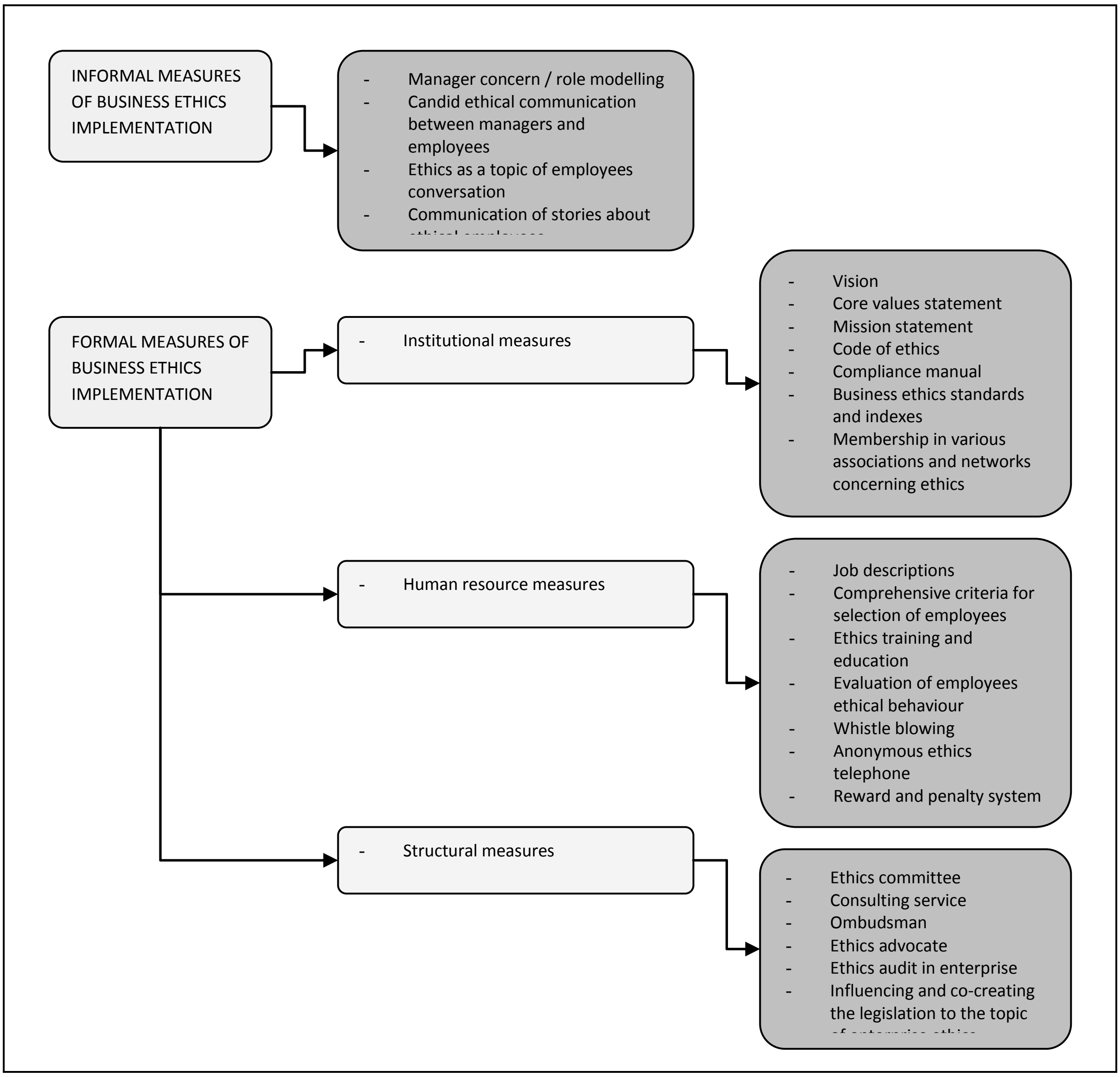

Figure 1: Measures of business ethics implementation (Source: based on Belak, 2008, pp.30)

According to Adam and Moore [1], the enterprise can employ diverse mechanisms of control, ranging from documents that specify the ethical code of conduct, which are used in the course of training; through the evaluation of employees' performance; up to enforcement procedures. Some controls (e.g. those used in selection and recruitment routines) appear early in the process of evaluating candidate's actions and attitudes. The three routines of formal metasures (recruitment, selection, and training) are very important in the process of employee socialization, which takes place in the first year of their membership in the organization [1]. The importance of formal measures of business ethics implementation is supported also by Sims and Keon [59] who argue that such measures are important form of communicating enterprise's expectations for employee decision making. Such a high importance is given to the formal measures of business ethics implementation especially due to the researches on correlation between formal measures and performance [42], [66], [69], [70], [16], which revealed that the enterprises with well developed formal measures of business ethics implementation recorded better performances. The enterprises that stress ethics have better images and reputation and yield higher long-term interests. The researches showed that employees' ethical awareness and decision making intent are influential on company performance, where in the absence of ethics, the individuals tend to promote their self interests at the expense of others in the enterprise when resources are unevenly distributed. Some of the formal measures of business ethics implementation are also presented in Figure 1.

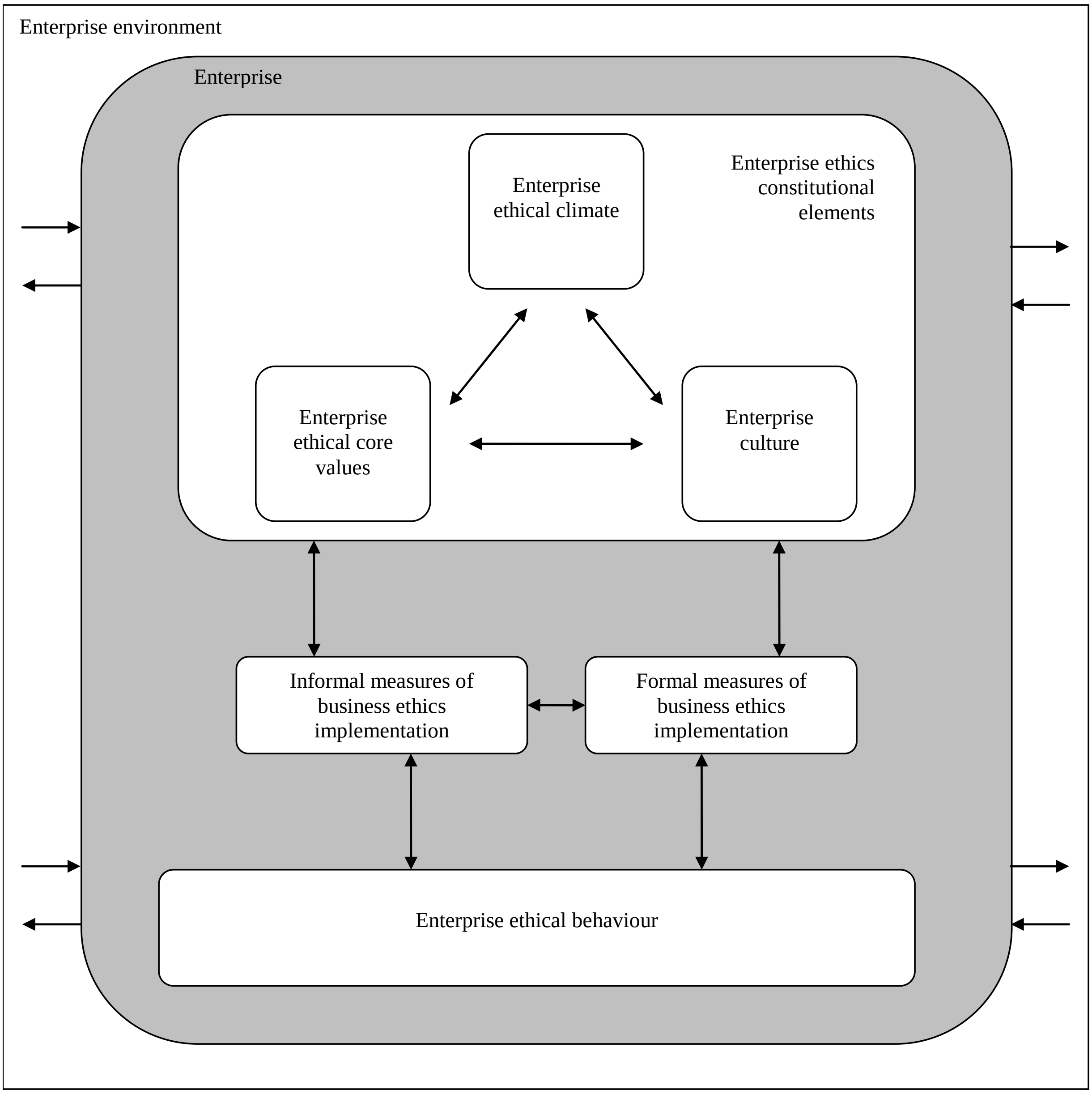

Figure 2: Constitutional elements and measures of holistic enterprise ethics implementation (Source: based on Belak, 2008, pp. 29)

Figure 2 represents the constitutional elements and measures of holistic enterprise ethics implementation. In order to behave ethically the enterprise must "posses" ethical core values, culture and ethical climate defined as the enterprise ethics “constitutional elements” as well as an enterprise must dispose with informal and formal measures of enterprise ethics implementation. We argue that the achievement of these "conditions" should not be regarded as a result of a mere accident but should be a result of the holistic planning of core values, culture, and ethical climate as well as of informal and formal measures. The concept of such holistic planning is discussed in next chapter.

7. Planning of core values, culture, climate, informal as well as formal measures of business ethics

Thommen [63] pointed out that an enterprise’s ethical behaviour can be achieved only by complete enterprise conversion. We argue that this conversion should take place at all hierarchical levels of the enterprise’s management and governance process. Based on the concepts of integral management ([5], [9]) these levels are the political or normative one, strategic and tactical/operative (or operational) management level as shown in Figure 3.

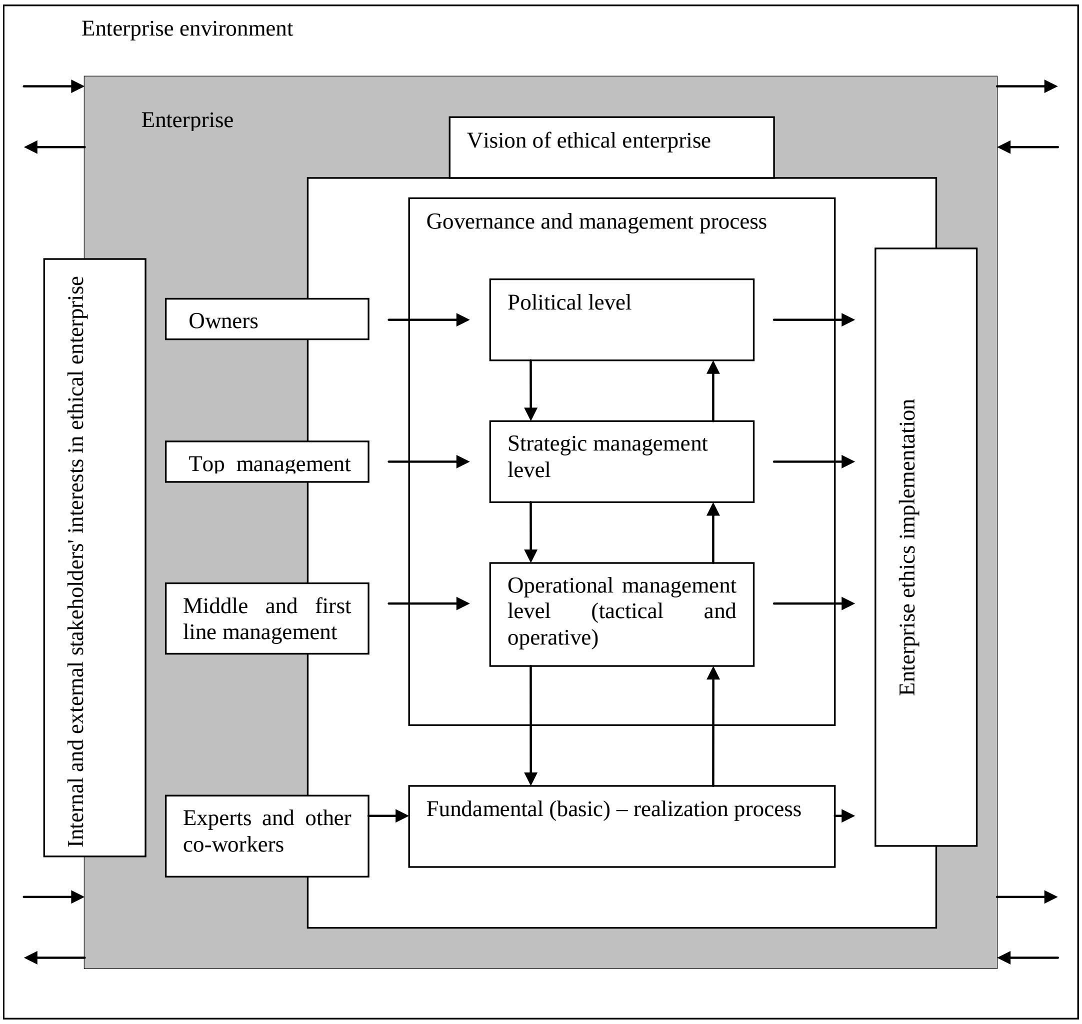

Figure 3: Framework of holistic enterprise ethics implementation (Source: based on [6], pp. 40)

The idea of an ethical enterprise strongly depends on an enterprise's key stakeholders – owners and top management. It embraces the activities of ethics and credibility initiation in an enterprise's vision, enterprise's policy (defined by Belak [6], [5] as the mission, purposes and fundamental goals), strategy, and finally in the processes and structures needed for the realization of this idea. The process of the development and realization of ideas is based on Kajzer's basic concept of transforming ideas into realization (shown in Figure 4).

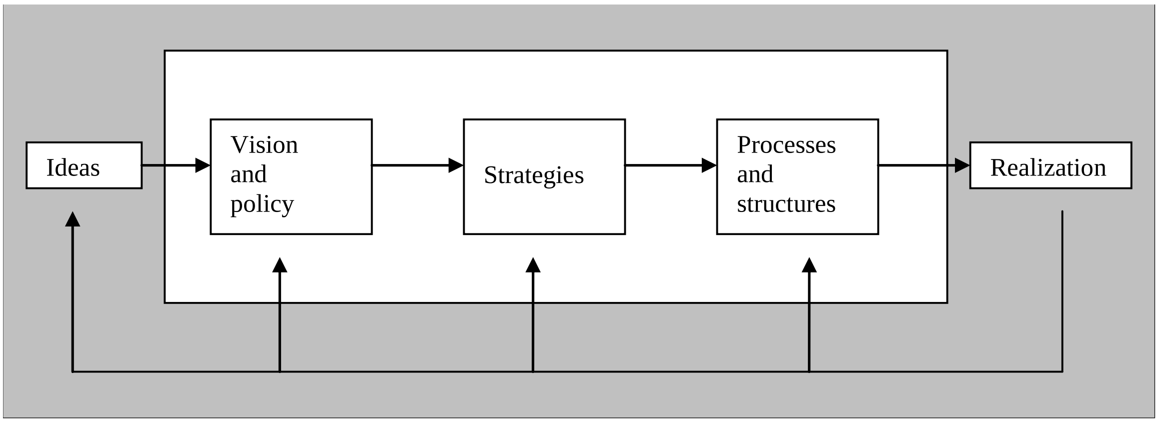

Figure 4: From development to realization of ideas (Source: [34], pp. 144)

Planning, organizing, directing, and controlling defined as the basic functions of governance and management process are of the great importance in the whole process of the realization of the idea of an ethical enterprise. In this contribution we limit our discussion on the function of planning of the holistic enterprise ethics. Firstly, the idea of an ethical and credible enterprise should be manifested by the enterprise owners in an enterprise's policy that is based on the vision of an ethical enterprise as shown in Figure 5. The mission, purposes and fundamental goals should be defined in accordance with a vision to be an ethical and credible enterprise. According to Bleicher [9], the vision of such an enterprise must be supported by the enterprise's responsible policy and philosophy. We should emphasize that the enterprise's policy strongly depend on the enterprise owners' (also top managers) values and norms, which are expressed by enterprise culture [53], [7].

At the strategic level of governance and management the process of planning the strategies and the strategic allocation of resources needed for following the vision and achieving mission and goals of becoming an ethical enterprise takes place. The top management of an enterprise holds the main responsibility for making decisions on strategies and strategic allocation of resources (as shown in Figure 5). It is top management's responsibility to find the most appropriate strategy for realization of the vision, mission, and goals to be an ethical enterprise.

This leads us to the question of corporate governance and different value perspectives (shareholder and stakeholder value perspectives). We could argue that both perspectives are at some point correct. The enterprise's long-term success depends on the successful harmonization of the stakeholders' interests [50]. If the enterprise's vision and enterprise's policy, influenced and created by the owners, are not in the interest of all stakeholders, they will simply not participate in the future business activities. Therefore it is in the owners' main interest to consider the interests of all stakeholders, which would consequently result in the enterprise's ethical behaviour.

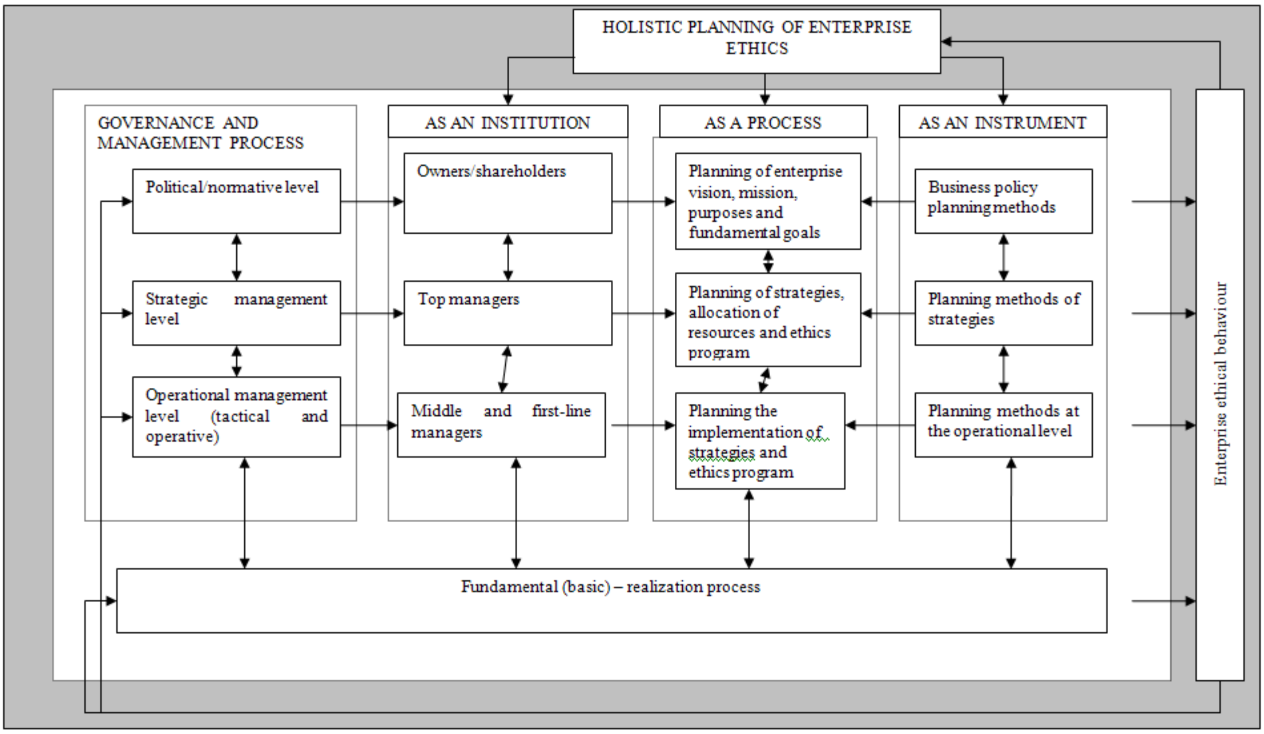

Figure 5: The concept of the holistic planning of constitutional elements and implementation measures of enterprise ethics

For successful implementation of strategies it is of great importance to develop an ethics program by defining the activities and the responsible performers as well as needed resources of these activities for successful implementation of such program. The purpose of such ethics program is to make strategies action-oriented. The responsibility of implementation of such ethics program lies also at the operational level (as shown in Figure 5).

In order to successfully realize the planning process at all hierarchical levels adequate planning instruments should be developed among which especially planning methods are of great importance (compare with [5], [6]). Whether these should be completely new methods or some of the existing methods could be adopted (proposed by different authors, e.g. [8], [13], [22], [32], [67], [68]) should be theoretically as well as empirically studied in the future. The institutional dimension within the proposed concept of holistic planning model describe the responsibilities of different stakeholders within the enterprise (that is owners and managers) regarding decision making in the planning process as well as experts and other co-workers that are in accordance with enterprise owners and managers responsible for enterprise ethical implementation and behaviour.

8. Discussion

To achieve the optimal effectiveness level of initiated measures of business ethics, these measures should never be implemented as isolated tools, but only in the frame of a full and complete ethics program [63]. The initiated business ethics measures have to be correctly adjusted and coordinated, as well as integrated, in a common business ethics concept, program or plan. An enterprise's top management can be considered as the "agent" responsible for harmonization of stakeholders' interests (as well as different cultures); therefore we argue that formulation and implementation of an ethics program strongly depend on top management. In our opinion, the top management can also be considered as the executor of the enterprise's culture (values and norms initiated by the enterprise owners), which represents one of the most important elements in the context of an enterprise's ethical behaviour.

For successful implementation of the ethics program or plan, it is important that it is internalized by all (especially internal) stakeholders within the enterprise (owners, managers on all management levels, experts and all other co-workers). We have shown that credibility and ethical behaviour of an enterprise can be achieved only through holistic enterprise planning (as shown in Figure 2, 3 and 5). It should be implemented from top to bottom, starting with the enterprise owners' values that influence enterprise's vision and enterprise's policy [63] and to the fundamental (basic) – realization process and in all of it's own pore incorporated also in enterprise environment. One of the important argumentation of the present paper is also that the proposed concept of the holistic planning of constitutional elements and implementation measures of enterprise ethics has a major impact to the environment of an enterprise functioning and vice versa.

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Safety and Security as a Systemic Challenge

RESILIENT EMBEDDED SYSTEMS - THE NEXT CHALLENGE

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Abstract

Networked embedded software-intensive systems are already almost "omnipresent" – and key to most of the innovations today and in the future in almost all domains of our life. Embedded systems are completely integrated in their environment ("hidden" computing"), and in many cases integrated in networks of different connectivity, interacting with each other, with humans and environment via various means. Reliance on their services became a critical issue, although humans are very well able to adapt to unsatisfactory performance and reliability to a certain extend – today's Windows-PCs, SPAM-emails and Internet are very good examples.

Dependability describes a complex "umbrella"-property, including sub-properties such as safety, reliability, availability, security, maintainability, survivability. Safety standards rely on properties like "traceability" and "predictability" of requirements of systems and components – best is to be able to configure and predict behaviour at system-design and build time in a static manner.

With the emergence of smart, autonomous systems ("robots", although this could be large variety of machines, even interacting with humans in an active manner) with perception, cognition and understanding of environment and even humans, these properties cannot hold any longer. This new paradigm is called "resilient systems".

Resilience is the persistence of service delivery that can justifiably be trusted when facing changes, i.e., the persistence of dependability when facing changes. Resilient embedded systems are the next challenge – adding new dimensions of complexity to manage!

1. Introduction: Embedded Systems

There are many definitions of Embedded Systems around. Generally speaking [3], embedded systems are a combination of processors, sensors, actuators, "intelligence", "hidden computers" and massive deployment, with intensive interaction with an uncertain environment: "A physical process with dynamics, fault, noise, dependability, with power, size and memory restrictions (in general: resource restrictions)…" [19]. To be able to develop dependable systems from components with these characteristics, foundational system infrastructures and methods ([9], [5]) are needed as core technology (e.g. systems following the time-triggered paradigm) (e.g. as developed in DECOS, partially funded by EU-IST-FP6-511764, and now further developed in projects of the ARTEMIS Joint Undertaking) [21].

Embedded Software constitutes a very specific and critical part of embedded systems. It provides new capabilities to HW transducers ("defines physical behaviour of a complex non-linear device"), because of its potential criticality we need HW/SW co-design, and issues like dependability, low power, timeliness are becoming software issues with all the consequences. We need dependable system architectures to cope with the potential risks, including safety as well as security requirements and counter measures. Be aware, that security aspects are often neglected by safety engineers!

While conventional computing at the beginning was just speeding up off-line data processing and calculations, software has then made dramatic progress into all kinds of technical equipment, replacing conventional mechanical and electro-mechanical subassemblies. Software moved more and more from pure "data processing" to "automation and control", thus "becoming really dangerous". This is shown also by the fact that besides IFIP, the International Federation for Information Processing, a second international organization, IFAC, the International Federation for Automation and Control was founded and both organizations still exist in parallel. Both areas are inherently different with respect to their treatment of process control and automation, also being concerned with hard real-time applications.

Recent market research shows that 90 percent of innovation in the automotive industry is expected to come from electronics by 2010. These applications are usually summarized by the term "embedded system" and establish the next step of evolution of computer control systems. They are special-purpose computer-controlled electro-mechanical systems in which the computer is completely encapsulated by the device it controls or completely integrated in its environment ("hidden" computing).

In many cases it is not a single-task system but is integrated in a network of (co-operating) embedded systems interacting with their environment. An embedded system has specific requirements and performs pre-defined tasks, unlike a general-purpose PC. In both cases high financial investments and the lives of many people depend on these systems.

2. Dependability – already a conventional concept?

Dependability is not a simple single issue – it has to take into account hardware, software, communication, networking, interfaces, environment and humans (behaviour and different mind models, human mistakes, [10], [15]), all in different roles. Systems are not always critical by definition, often the actual criticality and dependability levels rise based on our desire for enhanced reliance on them!!

Examples are: safer cars imply more aggressive driving behaviour after some time; or: (almost) perfect driver assistance systems may lead to too much reliance on them thus becoming safety critical. On the other hand, by their originally not implied usage or unforeseen combination of incidents not taken into account by risk and hazard analysis, systems become (more) dangerous: examples are the Kaprun cable car fire catastrophe, or the London Ambulance System Disaster: The ambulance car emergency management system was not considered safety critical – but because of ambulances not arriving in time or at all at the required location several people died! The same would be the case if security breaches, e.g. malicious insertion of wrong data or commands in a control loop, could cause dangerous situations (chemical reactor explosion, traffic jam, air traffic control, …), and nobody has thought it likely that someone could have interest in such an incident. Not only after 9-11, we must to take into account malicious actions. Additionally, public acceptance (or non-acceptance), legal or environmental issues, liability, and social aspects influence system usage and dependability as well.

Whereas safety and reliability have a long tradition in several technical areas (industrial plants and machinery – the TÜV was founded after too many of the newly introduced steam vessels exploded; railways, aircraft industry), security is rather a newcomer and started with data protection, access control and related issues on large database installation and centralized computer systems. With increasingly networked, distributed computer systems the risk of deliberate malicious interactions, using software-based tools, became a serious threat. Many-fold related issues like data protection, privacy, integrity, authenticity, and denial of service attacks, viruses, worms etc. lead to a separate community to be established, which is nowadays in the main focus of the public as was safety some time ago (and still is – but only after catastrophic events). This community developed separate standards, methods, taxonomy and ways of thinking.

For a long time, safety-critical systems were mainly proprietary, isolated from the environment and not coupled with other systems were a larger public has access to. With ubiquitous computing, seamless connectivity, massively deployed networked embedded systems [1], use of public networks for critical controls, maintenance access from outside to critical systems, or even interaction between critical components or subsystems via public networks or wireless, the situation has changed dramatically: Security breaches may become safety critical, and safety problems or measures to maintain safety integrity levels may open loopholes for security attacks. Additionally, autonomous systems interacting with humans in a shared environment, and with humans adapting their behaviour to the advanced abilities of such systems to prevent loss of live or limb, add a further dimension. Ambient intelligence in ubiquitous environments may even lead to loss of human abilities – what has already happened under certain circumstances: mental arithmetic and estimation of meaningfulness of results was considerably reduced by the massive use of electronic calculators, and the ability to remember numbers and complex issues was reduced by mobile phones' storage and recall features and intensive use of internet (Google replacing permanently available personal knowledge). Therefore we have to take a holistic view of critical systems to be able to foresee their impact in the short as well as in the long term – not stopping their application, but evaluating the additional, in the short term often unforeseeable risks.

3. Dependability – a holistic umbrella term

As already outlined in [1], used in [5], [9], or in the multilingual book "Dependability – Basic Concepts and Terminology" (J.-C. Lapries, A. Avizienis, H. Kopetz, U. Voges, T. Anderson, Springer), a set of basic definitions on dependability as an umbrella term of various system attribute (*Figure 4*) (not necessarily complementary, but in certain cases (application dependent) even contradicting) is provided, which fits best the goal of a "holistic system view". In short, the most important ones are:

Dependability: Trustworthiness of a computer system such that reliance can be justifiable placed on the service it delivers. Thus dependability is an umbrella term for a set of sub-properties: availability, maintainability, reliability, safety, security (including confidentiality, integrity, authenticity), survivability, (robustness).

Safety: Dependability with respect to non-occurrence of catastrophic failures (freedom from unacceptable risk, based on un-deliberate actions or events, "risk to life and limb")

Security: Dependability with respect to unauthorized access or information handling (deliberate action!) (including confidentiality, integrity and availability/access)

Reliability: Dependability with respect to continuity of service ("time to failure", probability)

Availability: (Readiness for use): The ability of a functional unit to be in a state to perform a required function under given conditions at a given time instance time or over a given time interval, assuming that the external resources are provided ([3], [20]),

Maintainability: (Easiness of maintenance): From a hardware/software systems point this includes more than just the preservation of the status quo of a system (as in (ISO/IEC (ed.), 1996)). It includes enhancements and modifications to perform new/additional functions to fulfil new requirements, e.g. upgrades and adaptations). In the system context (and context of the dependability definitions of (Laprie et al., [1]) it can be defined as "The ease with which a (software, hardware) system or component can be modified to correct faults, improve performance or other attributes, or adapt to a changed environment, for details see [13], [16].

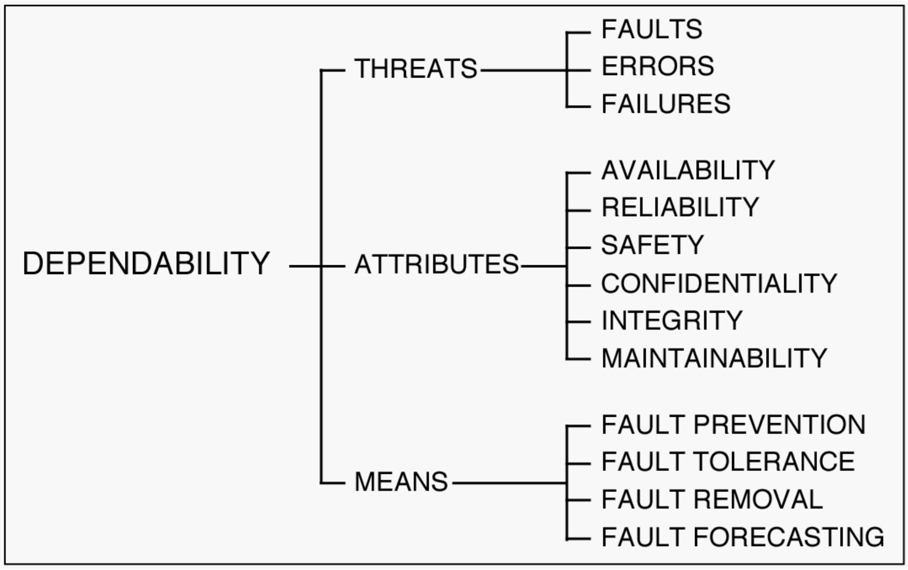


Figure 4: Dependability - Basic Concepts and Terminology

Critical systems may be safety-critical (e.g., avionics, railway signalling, nuclear power plants) or availability-critical (e.g., back-end servers for transaction processing, mobile services).

Although this very clear terminology does exist since many years, the use of the terms is imprecise. Very often, the term "Dependability" is now used more or less as synonym for "Security", even in EU-publications or standards.

Another important contribution of the referenced terminology was the "fault – error – failure - …" chain, which provides a deeper understanding of fault propagation, fault containment and fault consequences in critical systems: A fault in a hardware part, component or subsystem may lead to an erroneous state of this element of the system, which may lead to a failure of this element (the fault is the cause of the error respectively failure, the failure the consequence of the fault respectively error). The failing component constitutes a fault of the subsystem where it is embedded, and so on. This is important especially in case of security breaches: then a fault is inserted into the system (deliberately) to lead to a failure, which may impact safety of the system.

(…(((Fault → Error → Failure) = Component Fault → Error → Failure) = Subsystem Fault → Error → Failure) = …….)

4. Functional Safety Standards: The classical approach to safety and dependability

4.1. The Approach of IEC 61508 – the Safety view

To understand the underlying principles of IEC 61508 [8], (*Figure 5*) explains the safety-view and basic assumptions:

There is equipment under control (EUC), which, with its control system (which is the safety-related PE System) poses a (potential) threat to its environment (in case of security, the system is threatened by its (may be far remote) environment, what, in turn, might pose a threat to its close environment).

- Safety functions are performed by the E/E/PE Systems
- Steps are to be taken to understand the risks involved and reduce them to a tolerable level

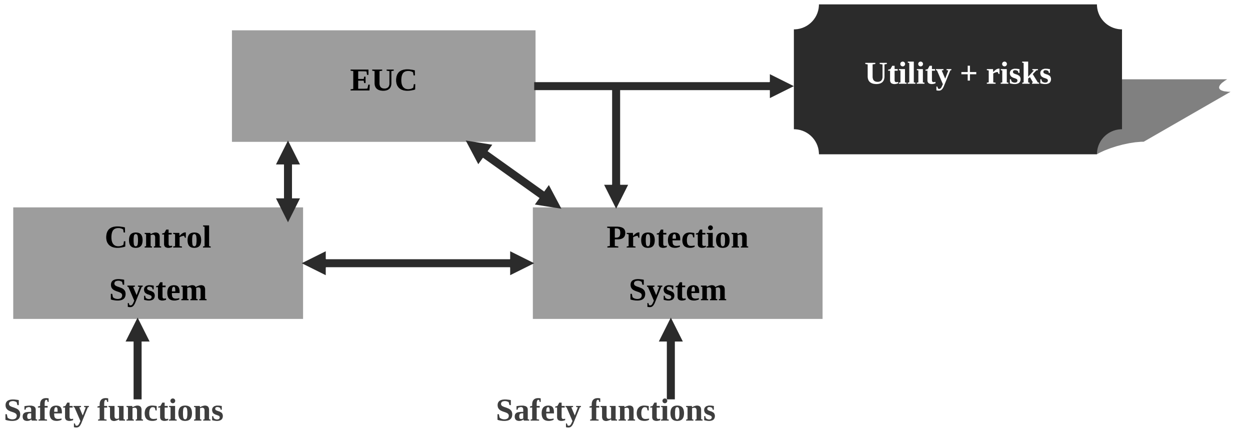


Figure 5: IEC 61508 – Equipment under Control

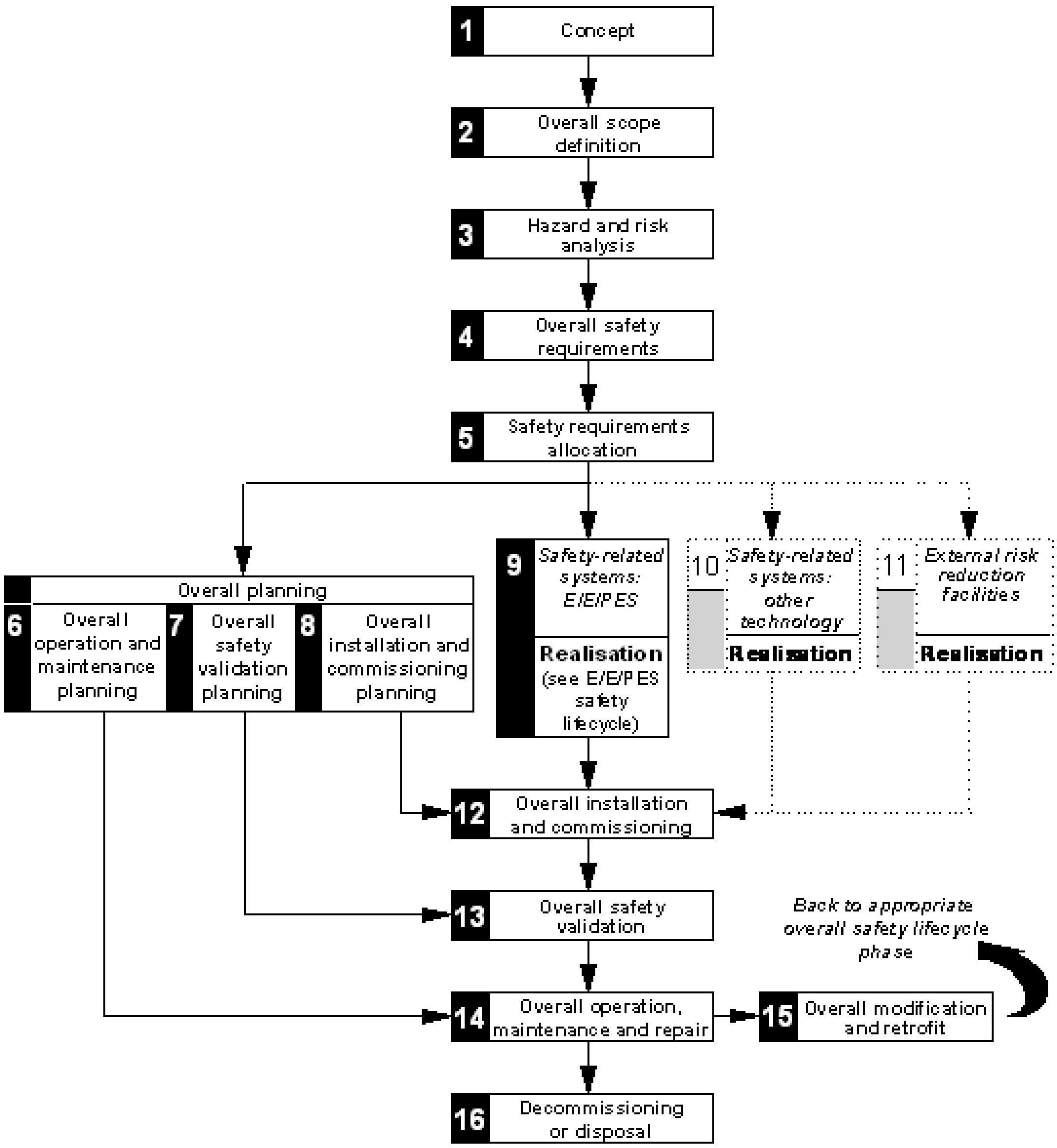
To fulfil these goals, the standard requires:

- Assessment of the risks posed by the EUC
- Decision on what level of risk is tolerable
- Decision on which risks should be reduced
- Determination how the risks could be reduced best

Applied is the ALARP-principle – risk should be as low as reasonably possible.

The standard gives guidance on E/E/PE Systems. The goal may be achieved by more than one safety-related system and by a bundle of measures, but always based on hazard and risk analysis, on getting the overall safety requirements right, and by developing a concept for proper safety requirements allocation.

To structure guidance, IEC 61508 proposes a well defined safety life cycle (*Figure 6*).



NOTE 1 Activities relating to *verification*, *management of functional safety* and *functional safety assessment* are not shown for reasons of clarity but are relevent to all overall, E/E/PES and software safety lifecycle phases.

NOTE 2 The phases represented by boxes 10 and 11 are outside the scope of this standard.

NOTE 3 Parts 2 and 3 deal with box 9 (realisation) but they also deal, where relevant, with the programmable electronic (hardware and software) aspects of boxes 13, 14 and 15.

Figure 6: IEC 61508 – the IT/DES Safety Life Cycle (from the IEC 61508 Standard)

The principles involved are:

- The safety lifecycle is a model for identifying the activities appropriate to safety-related systems
- A risk based approach means not merely following a procedure and assuming that “safety” will result, but: Identifying the risks and reducing them appropriately

- Safety integrity levels (SILs) provide targets for risk reduction
- The safety requirements specification defines the safety requirements necessary for risk education
- Carrying out safety planning ensures a methodical and auditable approach

4.2. Integrating Security – the next step of developing system analysis further

The situation drastically worsens when considering large, networked, evolving, mobile/wirelerss systems. A simple example will highlight the security issue (from a presentation of DaimlerChrysler at SAFECOMP 2004 in Potsdam, [4], *Figure 7*): Wireless communication between cars on a highway enables early warning if the first one in a long column of cars is braking so that all following cars can easily adapt. This makes higher throughput, shorter distances between cars and fewer accidents possible at the same time.

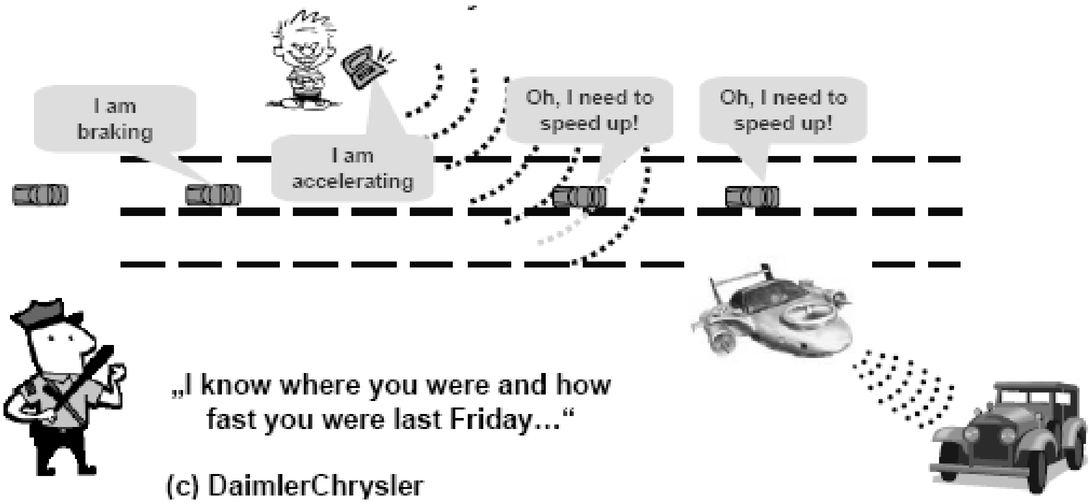


Figure 7: Security breaches endanger safety and privacy (from [4])

Imagine now someone fakes such messages, resulting in an uncoordinated jam on the highway, i.e. may be in a catastrophic event. There are of course considerations how to avoid such problems – but all countermeasures have to take into account real-time and long-term usage (20 years!) requirements as boundary conditions so that simple encryption does not work (from [4]).

- Fake messages could cause severe damage
- Information of vehicle’s communication could be used against its driver or owner
- Vehicles could outlive their security solutions

Cost-effectiveness and mass deployment of critical systems in combination with non-critical systems is a trend, where many other application areas will benefit from, so that there is a clear need not only for application-specific ICT-technology, but for generic dependable ICT-technology (hardware, software, SoC (Systems-on-Chip), building blocks, communication) (DECOS, [5]), which fulfils the requirements of generic functional safety and security standards as well as of sector-specific ones (certification to create trust in these systems!).

As already stated, security very often has safety impact, and vice versa. But there still exist two separated communities at the moment, with different traditions, standards, methods, almost ignoring each other [12].

The generic standard of the safety community is IEC 61508 [8], Functional Safety of E/E/PE safety-related Systems. The engineering community has built a set of standards based on IEC 61508 for specific sectors, taking into account the experiences, background knowledge and requirements: the process control sector, medical sector, nuclear, railways, and is still continuing (e.g. automotive (ISO 26262) in progress). But this standard took only the safety view, security is not even mentioned!

The conclusion was to add separate clauses into IEC 61508 everywhere where security could have an impact on safety giving advice on how to integrate the security aspect as an additional hazard (risk) for the safety-critical system, i.e. to look at the safety impact of security breaches and then derive requirements for the safety critical system, based on a joint hazard and risk analysis.

On the other hand, we have ISO 15508 (Common Criteria, focusing on component evaluation) and ISO 17799 (system guidelines on security, holistic, not only IT), for Security. They have even another "language" than the safety community, and another view what levels of protection mean (EALs vs. SILs).

(Note: The aspects of "multilateral security" could be correlated to SILs according to [17]).

In industry, independent work was started in the meantime to define "Security Profiles" for Avionics by CAA (Civil Aviation Authority) [2] and the US Industrial Automation Group PCSRF – Process Control Security Requirements Forum ([11]), very much triggered by ISO 15508. On the other hand, the maturity and process assessment models of CMMI and SPICE (ISO 15504), where the maturity of processes within companies with respect to IT-development are assessed and made comparable, have found their counterparts already in the security world [19].

The important step to safety as well as security is hazard and risk analysis beforehand – and based on these, safety requirements may be defined and allocated as well as security requirements. This approach was already presented by the author at the NATO Cyberspace Security Conference in Gdansk [17].

To identify the hazards of the EUC in all modes of operation, the event sequences leading to the hazards, and the EUC risks associated with the hazards have to be analyzed (methods are well known like FTA, FMEA, FMECA etc.):

This is achieved through a sequence of three activities (may be iterated if required):

- Hazard identification
    - Define hazards and hazardous of EUC and EUC control system for all reasonably foreseeable circumstances
        - Fault conditions
        - Reasonably foreseeable misuse
        - Human factors (not sufficient to confirm that normal operation is safe)
- Hazard analysis
    - Determine the event sequences leading to each hazardous event
    - Identify the causes of hazards and assess the consequences of hazardous event

- Risk analysis
    - Determine the risks associated with the hazardous events

The result of the consideration that there are similar activities in both, the security and safety life cycle, a unified approach was proposed (*Figure 8*):

System Requirements – *Unified Approach*

Security	**Safety**
|	|
|	|
Security Analysis	**Risk/Hazard Analysis**
(Environment, Risks, Threats, Counter Measures, ...)	(System Boundary, Probabilities, Effects, Mitigation)
|	|
Security Requirements	**Safety Requirements**
|	|
Security Design	**Safety Design**
(Secure components, Inter-action, Procedures)	(Safe Components, Inter-action, Procedures)

Figure 8: System Safety & Security Life Cycle - Unified Approach

Activities may differ very much between Safety and Security depending on requirements. As an example, the Decommissioning and Disposal phase can be discussed briefly (Life Cycle Phase 16):

Security: Secure management of data, i.e. un-retrievably destroyed or secure archiving of preserved integrity, depending on application)

Safety: Safe management of shut down or continued (degraded) operation

The unified approached requires analysis and evaluation as well as requirements definition and allocation with both, safety and security in mind. For details, how to handle the security issues, the security standards and the relevant chapters should be referenced (not to re-invent the wheel!).The security life cycle of safety-related systems has to take into account the complete IT-security management life cycle as addressed in ISO 17799 and many national IT Security Handbooks, equivalent to the safety life cycle of IEC 61508. Security Management is a continuous process of

- Development of an IT – Security Policy
- Implementation of an IT – Security Policy
- IT – Security during Operation

IT-Security includes the following processes, which are related to the corresponding phases of the IEC Life Cycle Model (in <nn>, *Figure 3*). Following this concept, the complete security management life cycle can be considered and integrated in a holistic, unified model of parallel, equivalent activities:

- Definition and Implementation of Security Policy (phases <1> – <5>, from „Concept“ to „Security Requirements Allocation“)
- Security during System Development (includes Security during the whole lifecycle of the system (phases <6> – <11>, Documentation, Evaluation and Certification phases <12> – <13>)
- Maintaining Security Level during Operations <14> (includes Maintenance, Change Management and Incident Handling), Disaster Recovery (phases <14>,<15>)and Business Continuity Planning (phases <15>, <16>)

5. Resilience – challenge of change: taking into account the unexpected

The latest evolution is characterized by putting intelligence (machine perception, situation awareness, computer vision, machine learning) on top of networks of embedded systems in order to enable them to behave autonomously as a system. The terms "embedded intelligence" or "ambient intelligence" are used for these systems. They require (and create) their own pervasive environment, which needs seamless connectivity to deploy its full potential – they are called “ubiquitous systems”, with demanding requirements driven by their domain of application, building the basis for “ambient intelligence systems” (AmI). There is evidence that these systems suffer from a significant drop in dependability and security in comparison with conventional systems, where these demands have been addressed over time. There is thus a *dependability and security gap* endangering the very basis and advent of Ambient Intelligence (AmI). For these systems, somehow operating in an undefined environment, attributes like robustness (well known from the past, before the terminology of “dependability” was created), some new attributes and properties were defined:

- *Survivability:* The capability to withstand a hostile environment is the capability of a system to avoid or withstand a hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission. This includes any kind of impairment especially from the environment, including security attacks etc.
- *Resilience:* The persistence of service delivery that can justifiably be trusted when facing changes, i.e., the persistence of dependability when facing changes.

The failure of these systems can have and often has considerable financial, social and health consequences.

Safety standards rely on properties like “traceability” and “predictability” of requirements of systems and components – best is to be able to configure and predict behaviour at system-design and build time in a static manner.

With the emergence of smart, autonomous (mobile) systems (“robots”, although this could be a large variety of machines, even interacting with humans in an active manner) with perception, cognition and understanding of environment and even humans, these properties cannot hold any longer. They have to cope with the “real world environment”, which is clearly neither well nor completely defined. Again, the new paradigm of “resilient systems” has to be applied.

Resilience, as stated before, is the persistence of service delivery that can justifiably be trusted when facing changes, i.e., the persistence of dependability when facing changes. Resilience involves four major properties:

- evolvability, i.e., the ability to successfully accommodate changes, including adaptivity, i.e., the capability of evolving while executing., i.e. the ability of dynamical reconfiguration, what significantly complicates the behaviour of a system,
- assessability, in both senses of verification and evaluation, requires integrating techniques for safety analysis, reasoning about fault tolerance, evolution and security into the engineering of such systems
- usability, and
- diversity.

The concept of "resilient computing" extends the concept of dependability considerably, adding a new dimension of complexity – a severe challenge for the future, demanding even more a *holistic system view to take into account the unexpected.*

According to the outcomes of the ReSIST Network of Excellence, there is a demand for a pervasive information infrastructure with *scalable resilience* for survivability. All of the various classes of threats have to be considered in this pursuit of scalable resilience: development or physical accidental faults, malicious attacks, interaction mistakes. Here again, besides technical issues, the human factor is a key issue ([10], [18]).

Resilience engineering, as per definitions given by Erik Hollnagel ([6], [7]) "aims to enhance the ability of organizations to create processes that are *robust yet flexible*, that can use resources proactively to accommodate for *external disruptions or internal ones* (e.g. production and economic pressures, human errors). In Resilience Engineering, failures do not the result of a breakdown or malfunctioning of normal system functions, but rather represent failure to adapt to real world complexity*"*.

The concept of "resilient computing" (*Figure 9*) extends the concept of dependability considerably, adding a new dimension of complexity – a severe challenge for the future, demanding even more a *holistic system view to take into account the unexpected.*

For autonomous, mobile ("robotic") systems this means: Perception and cognition, reasoning and interpretation of scenarios from the environment need new methods to describe this scenarios in a formal manner (there does not even exist a modelling concept for vision systems which could allow simulation of scenarios and reactions triggered by vision and vision based perception!). Further on, this requires new testing and validation methods, and in the end new methods for tool qualification and system evaluation and certification – a requirement in case of safety critical interaction between autonomous (mobile) systems with humans and environment. A method to define "situation awareness" and for testing some approach to measure "scenario coverage" are needed. There is a lot of research necessary, and we are in fact at the dawn of a completely new era.

From one of our present research proposals, the following text is taken:

For autonomous systems with complex optical sensorium, cognition, behaviour adaptation, and acting capabilities, no objective measures exist to assess their functional correctness and the level of fulfilment of dependability requirements such as safety or reliability. For instance, which test cases – i.e. video sequences or corresponding scenarios – are needed to prove that a stereo vision algorithm used by a robot behaves as required in, say, 99,99 % of all situations it may be confronted with? Today, either public test suites are applied, which provide generic video images or scenes in a quality usually higher than those provided by the sensory finally implemented, or dedicated test data are captured by the development team or related persons. If the latter is not performed in an exhaustive – and thus expensive – manner, the resulting tests can only be considered as punctual, and provide little information about the covered fraction of possible sceneries the target system may experience. Therefore, it has to be investigated how test cases (i.e. input data for the sensors) can be generated for resilient real-world systems with measurable situation coverage, taking sensor characteristics like resolution, frame rate, and noise into account. Systematic analyses of the scenarios such systems can encounter have to be performed, for establishing formal domain models. From these models, the relevant test vectors will be derived by identifying equivalence classes of scenarios with respect to expected output (i.e., recognition and behaviour).

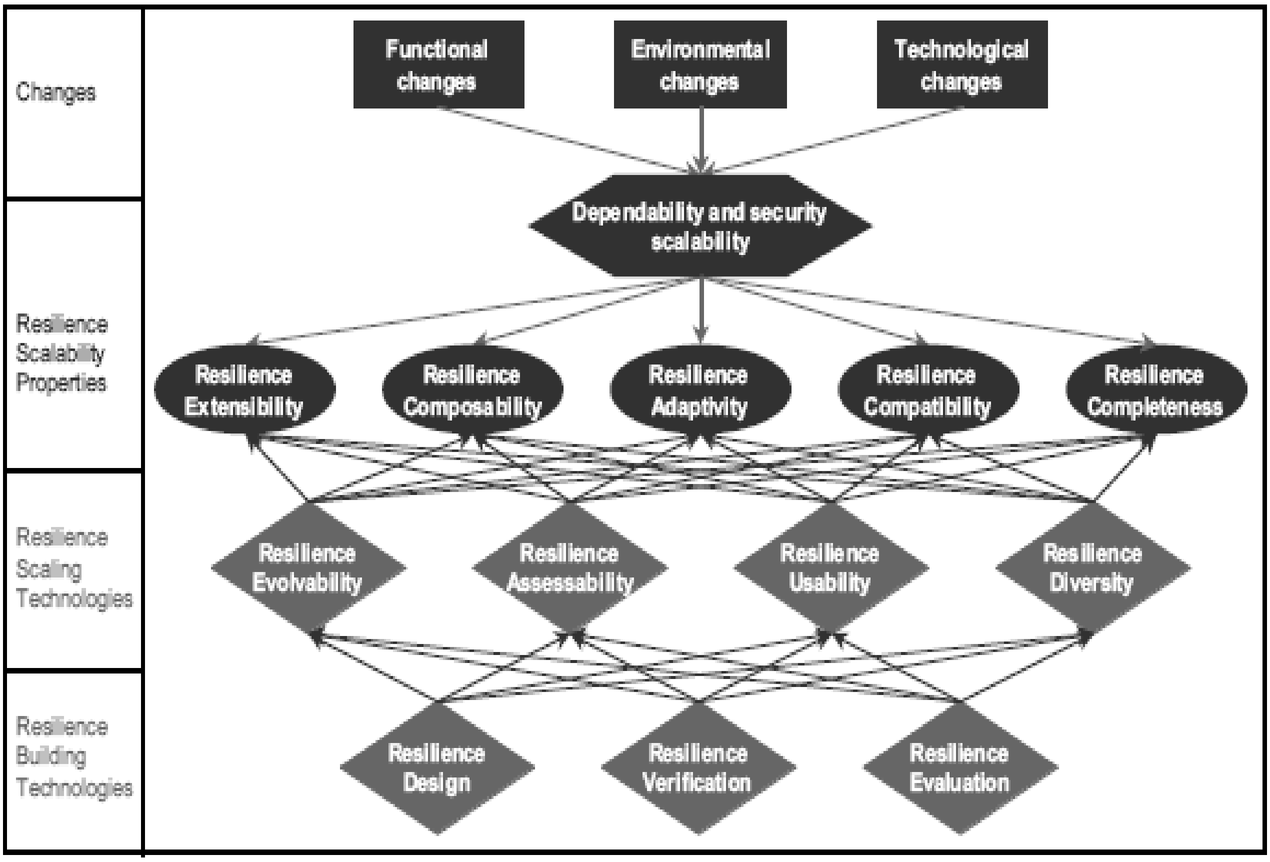


Figure 9: Scalable resilience (from [14])

6. Conclusions

It has been demonstrated, that mass deployment of networked, dependable embedded systems with critical control functions require a new, holistic system view on safety critical, security critical and survivable (“resilient”, adaptable) systems. As a first step, a unified approach to address the safety and security requirements of safety related systems is proposed, based on the functional safety standard IEC 61508 and IT-Security management standards, handbooks and guidelines. As a second step, the challenges of autonomous systems and ambient intelligence systems are explained, requiring a new approach to system safety, now defined as “resilience”. This includes a combination of properties beyond those which are satisfied by the classical safety requirements like predictability, since evolvability, adaptability, facing appropriately unexpected situations (“situation awareness”) are the key issues.

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COMPLEX SYSTEMS AND SAFETY: AN EPISTEMOLOGICAL APPROACH

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Abstract

The topic of this paper is the epistemological approach to safety in complex systems like aviation. We'll discuss how the research in aviation safety is often biased by a mindset given by general way of thinking: the epistemic frame of the considered period. Aviation is a complex system made of people, technology and environment, each of them complex in itself. Along the years, analysis and solutions have changed according to new perspectives. In particular, in the aviation industry the focus shifted from the engineering approach (relationship human-machine), to a psychological one (relationship human-human), eventually coming to a philosophical approach that, as this paper intends to demonstrate, is necessary today (human-environment).

1. Introduction

According to ICAO (International Civil Aviation Organization), an agency of the United Nations, who issues rules and recommendations to regulate civil aviation around the world, safety "*uses the system's engineering and managerial techniques in order to help the systems to be safe in their lifespan".*

As well, the *Enciclopedia Britannica* (vol X, pag. 296) gives the following definition of the *Safety engineering*, as:

"*The general areas that have been identified as the major functions carried out by the professional safety engineers: means of identification of accident producing conditions; the development of accident and loss-control methods, procedure and programs; the communication of accident to those involved and the emphasis on prevention*".

We see that the emphasis regards the engineering side of organization, leaving the "*liveware*" on the faded side. Actually, we should point out, preliminarily, that aviation is a complex system in which people, technology and environment interact. Each of them is a complex system in itself.

So, we begin our brief paper with the definition of complexity, then we'll point out some peculiarities of complex systems in general and eventually we'll draw some conclusion regarding safety in a specific domain like aviation.

It is puzzling to give a thorough, clear, exhaustive definition of Complexity, since it could be defined more by its negations that for its peculiarities. Complexity is not a theory, not a doctrine, but is a constellation of theoretical approaches that arose from the Eighties on, caused mainly from the insufficient achievements of reductionism in several scientific disciplines in their investigation of Nature.

The term “Reductionism” comes from the Latin “*Reducere*”: to diminish an entity towards the smallest, simplest and tractable parts. Actually, the reductionist approach allowed the discovery of a lot of new entities, new methods, new theories in the science domains. That’s why we must focus on *which* interpretation of reductionism does not fulfil the scientists’ community approach. Reaction against the reductionism is not a unique, a monolithic refusal of all of its principle, since we may distinguish three forms of reductionism: ontological, epistemological and methodological. In its first qualification, the ontological reductionism sees the Nature as made of particles, of elementary bricks of matter, so that we can decompose, quantify, measure, manipulate and foresee its behaviour. In the last twenty years, it is more and more evident that this is an outdated approach, as could be detected in biology, physics, medicine and so on.

In a complex system, every single part is connected to the whole in a double bind: it acts as a unit, as a part of a whole in a bottom up dynamics, but is submitted to the influence of the whole in a top down circuit and it shows, now and then, the so-called “emergent properties”. The emergent properties are phenomena that cannot be predicted *a priori* by observation of the system’s configuration. They arise from the interaction, the integration, the retro-action given by the feed back loop patterns.

The feed back patterns could be negative or positive. In the first case, the negative feed back tends to stabilize the whole system, dampening the oscillations around a mean value. A simple example of negative feed back is the thermostat present in most of the houses. A predefined value is set and the environment sensors supply the actual ambient temperature. The difference detected between the environment’s temperature and the desired one, generates a retro-input in order to increase or decrease the command to the heating system. On the contrary, the positive feed back lets the system deviate from a mean value so that every marginal difference will be amplified more and more, leading the whole system towards a new configuration (as an example, embryogenesis) or to its own destruction.

Let’s see now the epistemological reductionism, an approach that considers the scientific knowledge as a pyramid, with physics at the top. Since all disciplines could be reduced to physics, they must share the same view on Nature. In particular, if Physics, following a Galilean view, considers Nature as written in mathematical figures all phenomena should be investigated via a mathematical (numerical) approach. It is self evident that most of the biological disciplines, from palaeontology to ethnology, from medicine to psychology cannot be modelled simply within a mathematic framework.

It is really difficult to “reduce” the elements of every single discipline to the main paradigm of physics; so, we often encounter differences between the description of behaviours (i.e.: in Psychology) versus the prescription of the Law of Nature (Mechanics), the subjective historic interpretation (Palaeontology) versus the objective mathematical model (Thermodynamics), the final causes apparently reintroduced with the long distance action of the genome programmed to show its effects along the years (Evolutionary Biology), versus the deterministic computation of the genome matching (Molecular Biology). So, every discipline (to be said scientific) needs its own methods, its own language and paradigm. In this sense the epistemological reductionism is not suitable to cope with complexity. There is no “Queen of the Sciences”.

Finally, let’s see the methodological reductionism that reduces all methods to a master guide determined by physics. In this case, it is evident that not every experiment can be carried on inside a laboratory, with a foreseeable result that must comply with the error’s theory pre-defined in advance. It is evident as well that not every experiment can verify or refute the correctness of a scientific theory (*experimentum crucis*), since it is included in a broader set of assumptions that represents the background knowledge.

Measurability is another assumption of a methodology that follows the physical standard of testing.

2. Complexity

After this short introduction about reductionism, on which engineering is based, let's concentrate again on the definition of complexity. *Complexus*, in its Latin origin, means entangled, intertwined. In its very meaning it shows an impossibility to analyze a part without taking into consideration its environment.

In history of science and in epistemological life, the complex thought arose, following different streams of thought that left unaware their legacy to the next generation: the general system theory of Ludwig Von Bertalanffy, the studies of Robert Von Neumann and Norbert Wiener who initiated the cybernetics in late '40, the autopoiesis (self-creation) theory of Humberto Maturana and Francisco Varela, the eccentric, but resourceful, thought of Gregory Bateson. Nowadays, some authors like Fritjof Capra and Edgar Morin have found a kind of synthesis that, although it cannot be defined as a theory of complexity, nevertheless has reached a good level of theoretical achievement with their complex view on Nature, Life, Knowledge.

Given complex background knowledge, we must point out that, from an heuristic point of view, those approaches aren't yet fruitful, even though they help to set the right context for analysis. Although no relevant scientific discoveries have been claimed by those philosophers, nevertheless they contributed to investigate social and organizational life in a new perspective that could be helpful to imagine a new approach to safety based on the background knowledge provided by them.

Actually, resilience engineering has an approach that takes into consideration some aspects of complex systems even though not in a systematic way. Let's see some pivotal concepts in most of the theories orbiting around the main approaches to master complexity: the observer's role, the feed back loop, the impossibility of a thorough system description via simple and linear laws, dialectics between order and disorder, organization of structures, the role of chance, the hologrammatic principle, and so on.

Following the approach of Edgar Morin, who treated in a systematic way the complexity in all of its forms, starting from nature of Nature, the life of Life, the Knowledge of Knowledge, the Ideas and their eco-system, life and dynamics, we may propose, in a lesser and narrower perspective, the epistemological view applied to the aeronautical system to evaluate if the current approach is suitable to achieve higher levels of safety.

We'll see now why we opt for a philosophical approach as the new frontier of safety.

3. Accident Analysis: Why did it happen?

Let's start with the accident analysis history in aviation. Aim of an accident analysis is to determine the roots and final causes of the mishap.

At the beginning of civil aviation the accident investigation focused on human error, since most of the accident causes were attributed to poor human flying skills. So, the main causes were identified in distraction, fatigue, psychometric deficiencies. The solutions adopted relied on technology, introducing, for instance, the auto-pilot (to relief the workload management), the auto-throttle (to manage automatically the thrust setting).

At the time of the neo-positivistic trend, at around the '30 in the twentieth century, enduring till mid-60's, in the American variant of "standard view", the reductionism, with few, remarkable exceptions, was almost an ideological manifesto for scientists. Predictions, mathematics as universal language, reproducibility, measurements, were the key words welcome in the science community. According to this paradigm other disciplines followed that track: i.e., psychology switched to a behaviouristic approach, considering only the visible side (behaviour) of human activity since it could be displayed, measured, relegating the inner dynamics in a "black box". Psychologist considered irrelevant what was in the black box, since everything inside would have revealed itself in a tangible and measurable manner: the behaviour. At that time, big organizations were starting to acknowledge scientific management, the paradigm proposed by Taylor. The worker's performance was scheduled, measured, checked according to a clear concept of productivity.

In the Sixties a different approach emerged in epistemology, partly as reaction to the neo-positivistic view. Systemic approach replaced a strictly reductionist view and other elements of the whole ("holistic") entered the stage to be analysed. Popper, Lakatas, Feyerabend, Kuhn, apart from all their differences, set a new way of thinking, evaluating the dialectic of scientific knowledge, from its birth (psychology of scientific discovery) to its development (logic of scientific discovery) to its death (critics and replacement of old paradigms).

The constellation of principles connected with these theories influenced other specific disciplines like psychology and science of organization. Social psychology and the "total quality" concept were respectively two sides of the medal reverberating on big organizations. We are still talking about systemic thinking, which is different from complex thinking. In fact, as reductionism sees only parts, missing the whole, vice versa holism sees the whole missing the single parts.

Complexity theory keeps together these two visions, melting them together in a coherent context and investigating them in a top down as well in a bottom up approach. Here we are at the end of the Eighties. This kind of approach was needed due to the development of biology and other disciplines that cannot be investigated neither with numbers only, nor with generic views of the whole.

That's why we borrow now the methodological approach from biology (the new biology), commonly shared nowadays, waiting for the next paradigm shift. Translating the analytical and synthetic view of biology into big organizations we must set the correct level of analysis to determine at which level we should operate to ensure a safe level of operations.

Once the epistemic framework has been set we may look closer on how evolution took place in the aviation industry.

Historically, in aviation, the accident has been looked at as a disruptive event, and the system has been fixed following an accident. Often, research of the accident's causes stopped short of the wreckage of the airplane and the culpable was identified in the final user: we could call it "name and blame" approach. Once the responsible was identified there was neither a need for a thorough overhauling of the entire system nor for liability actions against the managers. Moreover, it avoided also the enormous retrofit cost connected to probable system's (hardware) failures.

Analysing the accident curve we see that the main cause of accident has been attributed to different factors along the years:

During the post war years, accidents in commercial aviation came from poor skill; during the Eighties they came from Human interaction onboard; today they come from the complexity itself.

To fix the main causes, different approaches have been implemented: engineering in the 50', psychological in the 80's, philosophical today.

4. Accidents and corrective actions - An evolutionary perspective

Let's see at the details which have been involved in the accident dynamics and the corrective actions taken to cope with the arising problems.

Around 1950 the main causes of accident were attributed to poor skill: loss of control, overspeed, stall, excessive bank angle, and so on. To fix these kinds of problems a change was due on the technological side: the introduction of the autopilot, the flight director, the auto-throttle, improved a lot the pilot's skills, providing redundancy to prevent distraction, fatigue and excessive workload. The engineering approach worked pretty well and following the introduction of those systems, the accident curve dropped sharply.

Nevertheless, barely a decade after such achievements a new kind of danger emerged, called "controlled flight into terrain": a kind of accident that involved a perfectly sound airplane that hits a hill, a mountain or an obstacle. The problem was identified by the investigators to be caused by poor human relationship inside the cockpit. To cope with this new challenge the industry aimed at the solution via a psychological approach: human factor studies flourished to explain why a crew doesn't interact correctly. The introduction of CRM (Cockpit resource management) or Crew resource management and eventually company resource management, were successful attempts to create an organizational climate able to let people work at their best.

But the accident curve, after a drop, started to rise again and even if the accident rate today is much lesser than fifty years ago, nonetheless we face an amount of take off and landing incidents that leads the public opinion to perceive a decrement in the air safety. Public perception may lead to economic disruption of the entire system, since an airplane accident has a worldwide resonance.

Nowadays, we are striving to understand from where the danger comes. Different authors agree about the main source of disruption: the system complexity itself, which creates a resonance effects, putting the whole system in jeopardize. How to cope with this new challenge? Our proposal is to reconsider philosophy, intended as the knowledge of the system's basic assumption, the acknowledgement of the scattered traps located beneath the "routine surface", which enables the final operator, the front line agent, to cope with unexpected, unwanted, undesired events that may arise from daily management. The main instrument to cope with complexity is training [6].

To recap, let's identify the new challenge: how to reach the lowest level of accidents happening, if not zero.

The main stream nowadays adopted to enhance safety are HRT (High Reliability Theory) and Resilience Engineering [5].

- HRT focuses on the imitation of the excellence centres as, say, the FAA (Federal Aviation Authority) in the United States. These organizations have a record of safety based on a continuous improvement of internal process, a thorough commitment to safety, a "just culture" [3] implemented to push forward a "no penalty policy". All those factors help to keep accidents at an acceptable low level.

- Resilience engineering, as per definitions given by Erik Hollnagel ([11], [12]) "aims to enhance the ability of organizations to create processes that are robust yet flexible, that can use resources proactively to accommodate for external disruptions or internal ones (e.g. production and economic pressures, human errors). In Resilience Engineering, failures do not the result of a breakdown or malfunctioning of normal system functions, but rather represent failure to adapt to real world complexity".

While the elimination of accidents (and serious incidents) would be desirable, a one hundred per cent safety rate is probably an unachievable goal [1]; Charles Perrow gave an extensive and detailed explanation in his "Normal Accident Theory" [17]. Failures and errors will occur, in spite of the best efforts to avoid them [2]. No human activity or human-made system can be guaranteed to be absolutely safe, i.e. free from risk [7]. Safety is a relative notion whereby inherent risks are acceptable in a "safe" system. The introduction of the concept of *acceptable level of safety* responds to the need to complement the prevailing approach to the management of safety based upon regulatory compliance, with a performance-based approach [19].

As we saw in this short introduction, historically, aviation safety focused on compliance with increasingly complex regulatory requirements. This approach worked well up until the late 1970s when the accident rate levelled off. But accidents continued to occur in spite of all the rules and regulations. This approach to safety *reacted* to undesirable events by prescribing measures to prevent recurrence. Rather than defining best practices or desired standards, such an approach, aimed at ensuring minimum standards, were met. Safety as compliance is outdated, on my opinion, since a lot of factors contribute to lower the threat's threshold.

5. The proactive approach

In order to keep safety risks at an acceptable level despite the increasing levels of activity, modern safety management practices are shifting from a purely reactive to a more *proactive* mode. In addition to a solid framework of legislation and regulatory requirements based on ICAO regulations, and the enforcement of those requirements, a number of other factors, some of which are listed below, are considered to be effective in managing safety. It must be noted that this approach complements, or is in addition to, the obligations of states and other organizations to comply with ICAO (International Civil Aviation Organization) or national regulations.

1. application of scientifically-based risk management methods;
2. senior management's commitment to the management of safety;
3. a corporate safety culture that fosters safe practices, encourages safety communications and actively manages safety with the same attention to results as financial management;
4. effective implementation of standard operating procedures (SOPs), including the use of checklists and briefings;
5. a non-punitive environment (or just culture) [3] to foster effective incident and hazard reporting;
6. implementation of systems to collect, analyse and share safety-related data arising from normal operations;
7. competent investigation of accidents and serious incidents identifying systemic safety deficiencies (rather than just targets for blame);

8. integration of safety training (including Human Factors) for operational personnel;
9. sharing safety lessons learned and best practices through the active exchange of safety information (among companies and States); and
10. systematic safety oversight and performance monitoring aimed at assessing safety performance and reducing or eliminating emerging problem areas.

No single element will meet today’s expectations for risk management. Rather, an integrated application of most of these elements will increase the aviation system’s resistance to unsafe acts and conditions. However, even with effective safety management processes, there are no guarantees that all accidents can be prevented. Here we cited some points of view about safety coming from authorities at international level. Most of them could be shared and joined, since they gather the basic assumptions from real operational life.

We just object that there are, nowadays in air industry, two opposite forces that often produce the conflict known as “production versus protection”. As far as managers try to keep costs at their lowest level, safety officers tend to lift expenses aimed at the safety improvement in order to maintain the risk well below a safety threshold. Every step towards a better safety level implies also its contrary, as two sides of the same coin.

- For example, technology is eroding competence in many areas traditionally linked to pilot’s ability: flying skills, computing and processing power, rule compliance.
- High levels of redundancy, while providing a better safety net against an accident, de-qualify the pilot who may discover not to be up to date to carry out his task in case of system’s failure.
- The only area left to pilots is the complex decision making, needed when there is no algorithm available to untie the “Gordian knot” related to critical decisions. Therefore, they are often made in a changing, ambiguous, hazy, environment, with no certainty that the final outcome linearly emerges from own actions.

It raises the question on how this knowledge could be available to front line operators like pilots. Here comes the epistemological side of decision making.

6. Knowledge based approach

A deep knowledge is requested in a professional community, via information sharing, peer to peer communication, informal networks, to detect even insignificant events, if considered at individual level or in a narrow perspective. Alas, as Sydney Dekker [6] pointed out, there is a tendency in the aviation industry that leads the pilot “to train for the test rather than for the task”.

The erosion of competence in a professional community is the main area of risk if we consider the next operational scenario, made of more and more actors, more and more technology. It must be clear a central concept in aviation: technology does not increase safety level, but keeps the risk at a constant rate, while permitting to increase productivity. So, it is vital to clarify which are the pilot’s competences that cannot be overridden by technology and why they shouldn’t.

The sources of knowledge, of a professional pilot, are:

- Theory,
- Experience and
- Flight data.

The theory is achieved via books, classroom lessons, specialized magazines, manuals and so on. It is transferable, checkable, public and subject to critics.

Experience comes from informal communication between peers, rumours, information given by understatement, and above all by the real situations witnessed in-flight, which, below the pilot's consciousness' threshold, provides a continuous feed back between expected outcomes and effective results. It also generates the "gut feelings", which cannot be entirely explicit, but are one of the main "drivers" during a border line decision making in a critical environment.

In particular, the resilience engineering approach relies upon the management of the unexpected. It is obvious that dealing with the unexpected is an ambiguous definition. In fact, in aviation, there are several concepts of "unexpected":

- First, to manage something not planned.
- Second, even if planned, things are running out of control or the outcome is not consistent with the planning.
- Third, something never happened before (i.e. terrorist attacks of September 11th).

The experience of a professional community relies upon information sharing, with a technical jargon that cut off most of the redundant information, so that it is hardly understandable by outsiders.

Having explained why the reductionist approach, made on measurability, quantification, observation of the whole de-composed in single components, is often unsuitable to analyse socio-technical system, we propose a rehabilitation of some philosophical aspects like description of relationship quality, cultural and sociological influencing the organizational mentality, catching the commitment of managers and employees with the so-called *esprit de finesse*.

Insight of the people living in the organization is fundamental, as is the sharing of the informal network to detect rumours, to breathe the organisational climate, qualities and characteristics that can be synthesized using a pertinent definition: "the artfulness of the intelligent worker".

Moreover, in a philosophical approach there is a latent inherent contradiction in the definition of resilience engineering. In fact, although most of the academics agree on complex systems unpredictability, on emergent proprieties, on flexible response to multiple environment demands, nevertheless they stick to an engineering approach that relies on measurability, reducibility, according to pre-defined models able to reproduce reality on a limited scale. While we may forecast the experimental outcome when in the laboratory, something very different happens in the real environment, where emergent proprieties appear, that are logically non-deducible from a given configuration.

So, the efforts to keep together philosophy (new approach to complex systems) and engineering is deemed to fail or to stay academic, as far as we try to translate the resilience engineering concepts and precepts in the real operational life. The paradox arises whenever we want to measure resilience comparing two given organizations: until a mishap occurs we cannot distinguish the two.

And it could also happen that an organization reputed resilient incurs in a mishap while others don't, raising concerns about the amount of investments in safety. Following the Morin approach, there is a way, based on the hologrammatic approach that conceives the general information regarding the whole as inscribed in the single part.

As we see in a cell, containing the DNA in which the entire body information is described, nevertheless the parts act as a part, while containing in itself the general order code. Translated into the real organizational life we may compare the DNA dialectics with training, aimed at the inscription of the basic information, regarding the entire organization, in a single front line unit: the pilot. This kind of information is valuable, because to cope with an ever changing environment we need a strategy, or a set of equivalent ways to reach our targets. Flexibility, creativity, renewal of old schemes in a new context builds the main resources to deal with the unexpected successfully.

On the contrary, in a pre-programmed activity, the more detailed the task, the less flexible the behaviour: This results in a tendency to inhibit the necessary flexibility, creating an obstacle to the adaptation to the new environment. That's exactly the message of the interpretation given by resilience engineering to the mishap: the inability to adapt to a changed environment.

We bring here just an example of how the introduction of technology gives rise to concerns about safety: the glass cockpit.

We consider some innovation and the impact on safety, since our assumption is focused on the new challenges to a resilient system represented by complexity. Our thesis is that complexity should be coped with philosophy of flight, pursued by pilot training.

With at a deeper scrutiny we analyze the introduction of some technological innovation and, evaluating pros and cons, we try to highlight the threat to safety caused by the mismatch between the potentiality of new useful devices and the shift in the mentality that follows. So, adopting the point of view of Sydney Dekker ([9], [10]), with his emphasis attributed to accidents coming from "normal people doing normal jobs in normal organizations", we'll try to provide practical examples of dysfunctional interaction between technology and safety.

Some concepts arose in the flight training, starting with the new generation of aircrafts of late 80's: glass cockpit, dark panel, flight management system, fly by wire, and so on.

The expression "glass cockpit" means that instruments onboard are displayed in an integrated rack, containing all the information in a single display which receives input from a central computer. The computer receives data from different sensors and processes the information to be displayed, whereas in the traditional cockpit every instrument (e.g.: the altimeter) had its own box that receives data directly from the relevant source of information.

"Dark panel" means that the overhead panel in cockpit is dark and flat; there is no switch, knob, lever, popping up from the panel, as in the traditional aircraft, built on the "touch and feel" philosophy, but the systems are activated pushing the relevant buttons. The feed back is provided by an illuminating integral light. The philosophy behind this new concept is that if the panel is obscured everything is OK. Failure or abnormalities are detected by an illuminating button, recalled by a master caution/warning light just in front of pilots' eyes.

On the contrary, during the past, pilots of traditional aircrafts were trained to operate the "blind panel", by covering the pilot's eyes with a cloth and challenging him to recognize at first touch every overhead panel switch without seeing it. Aim of this exercise was training of the pilot's skills for emergency situations, in order to activate the airplane systems even without looking at them.

It is not an implausible situation, after all. Imagine, say, the electrical smoke in cockpit and the impaired visibility given by a thick layer of dense, white fog. That's no other way than to act "by heart" to activate the systems. *Vice versa,* imagine a dark panel with smoke onboard. It is really challenging to spot where to place your hand and which is the system's feed back, since the system configuration is given not by the switch position, detectable also with the hands, but by an ON/OFF light, often undetectable.

What do all these concepts stand for? They represent a new philosophy of flight, based on fully automated flight, managed by a central system, which integrates several functions to compute the aircraft performances, optimising the vertical and lateral navigation. The inputs to the computer are given from a keyboard, the outputs are displayed both on the scratchpad of the keyboard and in the primary flight displays just in front of the pilot eyes. Moreover, information is displayed also via led's, caution lights, aural and visual warning and feed back forces on pilot's cloche.

There are several advantages of this new philosophy of flight: optimization of flight performances, workload relief, less maintenance costs.

7. Performance optimization

First of all, performances are optimised, reducing fuel consumption. The integrated data system provides continuously a set of options to fly at best performance. This computing capacity could not be achieved by a standard crew doing a normal job. I.e., the balance of the aircraft (to oversimplify: the flight attitude of the airplane) is obtained keeping it in an unstable equilibrium that by contrast requests a continuous adjustment to fly safely. Had a pilot to perform the same task to obtain such an optimum performance, he would employ too much energy and attention overstretching his flying capability. But this fuel saving technique could be easily achieved letting a computer fly the aircraft.

Another factor affecting safety is that the pilot's input are not immediately directed to the flight controls (ailerons, elevator and yaw) and connected to them via cables and rods as in the conventional aircrafts. The input given on the cloche is electronically sent to a central computer which gives an electronic input to the servo-mechanism that actuates the wing's surface. Obviously an electric failure is something really challenging, since most of the tasks are performed via computers. This provoked in pilots a sense of uneasiness due to the perceived capability to take over control and fly regardless any automatisms.

In the new philosophy, pilot should fly "together" with automatic control systems, understanding the implicit system's behaviour. But, due to the complexity of such integrated system, pilots hardly know the logic hidden behind the features they routinely use.

A case study helps to explain this concept, such as the airline flight with a newly introduced airplane equipped with fly by wire and glass cockpit. The co-pilot is de-selecting the ground stations that emit VHF signals in order to provide route information to flying aircraft in close range. In a sense, he is "playing" to practice on the new plane, a kind of "Hands-on training". After the de-selection of the tenth navigation aid, the aircraft suddenly de-pressurizes and the crew was forced to perform an emergency descent.

In conventional airplanes there is no connection between a navigation aid and the pressurization system. But the complex interaction between the airplane modules, unknown to pilots, caused the aircraft to de-pressurize. So, as first conclusion, pilots are trained to fly this kind of airplanes in a different way. Once, the pilots were requested to know precisely the entire airplane's systems in order to fix them or to take over control in case of failure or emergency. Now they are trained to "know what", not how. In a sense, they are becoming system's operators, flying with the "push the button" syndrome.

We'll see which of the threats are linked to this new approach to flight.

8. Workload relief

Flying with conventional aircraft requests the pilot to have a thorough knowledge of the environment, of navigation techniques and of the airplane performance's envelope.

The use of the weather radar is within the first topics. As for a surgeon the reading of an x-ray is something coming from experience, the interpretation of weather radar is vital for a pilot and experience too is needed. With conventional aircraft black and white displays it required a lot of experience to understand the severity of the clutter depicted on the screen. In a glass cockpit aircraft the integrated data provided by several systems like route displays, obstacles detection and traffic avoidance gives the pilot the opportunity, with colours screen, not only to have a clear idea of the intensity of the thunderstorm activity, but also to navigate according to the intended route, to the obstacle clearance and avoiding other airplanes flying in the vicinity.

Much easier: The reverse is that while for an expert pilot, the map displayed on the colour screen helps to lower the workload, for a new pilot it is sometimes over-redundant. In fact, as we said in the introduction, the pilot too reliant on the automatism, he doesn't know anymore which are the basic assumption of flight, he is prone to lose the situation awareness, geographically or related to the flight envelope (the flight management system is flying on your behalf).

In the USA, the FAA (Federal Aviation Administration) issued a main concern regarding the "back to basic" training, in order to provide the pilot the essential knowledge to understand the raw data that cannot be lost during the flight: altitude, speed, thrust. It is necessary to have an overview of the main characteristics of flight in order to take over control (or, at least, the managing of the onboard computer) to stay within a safe flight envelope.

Another problem with this kind of representation comes from its ergonomics: In an integrated instrument, like the PFD (Primary Flight Display) on a single screen several flight data are provided: speed, altitude, vertical speed, navigation aid, and attitude. On the conventional airplanes these data are displayed on several instruments. Even if in conventional airplanes the cross checked span in an area is wider along the panel, nevertheless information is displayed via drum instruments: a circle, dotted background on which a needle moves providing a "field vision".

Information can be grasped at first glance and difference between left and right instruments could be detected without focusing on the particular value. Just look at the needles and you spot if there is any asymmetry.

On the contrary, in the glass cockpit, information should be analysed to understand the real meaning of the displayed value. It is called "analytical vision".

Let's look at the difference in speed indication between conventional and glass cockpit. In the former we just see a needle moving clockwise to indicate a field of operation that we can classify as:

- dangerous area (speed to low to sustain the flight),
- normal area (speed is good in an area that permits to fly the normal performance envelope)

- limitation area (speed too fast, eventually leading to excessive strain to the aircraft surfaces).

In the glass cockpit, due to limited space to display too much information at the same time, only a figure is provided on a speed tape moving up and down according to the speed increment or decrease. For instance, when the pilot sees the figure 245 Knots, he must translate this analytical vision in something sensible to operate. This is time and energy consuming. Paradoxically, in normal operation the speed tape indicator is shown with colours and indexes that help the pilot to visualize the correct range of operations. Unfortunately, in some airplanes, when a failure occurs, all those markings are removed worsening the situation awareness of the pilot, already under stress to cope with the emergency in progress.

9. Training process and glass cockpit

When the glass cockpit philosophy was introduced, pilots strove to adapt to the new mentality and some accidents occurred for improper use of such airplanes.

For instance, the flight so far conducted in a "tactical" way. Information was displayed in front of the pilot's eyes and provided relevant data regarding the given phase of flight. Input and output were immediately accessible to the user.

In the glass cockpit, insertion of data in the flight management system was no more accessible at first glance. Both pilots should be aware of what is inserted in the computer, and a special kind of training has been introduced to work as an integrated team. Every pilot should cross check what his colleague is doing while manipulating the flight management computer, since a datum inserted in Rome could take effect on arrival in Los Angeles, twelve hours later.

For pilots trained directly on this highly technological aircraft it is vital to understand thoroughly the crew coordination and crew integration concept, so the interaction based on clear human factor principles is placed directly at the core of training for the next generation of pilots. The crew coordination is the specific task assigned to each crew member, while the crew integration is the capability to have an effective team work to reach the highest performance.

We may say that in the conventional airplanes the captain could fly alone, with some help of an assistant (the co-pilot). In the modern fleet, the crew must co-operate to carry on the routine tasks and above all to manage emergency situations.

It depends, mainly, on the kind of operation used in different airplanes. In the traditional ones, in case of emergency, the Captain usually takes over control of the aircraft and ensures the correct flight path, while the co-pilot manages the airplane's systems to comply with the degraded performance normally associated with an emergency. Nevertheless, the captain has the possibility to oversee what is going on, even if he is absorbed by augmented flying skills necessary to cope with the emergency in progress. He is able to do this thanks to the peripheral vision that enables him to know where his colleague is putting his hands (which area of the overhead panel he is touching) and to detect which system is being activated or deactivated.

In modern airplanes, when the captain flies the aircraft, he has no way to understand which system is being activated because the co-pilot inserts data in a computer, with no immediate feed back to the pilot flying [16]. Information sharing becomes obviously vital in such a situation.

Last but not least, a hint over some concepts often misunderstood, namely the difference between user's friendly system and the pilot's friendly systems. A user's friendly system is something that takes into consideration the ergonomics of the cockpit, i.e., how to reach the switch to operate a system, or how the operator could see a display or how to calibrate the volume of a warning chime.

Pilot's friendly concept is somehow different because it takes into consideration how a pilot thinks. For example, what is needed to be displayed on a screen, in which colours, how often. Every warning or caution light should be significant.

To display too little or too much makes no sense in terms of the pilot's needs [21]. Recently, a software firm was implementing a new system to reduce, or avoid, the runway incursion phenomenon. The engineers first designed the system, regardless of the final user opinion. Only at an advanced stage of the project the pilot was asked if it was suitable to operate and if it could be useful, according to his needs. Regretfully, the test pilots said that most of the features were nonsense, since no pilot would use a display in particular flight phases. Even if, according to the engineers, the system was user friendly, the project had a stop to re-evaluate some human factor principles according to the final operator's needs.

10. Conclusions

Considering the introduction to reductionism, on which engineering is based, the new concepts of safety (HRT and Resilience Engineering) were pointed out: the paradox of a combined approach between engineering and philosophy.

Both are needed, but there is a latent contradiction in their co-existence in the training process. While engineering tends to reduce elements to single parts, philosophy recognize the emergent properties arising from the complex system behaviour as such. A pre-programmed approach (technological) strives with a strategic approach (mainly human) in an ever changing environment.

Unfortunately, another paradox affecting pilots emerges in this area. While airplanes are designed to be flown as users rather than pilots, limiting the pilot's knowledge to a minimum needed to carry out simple tasks, a much more widespread knowledge is requested to cope with more technology in a jammed environment, in which human interface interaction plays a dominant role.

Technology requires knowing less; environment requires knowing more.

A shift in the pilots' training programmes is necessary to cope with new challenges: from human-machine interaction of the 1950's to human-human interaction of the mid 80's, to human-environment interaction of today.

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DEPENDABLE SYSTEMS, EMERGENCY INTERVENTIONS AND ORGANIZATIONAL PROCESSES

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Abstract

First responders (fire brigades, ambulance services, police forces) are the first ones to be on the site of an emergency trying to intervene. We interpret such interventions as a 'compensating processes' to the effects of a menacing system which caused the emergency. This allows us to apply concepts of process view and process assessments from software engineering enabling the assessment and improvement of emergency interventions.

1. Motivation

Natural and man made catastrophes have always threatened people. In the last decades both the awareness of threats and the occurrence of actual catastrophes (many of them man-made or at least triggered by human activities) has grown. Very soon it was recognized that specialized organizations were needed for eliminating or at least mitigating the negative impacts of such catastrophes. Already in 23 BC the Roman Emperor Augustus established an organization of fulltime, professional fire fighters (vigiles).

From a broader perspective we can make several observations:

- Today's catastrophes usually endanger considerable more persons and larger areas in more diversified ways.
- More effective methods are needed as countermeasures and the interplay of several organizations of so-called First Responders, e.g. fire brigades, ambulance services, police forces, becomes more important.
- A holistic, systemic approach to interventions is needed if we want to avoid additional dangers to life and property and a long term deterioration of the environment.
- The basic objectives of interventions are largely analog to (re-)establishing and ensuring system properties which are required from *dependable systems,* namely ensuring *safety, reliability, availability, security, maintainability, survivability, etc.*
- Today it is understood that the quality of an enacted process [4, 8] be it for building dependable software systems, for maintaining existing systems or for performing interventions during catastrophes is a key to success.
- Methods from the field of software development [9, 12, 13, 18] can also be taken over in order to evaluate and compare arbitrary processes with respect to their capability, efficiency

and effectiveness. They can be applied in all areas mentioned above and be transferred in an interdisciplinary fashion.

In this paper we will discuss intervention processes for First Responder from the viewpoint of dependability of systems. The basis is the project SimRad.NBC [7, 28] which concerns itself with the training of First Responders in view of emergencies due to 'invisible' dangers caused by nuclear, biological, chemical and atomic sources.

The structure of the paper is as follows: After discussing our concern with First Responders' in emergency interventions (section 1), section 2 looks at issues of the dependability of systems and the relationship of properties of systems and subsystems. This leads to considering an intervention as a dynamic subsystem attempting to compensate a menace caused by another subsystem (section3). The identification of the intervention as a bundle of processes (section 4) leads to section 5 where we look at possibilities to assess the organizational maturity of the organizations responsible for such interventions.

2. Looking at the dependability of systems

From a stakeholder's or even more a user's viewpoint dependability is a highly desirable property of a system: roughly speaking dependability means that the system behaves as expected. As a consequence dependability is a complex property and its definition has undergone considerable modifications in the last few years. Erwin Schoitsch [27] discusses the dependability properties shown in Figure 1.

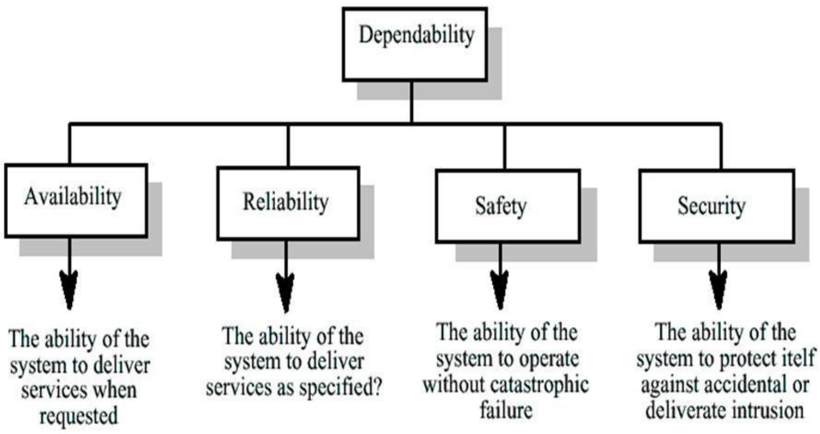

Figure 1: The components of dependability

When considering dependable systems we expect them to fulfil the properties as shown in fig. 1 to a sufficiently high degree. Besides the volatility of the notion of dependability also the notion of 'system' is volatile. A common phrase is: a *system is in the eye of the beholder*. From a systems standpoint systems usually consist of subsystems.

Issues of dependability strongly depend on the definition of the system's boundaries and thus have to take into account the chosen/considered system boundaries (Figure 2). Each of the subsystems (cf. Figure 3) will also possess (different) dependability properties. Despite a common definition these properties also change their pragmatic meaning when moving up or down the system/subsystem hierarchy: the reliability of a computer chip is - intuitively speaking - quite different from the reliability of an atomic plant although the unreliability of the computer chip might be the cause for the unreliability of the atomic plant. When composing a system from subsystems (components) the properties of the resulting composed system (and their predictability!) are one of the key issues of software development [10][25].

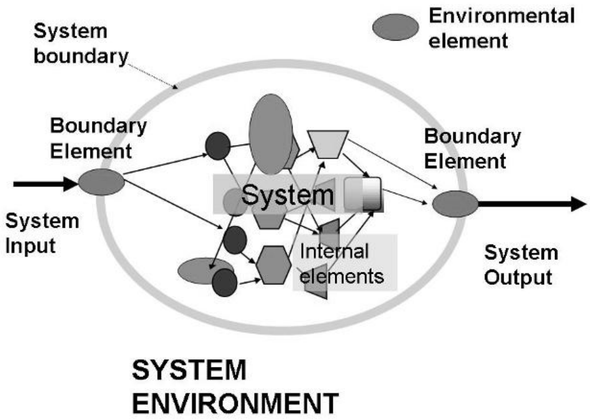

Figure 2: Basic notions of a system

A major question is: "How do the properties of individual subsystems of a system contribute to a system composed of them?" Deriving the properties of the total system from the individual systems' properties is far from trivial, it may include 'surprises' (emergent properties!) and is often not amenable to computation.

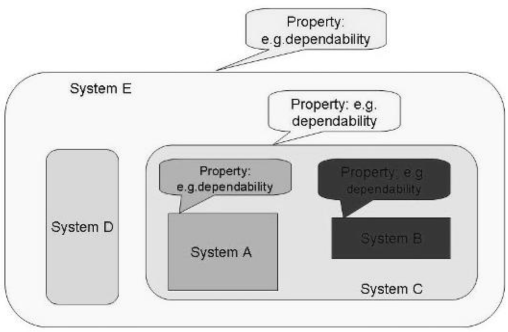

Figure 3: Hierarchy of system properties

A property P_i of a system is basically influenced by the following factors:

- The aggregation/summation of the corresponding properties p_{ij} of its j subcomponent (Trivially the weight of a system is the sum of the weights of its components)
- The influence of k additional properties of the subsystems p_{kj}. Typically increasing the security of a system often reduces the useability (Mounting three locks on a door increases security but makes unlocking more cumbersome).
- These properties of the system depend strongly on the structure, arrangement and interfacing of the subcomponents (It makes a difference in strength if two chains are attached in parallel or one after the other). In general different properties P_i may depend in a completely different way on the structure and the components' properties.
- As a consequence of above factors a system may exhibit 'unexpected' behaviour due to the appearance of so-called emergent properties. The notion of emergence is a key to

understanding the notion of 'system'. This is loosely expressed by *"A system is more than the sum of its parts"*. The theory of emergence is still highly controversial [1, 2, 6, 14, 26]. A well-known example of emergence is the vibration of a car if a wheel is not well balanced. Emergent properties are strongly dependent on the structural arrangement of the system's subsystems.

- An additional factor is time: systems change their behaviour over time, especially if we consider feedback and systems with memory [22].

Above factors are a key to the behaviour of a system consisting of components. An extensive discussion of this can be found in [5].

Thus the i-th property of a system can be expressed as

$$P_i(t) = f_i\,(S(t), P(t))$$

where S(t) is a representation of the system structure and P(t) denotes all properties p_{kj} of all k components of the system. We call f_i the aggregation function for property i.

3. Looking at Interventions as a Compensating Subsystem

3.1. The concept of Compensation System

It is known from many technical applications that one is able to construct dependable systems composed of components with less dependability. This is achieved by having several components which interact with one another and 'compensate' undesirable influences. Broadly speaking, in the total system we employ next to the menacing system additional components which act as compensating system, see Figure 4. In this sense we can consider the actions of the First Responders in an emergency as a compensating subsystem attempting to reduce/eliminate the undesirable effects of the total system (menacing system and compensating system).

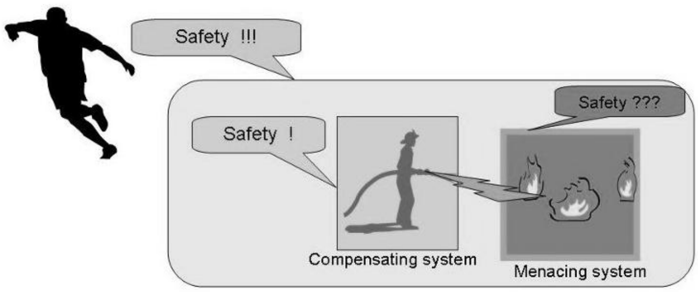

Figure 4: System with compensating action

With respect to the interaction between the menacing system and the compensating system we have also to take into account that the menacing system is dynamic, changing over time. This time dependency can be internal (e.g. a chemical source or a house on fire change their properties over time) and/or due to changes caused by the compensating system, e.g. by neutralizing the chemical substance or fighting the fire.

This property is related to the notion of autopoiesis: "*The condition of a system able to regenerate itself by self-reproduction of its own elements and of the network of their characteristic interactions*" [11, p.52]. This notion has been introduced by Humberto Maturana: "*... there are* *systems that are defined as unities of networks of production of components that ... recursively, through their interaction, generate and realize the network that produces them; ...* "[24, p.21].

4. Looking at interventions in a process way

We can observe that by including ’compensating systems’ we can enhance the dependability properties of a given system. An outside stakeholder might not be interested in how a system manages to achieve highly desirable dependability properties, as long as the properties can be guaranteed. Thus we can consider the intervention of First Responders as seen from outside of the boundaries of the system (Figure 4) as an attempt to maintain the desirable properties of dependability in a autopoietic way. Since a dynamic system changes over time (specifically the menacing system!) the intervention must also be a dynamic system.

The key to interventions (First Responders!) are humans. This means that the ’compensating system’ is a socio-technical system. It has to perform numerous activities to achieve its mission, i.e. it is a complex process, which consists of numerous individual processes.

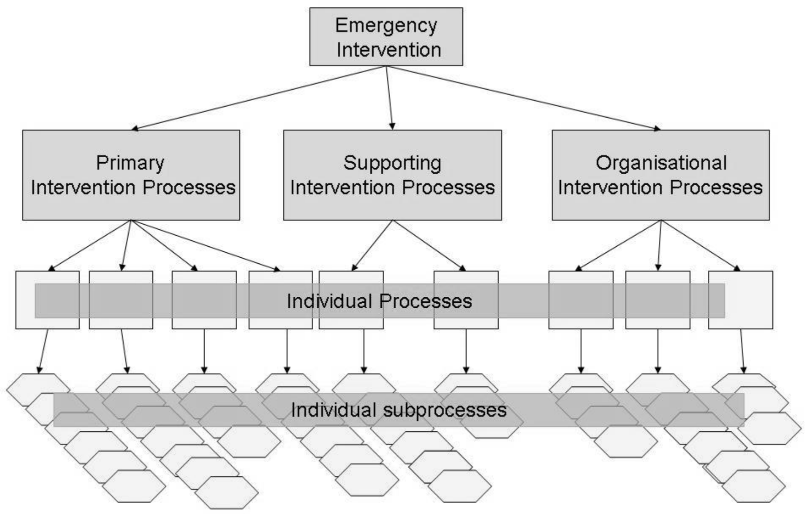

Figure 5: Hierarchy of Processes

Following ISO/IEC 12207 [20] the processes to be enacted by the First Responders can roughly be classified into three essential categories (see Figure 5) [8]:

Primary Intervention Processes consist of processes that serve primary purposes and goals of the intervention, in our case resolving/eliminating/mitigating an emergency. Examples are: Reaction to an Alarm, In-situ Analysis, Evaluation of a Situation, Making Tactical and Strategic Decisions, Actual Intervention, Terminating an Intervention.

Supporting Intervention Processes consist of processes that support other processes as an integral part with a distinct purpose and contribute to the success and quality of the intervention. A supporting process is employed and executed, as needed, by another process. Examples are: Communication, Management and Coordination, Accounting for Human Reaction, Utilizing Electronic Decision Support.

Organizational Intervention Processes consist of processes employed to establish and implement an underlying structure made up of associated processes and personnel by continuously improving the structure and processes. They are typically employed before and after a specific intervention and utilize lessons from interventions and from theoretical considerations in order to improve the organization. Examples are: Training, Process Evaluation and Optimization, Reporting, Failure Prevention.

5. Assessing Organizational Maturity of the Intervention

5.1. Basic Concepts of Process Assessment

It is reasonable to ask "How good are the processes of an intervention?". In industry the primary interest is in product quality, hence standards like ISO/IEC 9126 [16] and today ISO/IEC 25000 [17] were created. It turns out, however, that for any product beyond a minimal sophistication (e.g. software) the quality of a product can only be ensured consistently by establishing and following a quality process. One of the early approaches was the standard ISO 9000. In the software industry, due to the non-physical nature of the products and the complexity of the development process soon further (de-facto and de-jure) standards appeared, e.g. ISO 12207 [20].

The seminal book "Managing the Software Process" by Watts Humphrey [15] triggered a strong focus on the software process and lead to various assessment standards: CMM [15, 13], CMMI [3, 23], Bootstrap [12], SPICE and ISO/IEC 15504 [9, 18], etc. While ISO 9000 essentially only provided a binary verdict 'passed/not passed', the other assessment standards went further: CMM and later CMMI introduced the notion of 'maturity level' of the processes. Bootstrap and ISO 15504 additionally introduced the splitting of the maturity evaluation into individual processes, thus providing a profile of the individual processes of the production process (Figure 6).

These assessment methods assess a specific organization with respect to a so-called reference model. ISO 9000 is based on the existing process model of the assessed organization. CMM, CMMI, and Bootstrap have their own ('internal') reference models. ISO/IEC 15504 separated the assessment process from a direct association with a specific reference model. The essential assessment process is defined in ISO/IEC 15504 part 1 and 2. The process reference model can be chosen from several models. Each of them has to conform to a set of 'formal' requirements in order to be 'conformant'. Current conformant process reference models are: ISO/IEC 12207, ISO/IEC 15288 [19], and Automotive SPICE. Others will follow. For ISO 15504 the result of an assessment is (see Figure 6) a list of processes on the x-axis and their capability on the y-axis.

Part 7 of ISO/IEC 15504 [21] contains an Assessment Model for 'Organizational Maturity'. It states: "*As defined in this part of ISO/IEC 15504, organizational maturity is an expression of the extent to which an organization consistently implements processes within a defined scope that contributes to the achievement of its business goals (current or projected). An Organizational Maturity Model is based upon one or more specified process assessment model(s), and addresses the domains and contexts for use of the process reference model(s) from which the process assessment model(s) are derived.*" Typically [21, section 5.4.3] defines the scope as "*one more site locations, one or more geographic units, ... one or more organizations, ...*".

Thus one distinguishes between the process capability concerned with the quality of a process leading to a quality product and the organizational maturity which is concerned with the capability of an organization to maintain its quality processes. The two scales, while consistent, characterize different attributes of separate entities: the process and the organization.

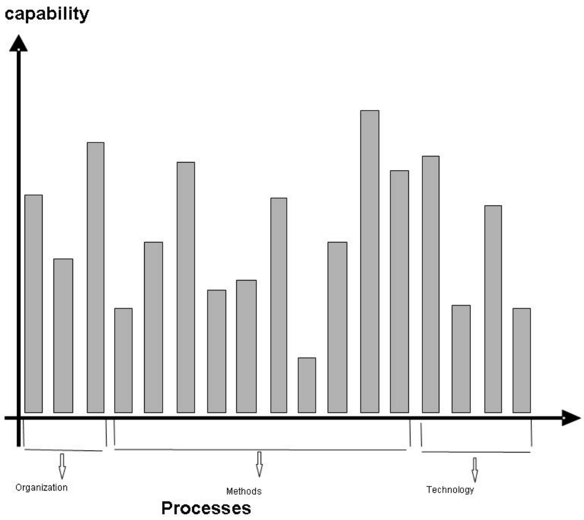

Figure 6: Process profile

5.2. Considerations for Intervention of First Responders

The discussed reference models essentially expect a more or less consistent set of actors with the ultimate objective of producing a product. For First Responders two essential differences exist:

- The intervention is successful, if the created status is as good as the status before the catastrophe.
- Many teams of First Responders with different methods from different locations and organizations with different (and unknown) knowledge, experience, and background participate.

Thus for the processes and their assessment a third dimensions has to be considered: compatibility of methods. An assessment over the various organizations should therefore result in a model with methods included as a third dimension (Figure 7).

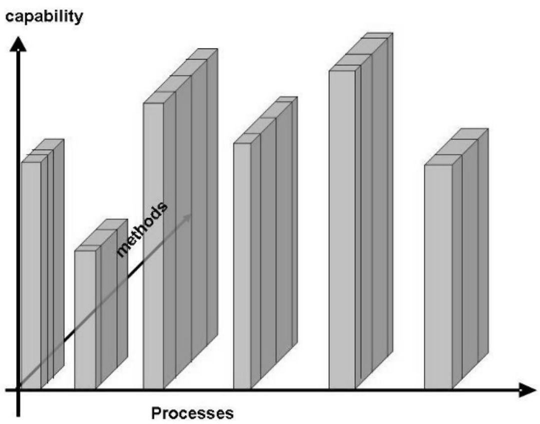

Figure 7: Process Capability and Methods

6. Conclusion

In this paper we have shown how a systems view and a process view offer interesting approaches to the assessment of interventions of First Responders. The systems view allows to better understand the interaction of the processes of the menacing system and the intervention as a compensating system in order to maintain the (outside visible) system properties within acceptable or desirable limits. The process view allows, based on standard assessment methods like ISO/IEC 15504 from the systems development domain, to assess the quality of the intervention processes.

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CONCEPTS FOR THE DEPENDABLE OPERATION OF AUTONOMOUS ROBOTS IN INCOMPLETELY KNOWN ENVIRONMENTS

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Abstract

Autonomous robots have to be able to tolerate not only component faults, but also disturbances of their gait or trajectory, caused by unknown external environment influences. With respect to this goal, traditional rule based approaches seem to reach their limit. Therefore, in this paper we consider the application of adaptive filters to make rule bases more flexible. This is discussed for the cases of traditional rule bases as well as fuzzy logic systems.

1. Introduction

Actually there is a trend towards embedded systems, as e.g. robot systems, where computing and control elements are dispersed in other physical components so that no clear separation is possible any more between computer components and their environment. Thus, for considering system dependability, also the dependable operation of non-digital system components more and more is felt necessary to be analyzed and improved.

In this context, the problem arises that for many of these areas, the details of fault mechanisms are either not fully understood, or they imply extremely large amounts of computing time to model them adequately. This problem is further aggravated if instead of considering just the malfunction of robot components, the influence of moving autonomous robots in environments which are partially or mostly unknown, is considered. Here, the impact of sudden, unknown conditions or events that might disturb the gait of the robot or other aspects of its operation, can produce effects that are equivalent to the impairing influence of component faults. Especially, sudden danger of steep gradients in the ground surface (holes, steps, channels, edges etc.) which are not easily detectable, might affect the robot´s actual movement, and, by leading to accidents, impair its health. So, there is the further requirement to achieve robustness against such unknown, undesired external effects [1].

For such situations, the classical artificial intelligence techniques, based on organizing expert knowledge in a fixed set of behavioural rules, have turned out to be insufficient. As a remedy, various adaptive strategies can be considered. One main class of such methods is based on “blind learning” from experience gathered during operation. Here e.g. adaptive filters have turned out to be promising candidates. Therefore, in section 2 we consider approaches also to apply such strategies for compensating operational disturbance, caused by external environments of robots. Alternatively, it can be tried to make rule-based approaches adaptive. In section 3 we shall describe concepts for such approaches, based also on additional use of adaptive filters.

2. Use of Adaptive Filters for Control in Unknown Environments

2.1. Basic Properties of Adaptive Filters

Especially for real-time applications, also simpler models of adaptive learning have been proposed, the so-called adaptive filters [2,3]. The adaptive filters are based on the use of a "history array" of parameter snapshots, which, with different weights, are used for the generation of output signals.

It is the basic strategy of adaptive filters to change linear parameters of the processing algorithm so that this error is minimized. With regard to the optimization strategy, there is a large variety of solution approaches. With regard to system topology, the most widely used class of adaptive filters is the so-called transversal structure [2].

The operation mode of the transversal structure implies that the generation of an output at a discrete time-point n depends on the "history array" of previous input values x(n-i) as follows:

$$y(n)= \sum_{i=0}^{N-1} w_i(n) * x(n-i)$$

Here, w_i (i=0,...,N-1) are the filter weights and N is the filter length. The filter weights are updated according to an adaptation algorithm. Standard adaptation algorithms usually try to minimize the error according to the method of least mean squares (LMS). For LMS filters the updating of weights is carried out according to the simple formula

$$w_i(n+1) = w_i(n) + 2\ k * e(n) * x(n-i) \quad (i=0,...,N-1)$$

Here, k is the so-called step size parameter of the algorithm. So, with regard to their computational structure, these adaptive filters are very simple.

2.2. Application to Behavioural Control

In [4] we have described how adaptive filters can successfully be implemented for the automatic masking of local faults in robot legs. In addition to this automatic compensation of local faults, adaptive filters, might, due to their very quick computational speed, be an appropriate additional check and correction method to control the stability of the robot when it is mainly being under the management of the rule base decisions, at a higher system level. This can be realized by implementing adaptive filters as additional checker elements for the main control variables that govern decisive stability criteria, as e.g. the angle of orientation of the main robot body with respect to the horizontal plain (inclination angle), and the first and second derivative of this entity. The implemented filters can the be trained, to autonomously trigger involved servo motors to either larger or smaller motor strength, to hold the robot within an uncritical orientation range.

3. Adaptive Rule Bases

3.1. Basic Mechanism

To make the application of a given rigid rule set more flexible, first we need to define under which conditions and in which way this rule behaviour is to be changed. The main idea is to make a rule set adaptive by adding a mechanism, by which the influence of the individual rules can be changed, on the one side depending on their managing a successful behaviour, or, on the other side in relation to causing tendencies towards mission failure. Initially, as a basis we have to define the notion "succesful behaviour" for the robot operation in a partially known environment. Here we make the assumption that such generally succesful behaviour comprises a number of core aspects with regard to maintaining the basic operational stability of the robot, as e.g.

- inclination angle of the main body;
- holding of velocities and accelerations of decisive components within uncritical ranges;
- maintaining a certain timeliness of movement if this is required in connection with the robot mission;
- successful execution of secondary goals as finding, identifying or manipulating of certain objects.

The contribution of these aspects to general success is then modelled by a metric mapping the influential values to a 1-dimensional real number interval [0,1]. This mapping is to be called the general health function (GHF) of the robot. The value of the general health function can be continuously monitored, and compared with threshold values representing satisfactory/optimal behaviour: These threshold values can be either rigidly assigned, or dynamically computed, the latter again by an adaptive filter that has been trained to reproduce a behaviour assumed to be correct, for the actually measured (or assumed) general environment conditions. If a non-negligible difference to that value is resulting, the influence of the rule set on the behaviour has to be changed; this will be described in more detail for the cases of classical rule bases and fuzzy rule bases.

There might be also the situation that there is a number of quite "orthogonal" key system parameters. In this case, the general health function can be assumed to be a product of partial functions correspondingly called orthogonal health functions (OHFs), each of these functions being independently derived by means of an own metric of orthogonal system parameters. Under this condition, the principles discussed can be realized, by applying them independently to the different OHFs.

3.2. Adaptivity for Classical Rule Bases

We need adaptive methods which enable us to upgrade knowledge for experience in (partially) unknown situations with, however, if possible, avoiding damages caused by moving the robot in the unknown environment. In the project ORCA, we are analyzing such problems by the example of the autonomous hexapod robot OSCAR, developed at the University of Lübeck [5] .

One possibility is the use of a rule base that by its organization can adapt to environmental changes: We have a set of predefined rules; each rule is triggered by certain specific environment and machine conditions. However, in addition to classical rule based approaches, as additional influencing element, so-called rule weight factors are associated to each rule.

Often situation conditions appear, where different rules can be applied. While starting more or less with an arbitrary choice of one rule among the set of applicable ones, the success or failing of the rule application is memorized by an updating of the weight factor associated to that rule. So, while at the beginning of operation to the rule weight factors of all rules equal start value are assigned, by the course of the robot operation these values might be changed.

Then, for subsequent rule selections, among the applicable rules that one is selected which has the largest weight factor value (deterministic strategy). For time periods where a positive or negative effect of the applied rules is not clearly showing up, as a weaker operation mode also stochastic selection among the applicable rules might be considered, i.e. here the probability of selecting one rule among the applicable ones is proportional to the weight factor of the rule.

3.3. Adaptive Fuzzy Rule Bases

3.3.1. Basic Principles of Fuzzy Rule Systems

Another approach for rule-based systems are the so-called fuzzy rules, to enable decision-making based on not completely precise, “fuzzy” information. Let us describe the basic working principle of fuzzy rule systems again by the example of an autonomous robot which receives certain input signal variables from the values of which decisions have to be made about the values of output signals which then control certain actuators for moving the robot.

Here, it is usually (except for the case of disturbed signals which we shall not consider here) not the problem that the values of the input signal variables are not distinct (i.e. they usually possess distinct, “crisp” values, e.g. integer or real numbers), but to interpret them in a distinct manner, i.e. the semantics of the signal value might be fuzzy.

So, to draw conclusions in such a situation, as a first step of the fuzzy decision calculus, the crisp input signal values that are to be used for deciding about the actual fine grain robot operation, are “fuzzified” into so-called linguistic variables, which have, as their values, fuzzy terms like e.g. “warm” “ cold”, “great” “middle”, “fast”, “slow” etc. To each fuzzy term we assign a so-called fulfilment function having as result range the real number interval [0,1]. It repressents a “degree of intensity”, i.e. how strongly each given crisp value is corresponding to the fuzzy term.

Moreover, there is given a set of fuzzy rules, setting fuzzy variables in relation to other variables that are to govern the output control signals, which then trigger the intensity of action of certain actuators. Usually all rules, for which the fuzzy transforms of the crisp input control signal fulfil the left hand side of that rule, are concurrently activated.

Such a concurrent activation of certain rules is called an inference. For an inference, the effect of an activated rule on the fulfilment function at its right hand side can be measured by the area under this fulfilment function. To obtain, for one inference, a common result reflecting the influence of all rules activated in this case, the union of these areas is formed.

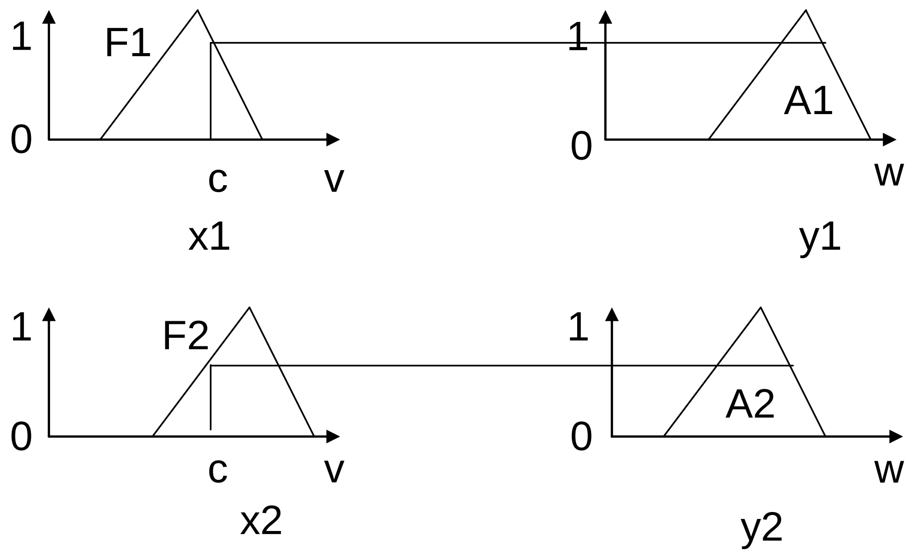

Figure 1 At left side: fulfilment functions f1 and f2 of two fuzzy terms x1 and x2, respectively, of an input entity v; right side: fulfilment functions of an output function w depending on x1 and x2 by means of the fuzzy rules R1: "IF v=x1 THEN w=y1" and R2: "IF v=x2 THEN w=y2"

In Figure 1 as a simple demonstration example, the fulfilment functions F1 and F2 of two fuzzy terms x1 and x2, respectively, of an input entity v are shown. An output entity w depends on v according to the two fuzzy rules

R1: *IF* v=x1 *THEN* w=y1 and

R2: *IF* v=x2 *THEN* w=y2.

For the shown crisp value c of entity v, the left hand sides of both of the rules are fulfilled, i.e. both of the rules are active. Carrying out the first rule for the crisp value c means that the area under the fulfilment function of y1 is truncated at the height F1(c), creating the area A1. In a corresponding way, for rule R2 the area A2 is resulting. As both rules are active, the common result area is given by the union of A1 and A2.

In a final step, from this area as the output result of an inference of the fuzzy rule base, again a crisp signal value for controlling an actuator has to be gained. This is for instance carried out, as one classical method, by computing the center of gravity of the mentioned area; from the crisp coordinates of this center of gravity then the desired crisp actuator control signal is directy derived. A detailed description of the operational principles of fuzzy rule bases sketched here can e.g. be found in [6,7].

3.3.2. Adaptive Fuzzy Rule Systems

As a main new mechanism, to each fuzzy rule an additional weight factor w_r is associated. If a rule, usually concurrent to other activated rules, is active during an inference, its fulfilment function is scaled up or down, by multiplying it with the weight factor. In the same way the truncation height h_{tr} has to be changed by this factor:

$h_{tr}* = h_{tr} * w_r$

Then, to complete the computation of the height $h_{tr\ RHS}$, where the fulfilment function of the rule´s right hand side is truncated, the minimum of $h_{tr}*$ and 1 is formed:

$h_{tr\ RHS}= \mathrm{Min}\ (h_{tr}*,1)$

The latter operation represents the condition that the truncation height can be at most 1; this latter case represents the strongest activity of the rule that is possible, i.e the situation where no truncation of the result areas occurs any more. Thus, we have created a mechanism to change the truncation height, and, correspondingly, also to change the result area under the fulfilment function at a rule´s right hand side.

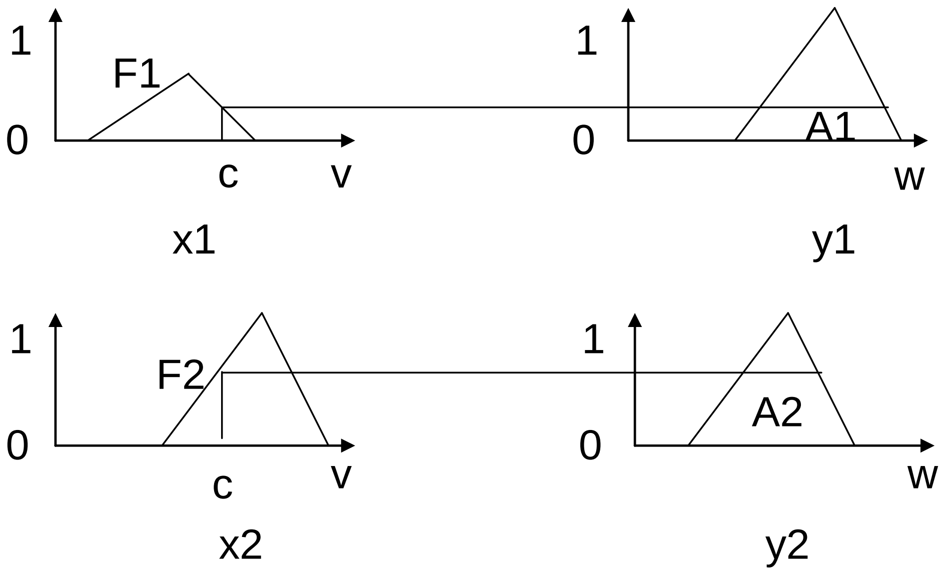

Figure 2 For the example presented in Fig. 1, now the fulfilment function F1 of x1 is scaled down by a weight factor, whereas F2 is left unchanged. This causes a change of the area A1, and, thus, also, of the entire result area that is formed by the union of A1 and A2.

In Figure 2, for the example treated in Fig. 1, now the fufilment function of x1 has been scaled down by a weight factor. It can be seen that correspondingly the result area changes. Thus, also the union of the two result areas is changing.

For each of the rule weight factors, an individual adaptive filter is associated, for controlling and updating this weight factor. At inferences, where the considered rule is not active, also the associated adaptive filter remains passive, and, as a consequence, the weight factor remains unchanged.

Changing of the weight factor depends on

- the resulting change of the general health function after an inference (either toward “success” or toward “failure”) and the amount of that change;
- the influence of the considered rule among the other activated rules of that inference step (measured in terms of its result area compared to the union of the result areas of all active rules).

The rule´s associated adaptive filter is trained to transfer such tendencies into a modification of the weight factor (increasing its value in case of positive influence of the rule application in the inference, decreasing it in the opposite case).

It should be noted that this operational scheme implies that the associated adaptive filter is not active at all inferences of the rule base operation. Instead the filter activity is asynchronous, event-triggered in contrast to most other adaptive filter applications where we have synchronous operation of the filter.

3.3.3. Deriving More Precise Rules

The described mechanism can also be used to “grow up” detailed rules from more vague original ones. Such an original vague rule can be characterized as follows: The fulfilment function of its left hand side is relatively flat, i.e. it has a broad range where it is larger than 0, and, on the other hand, also a relatively low peak. In addition, experimentally mutations of this rule are produced, where the left hand side fulfilment function has a narrower range, but a higher peak. Then, the use of such more specialized versions of the rule, together with the original vague rule, is monitored, and according to success or failure tendency, the influence of the mutations is changed by updating their weight factors. So, under the shelter of the “mother” rule some successful child rules might be grown up, whereas other, less successful child rules loose their influence and might finally be negligible.

4. Conclusion and Future Research

In this paper, we have discussed a spectrum of methods to adapt robot control also to suddenly changing external situations. As solution strategy, the application of adaptive filters has been described. Also, the combination of such filters with rule based systems has been considered. This has been carried out for classical as well as for fuzzy rule bases. Future work will focus on the implementation and evaluation of the discussed concepts.

It should be noted that the application of these strategies, described by the example of robot control for the movement of autonomous robots in unknown environments, can be further generalized to other fields of technology, or, also to general fields of organizational systems, e.g. companies in the field of economy [8].

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THE ASSOCIATION REACTOR IN A HUMAN-LIKE ROBOT ARCHITECTURE CONCEPT: AN INTERDISCIPLINARY APPROACH

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Abstract

One of the key abilities of an human-like robot architecture is to associate perceptions collected through robot's senses with similar perceptions from the past. A component called "Association Reactor" in the human-like architecture concept is demonstrated in the form of a win32 application, which was created using the .NET platform in Visual Studio 2008 with a SQL database as a memory of perceptions. The principles of association detection are based on a multidimensional perception model where each dimension represents a connection to similar perceptions. Some considerations about consciousness, reliability and performance of human-like robotic systems in general are completing the paper.

1. Introduction into the concept

At present, computers have the ability to quickly compute large-scale requests and instructions, but do not understand what they are doing. They work primarily with data, information, possibly with embedded knowledge "by man", but generally computers do not understand (in the strict sense) what they do. If you want the computer to understand, what it works with, I recommend to be inspired by the human cognitive system, to analyze its natural principles of thinking, to understand how one works (at least in key areas for the purposes of artificial intelligence), and construct an architecture, which will operate in a similar (but not identical) way.

In the first experiments of the laboratory KIT FIS VŠE several years ago, I quickly realized that in order to begin to explain words (used for communication) to a computer in order to make a computer "understand", we come across the problem of a looping definition. I can explain one word using others, but those must be already understood or defined.

If we do not want the computer to work with words, like we would work with words of a totally unknown language (e.g. Arabic or Chinese), without understanding their significance and depth, we must first create a reference set of words of knowledge and abilities, from which we can only infer and improve something. (The child first must absorb many things before coming to the ability to create creatively in an abstract way new ideas using its acquired ideas and skills.) This reference set of understood words, therefore probably cannot be defined by any other words in a cyclic way. How do I solve this problem?

To have this question answered, let’s have a look at the process of how words are created. The first words of a child are usually the repetition of what it hears. It is an attempt to reproduce in words a perception that is often repeated.

I presume that very soon the child begins to understand that if s/he can repeat a word, the word usually refers to an association with something that is also perceived by all the senses. Therefore the child recognizes mommy, daddy, dog, his toys, etc. At this step of development the word is, in my opinion, a kind of code, which denotes a certain child’s idea that the child created based on the large-scale repetition of a set of similar situations. (For example in case of a word "dog" it is barking and copying the movement of the hairy four-legged animal). The word "dog" is then associated with the idea, which is a result of many similar situations. Similar situations are assigned to each other automatically in humans resulting in a joined vision based on similarities under certain aspects. In our example this is a characteristic bark in combination with easily identifiable movements of a hairy four-legged creature. If a child sees a non barking ferret, it may ask: "what is it?", or the child may connect hairiness with something known. If the child sees a ferret and we play the same sound of barking, the child already knows, maybe the child itself says "dog" and will try to associate these perceptions with those already known (in conjunction with the dog) until we explain to the child, that this is not a dog but ferret. This is the way the child gradually learns to differentiate, so one day it will recognize the gender, race, etc. This creates new words like wolf-dog, badger-dog. These are actually codes for a specific association with the idea of wolf-dog respectively badger-dog, where the most similar (typical) characteristics dominate. These characteristics (the most frequent similarity) we often reveal when focusing on a human in his attempt to explain or define a word. In the dog case the man says, for example "It has four legs, it barks and it is hairy". In case of wolf-dog man says the same thing, but man adds to this that it is big, or may say: "It's a big dog."

Based on these facts we can now answer our question. The reference word set is needed to be defined using machine visions, which are represented by clusters of similar associations, according to certain parameters (the characteristics of the perception).

Our key discovery therefore results in the following assumption for the creation of the architecture: The architecture of the machine to understand and read needs to include sensory perception and visualization.

Moreover, we realize another important thing. If we want to expand the word reference set, we have to use other features that must be also defined using perceptions. We know for example the word "dog", but do not know the word "wolf-dog". If we would define wolf-dog (with no idea of the word "big" on the basis of perceptions) in a way as "big dog", we would make a mistake, because the word "big" would not be in terms of a knowledge-based perspective understood, although the word "dog" has been understood (assuming that the mechanism of understanding was resolved). So the word reference set is continuously needed to be extended by new words. New learned words must be based on perceptions to be sooner or later understood to serve as a reference platform for the future understanding of new words.

Now we got to the reason, why in case of the machine which understands learned words, we have a fundamental prerequisite. We need the ability to associate words with machine’s idea, which was based on similar perceptions, according to certain parameters of similarity.

There is therefore a great need to include senses into the architecture so that we can have (for the ability to understand words) the required perceptions. If we want to construct a mechanism or machine that should have similar senses as a person, it should also behave and think like a person, I see a compelling reason for this architecture (with the above explanation) to be called as an architecture of robots.

Let me just add that a lot of perceptions are needed for identifiable and correct functioning of this concept. We must take into account, how many things the child must first absorb before it reaches a level, that at the same level in case of the machine we recognize its ability to communicate and understand things. It's certainly on the current technological level a very high demand, but development in technology is still going ahead, so I believe that it will be possible at the time of complete specification to construct the architecture.

2. Research of robot architecture

I have been focusing on research of the architecture of the robot for several years. If we want to focus on the association reactor, which is part of this architecture, I present one version of rough models for understanding the integration of the association reactor into this robot architecture. This model (see Figure 1.) clarifies the role of the Association reactor which is further analyzed.

First, it is necessary to walk through the principle of operation of the whole architecture at least in broad terms.

3. Operation of robot architecture

The whole architecture (see Figure 1.) is shown using the modules, which communicate between each other. Thick arrows indicate the outer cycle, which is the most important feedback through the world in the architecture, where the output of the robot affects the perceived reality at the input. The second internal feedback circuit (not highlighted in the picture) is shorter and goes directly from the association reactor to the centre of internal sensors, which provides internal perceptions to a circular perceptual stack. However often is also even visualization processor included in the path, which ensures that the robot perceives, what it thinks about.

The third key (short-circuit) feedback cycle goes through the reflexes reactor, which serves as a lightning conductor for predefined reflexes, so the reactor gives immediately commands the coordinating centre without any thought.

This is the way how these three feedback circuits work, however there are many other secondary data streams to other modules and also among them. There are also other running synchronous threads serving other channels of communication in the architecture (the majority of data flows is shown in the picture using the arrows, but some of the modules and the arrows are not drawn in the model).

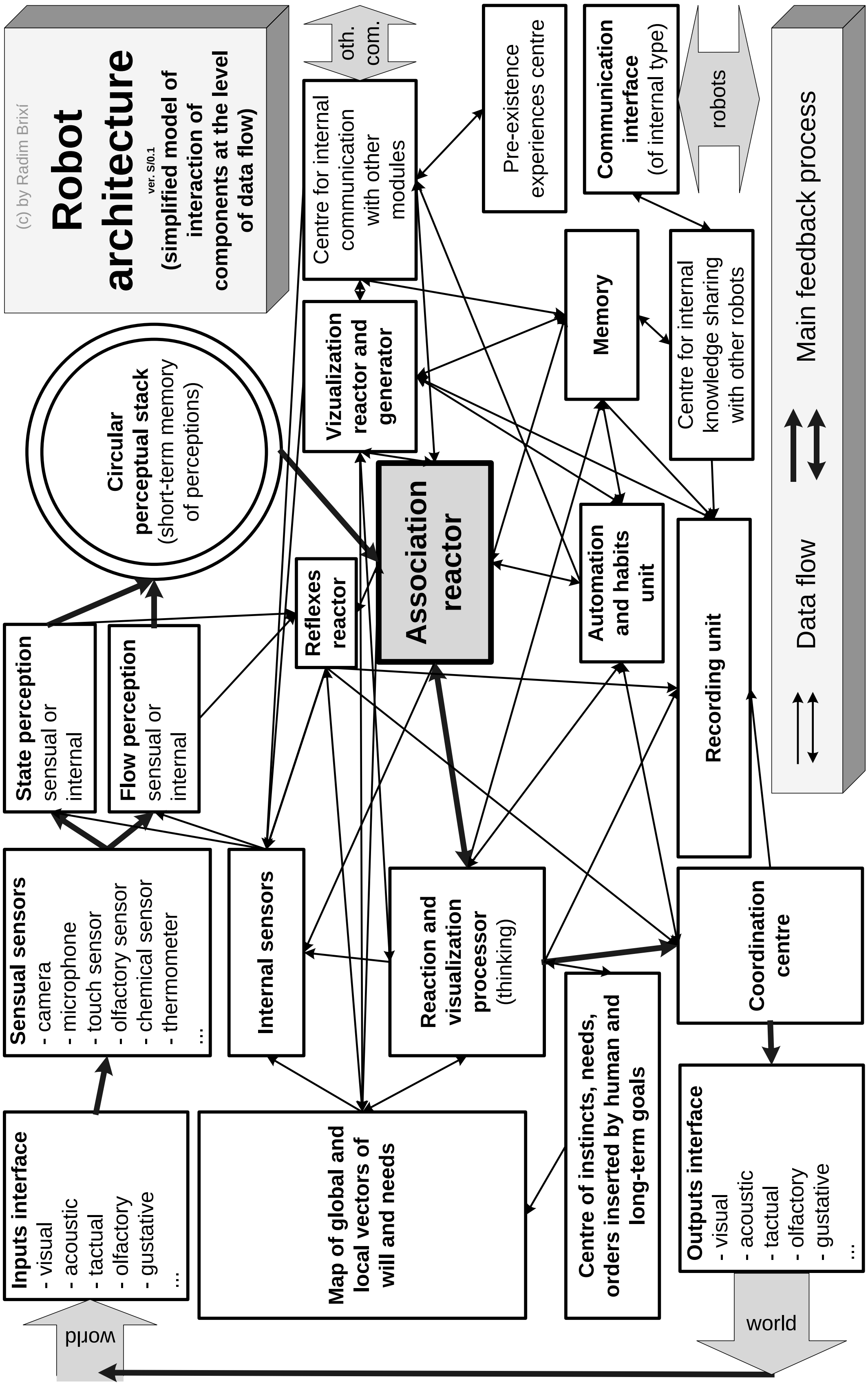

Figure 1 Association reactor in the robot architecture

Before we get to details of the Association reactor, I will explain first in general terms how the reactor operates when working with perceptions and ideas. The Association reactor gets those perceptions from the circular perceptual stack, which the circular perceptual stack managed to keep in short-term memory. The Association reactor makes an association operation with the visualized ideas from the visualization reactor based on greatest similarity using parameters and stores into memory a record of what has been perceived with a link to the previously registered similar perceptions. The association reactor creates associations of perception with something that is considered by the association reactor similar to what the robot has in memory. The process of differentiation or analysis is carried out by the visualization processor. The visualization processor tries to associate the perception or perception cluster with the most similar visualized idea in the visualization generator (similar to an association reactor), but based on parameters supplied from the module called “Map of global and local vectors of will and needs” (the associations are created differently according to the wishes and other aspects). Furthermore the association reactor makes various operations with the following identified perception in the context of the idea according to the will vectors.

The reaction processor then provides instructions to the coordination centre and to the centre of the internal sensor on the basis of newly created visualized ideas in the visualization processor. The visualization processor is in charge of all visualizations from identical perceptions visualizing abstract response plans based on the will vectors.

4. Technology and Features Association reactor

A first practical attempt to technologically grasp the architecture of robots has resulted in experiments with the association reactor for testing hypotheses relating to the principles of functioning of associations.

Good functionality of the Association reactor is a key to the functioning of the whole architecture. That is why I am interested in the technological possibilities how to define and implement the whole process of association in the best way.

Let’s consider that the perception can be completely of any kind. If we are supposed to be able to associate one perception with a different perception on the basis of similarity, it is necessary to define what is the similarity in perception, and also we need to define a range from most similar perception (consensus) to most distinct perception (absolute difference).

The aim of the association reactor is to retrieve a set of association proposals ordered from the most similar to the most different perceptions and associate the new just observed perception with those most similar ones (already stored in memory).

Subsequently, more complex conditions are previously stored and similar perceptions replaced with vision or figure (thanks to features of visualization generator, reactor and processor) and perception is compared at the entry with the vision. Internal perception can be a far more complex vision or idea, so over time the robot compares also the perceived vision of the second inner feedback circuit.

When processing perceptions, there are natively distinguished two kinds of perception from each other. The first is the state perception, where records such as colour of pixel are recorded; the second is flow perception, where the differences in consecutive perceptions are recorded. From the human point of view I consider the flow perceptions as the most important, despite the fact that in the association experiments initially are used state perceptions.

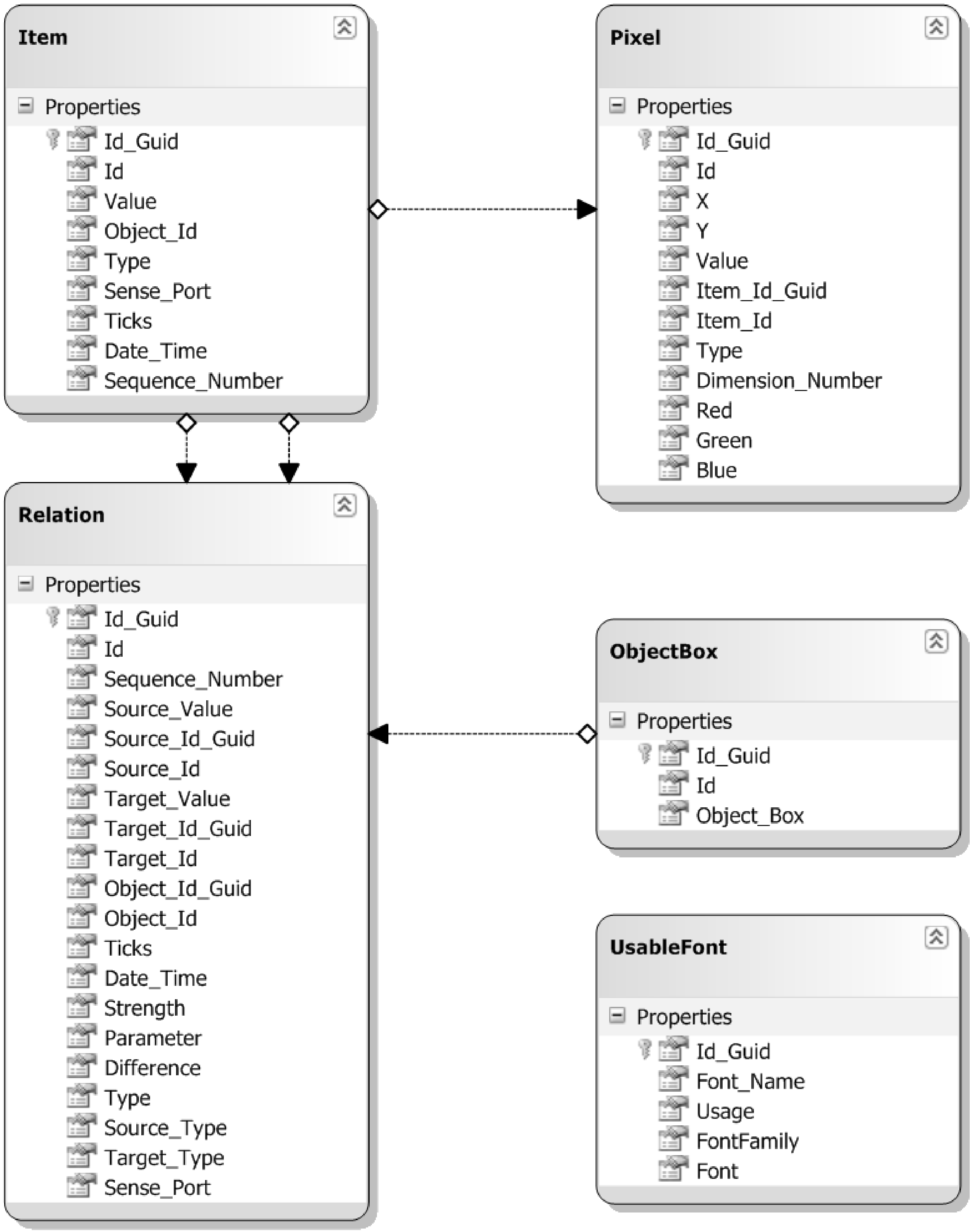

Figure 2. We have got saved dimensions in the table Items representing time and character, we can save into table Pixels necessary 1600 dimensions of the image with resolution of 40x40 pixels by using unique combinations of X and Y coordinates and n:1 relation with the Items table. (In spite of good database design principles is sometimes in the table due to easier and faster access and greater clarity recorded both value and the foreign key for easier experiments handling.)

In case of state perceptions it is a signal, thanks to which the association reactor later associates, defined using a so called “figure”. A figure is then a most accentuated set of partial elements of perception on a background of perception (e.g. in a graphical type of perception a set of dark pixels is a graphical representation of black splash on a white wall in the observed image in the circular perceptual stack).

The case of flow perception, the figure is not calculated only from differences in one perception, but figures are detected through differences in perceptions in time (e.g. during movement of objects against the surroundings we generally perceive movement at first, secondarily followed by a similar process of detection of the state perception figures).

The basic principle of detecting figures in case of flow perception is based on differences of two consecutive perceptions.

The first association experiments, as already mentioned above, are implemented using the visual state perception using the principle of similarity or identity of colour pixels in each image perception. I skip the figure detection in the first experiments and for easier testing purpose let’s consider the whole picture as such a figure. I plan further research methods for detecting figures in other various types of sensors not earlier then after association experiments. For the implementation of the experiments are used the Visual Studio 2008 and Visual Basic.NET programming language, where thanks to a Windows form application using the LINQ technology to access the SQL database a simulation environment is created allowing to test the behaviour of the association reactor.

Maybe it would be preferable to use Prolog or an analog computer, but because of my background and experience, I preferred the above platform, which provides many relevant and useful tools.

The entire association reactor is implemented as a class, which is applicable as a user control interface to the form. So multiple instances of the association reactor can be tested at the same time (see Figure 4.) and this is included in the live demonstration of the entire application.

The first tests are launched using a set of images, which is an association reactor supposed to associate with similar images. A character generator for different fonts has been programmed for this purpose (see Figure 3.), which can generate all the small characters in the alphabet in so many variants, as fonts are installed in Windows, where the program is running. Colour and background of the font can be also selected in this generator.

When filling the memory with reference images, we store each pixel as a row in the table "Pixels" (see Figure 2.) with parameters such as coordinates, the individual components of RGB, the image identifier, to which this line (representing one pixel) belongs, etc. This form of storage is technologically very time-consuming, because for every pixel it means a row in the table, but there are great advantages and possibilities when using a well designed SQL query.

There is a new mechanism used in the concept, that each element of perception (such as a pixel) is one dimension of a n-dimensional space, where n represents the number of elementary perceptions at the threshold of resolution for each sense. If we would consider for example the time dimension, the image perception of resolution 40x40 pixels and one character input, the number of dimensions for an entry in the memory is 1+1600+1, so it is the space with 1602 dimensions, where every memory footprint represents a point in this 1602 dimensional space. As the number of dimensions may vary depending on the complexity of perception, it is necessary to set the resolution of the robot to a constant level, or develop mechanisms for the conversion if the number of dimensions in the life of the robot has to change. Because of the given frequently large number of dimensions, the dimension of time is implemented as one column in the table 'Items', 1600 or more dimensions such as the visual perception is encoded using coordinates X and Y, where each unique combination of these two numbers represents the ordinal number of the dimension.

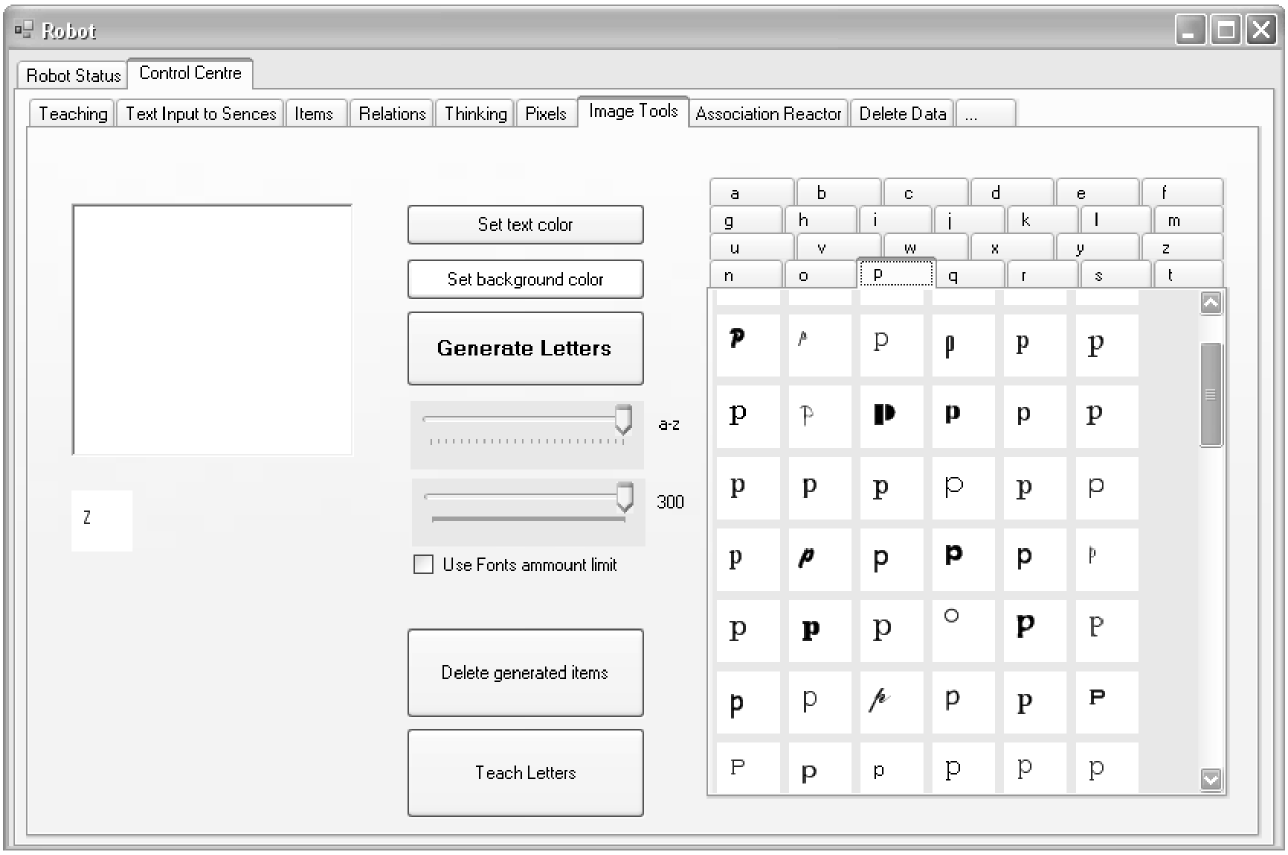

Figure 3. Generator of letter images using various fonts.

The character is then represented by an additional column in the table "Items" as a further dimension (last 1602nd dimension) and all the rows in the table "Pixels" relating to a particular perception have then the same identifier in the column "Item_Id_Guid", which is also shown in the recorded row of table "Items" in the column "Id_Guid". This mechanism reduces the number of dimensions in the column definition of the table and transfers it into rows with a unique combination of the coordinates X and Y.

The most important message is that even in the first graphically oriented tests that associate only absolute identical values of pixels in a grid, the association reactor is capable to associate new, yet unknown images of a letter, in such a way, that even with a relatively small number of previously learned reference images, it can correctly associate significantly large number of letters in the input images with images in its memory, where the same letter is stored (see Figure 4.). (It would be logically better to test it on similar random pictures with no common sense behind it, but thanks to the generator of letters, this method provides a good way, how to handle testing efficiently). I consider that this behaviour is a very positive real feedback supporting the concept of creation of associations in the architecture of the robot. In other phases of the research I plan to implement such capabilities of the association reactor, which will be able to cope with different positions in the figures, with different scale, with different rotation and deformation. These capabilities must not be entered into the architecture as knowledge of man, but there must be a robot evolutionarily realization. I believe that in nature there must be a very simple principle (the principle similar to fractals), thanks to which can evolve enormously complex robotic cogitative algorithms, when feedback and recursion are used with the ability to differentiate a more detailed picture of the world, which at the beginning of life represents the indifferent unity of everything. The fiction of differentiation apparently appears because of excitation resulting from tensions in the indifferent space, which results in different potentials of energy, so differentiation can begin. Then we perceive these differences as a new parameter of differentiation of the world. I suppose the robot will not see the world as it is, but will see only its vision, which is probably similar to humans, however with the important addition that in our point view the robot has no consciousness although it seems to some people that it has. One of the large and complex evidence and prove is given in the book “Shadows of the mind” [1] of Roger Penrose.

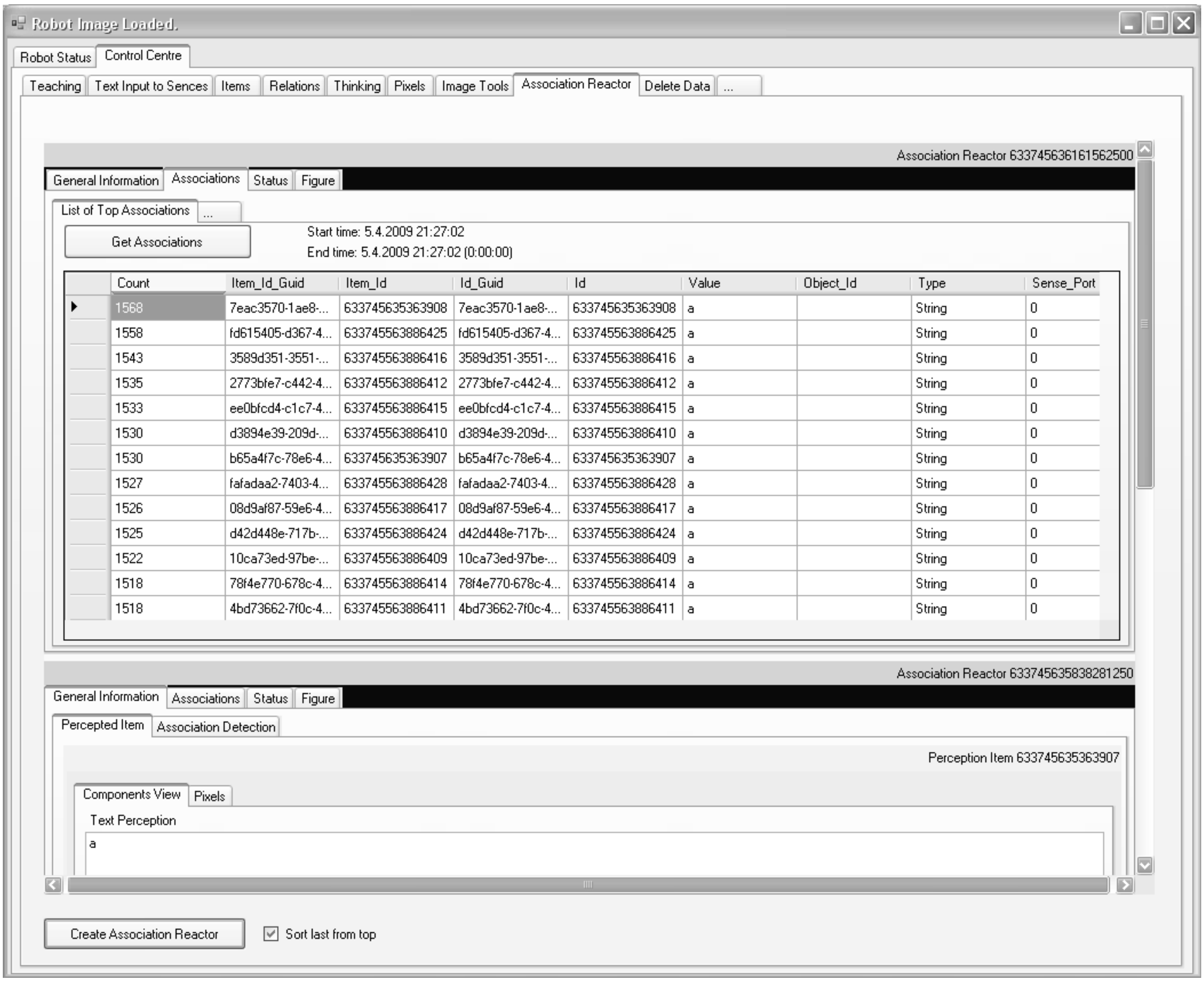

Figure 4. This instance of Association reactor was launched to return a table of previously memorized perceptions, which will include most similar association (of the image with letter "a") ordered by the most identical number of dimensions represented in Column Count.

5. Consciousness and Artificial Intelligence

From a theoretical point of view, it is necessary to consider the possibilities and limits of the robot architecture, in other words, consider the possibility of artificial intelligence (AI), which would be similar or even indistinguishable from humans. There is no clear answer to this question and at the same time, researchers in this area are in disagreement. Because of the scope of this work, we chose only Roger Penrose as an example of possible directions of thought.

For better orientation in a great variety of so many views and theories, we will borrow the classification of Roger Penrose (1994) [1], English mathematician and cosmologist. Penrose considered that the actual sign of true artificial intelligence is the presence of consciousness. This phenomenon, therefore, serves him as a point of sorting the attitudes with respect to the individual theories.

A - Under the first view, which is very conservative and strict, the mind is simply a sequence of calculations. Feelings of consciousness or awareness are caused simply by the appropriate calculations.

B - Supporters of the second group are looking at consciousness as a feature of physiological processes in the brain. They take into account that even if the computer can simulate any physical process, computer simulation can not by itself give rise to consciousness.

C - Appropriate physical processes of the brain result in the phenomenon of consciousness, but it can be neither simulated nor computed.

D - Consciousness is not possible to be physically, by computer or otherwise scientifically explained or examined.

It should be noted that this classification is more or less artificial and more used for clarity and for reader’s guidance in such complex problems. There are no clear boundaries among different groups, because some scientists with their views stand really "between". The author puts himself into the third group in his books and offers many sophisticated mathematical proofs.

Let’s have a look at these four groups and let’s start with more extreme positions. The first group is likely to be the result of the enormous enthusiasm caused by computer science as such, which was started during the 20th century and continues today. Behind is a faith, which partly became a reality that one can construct a machine which should have the same or better qualities than humans. In many ways this has already happened, even if we stay in the field of psychology - take into account the computers - their “intelligence” outstrips even the greatest genius in the field of mathematical calculations, Chess. From this point of view it is a small step to the premise, that living beings, including humans, are nothing more than a set of well connected elements and computational processes. It is therefore not surprising that even consciousness is considered to be nothing more than the outcome of the calculations. Opposite position is D - consciousness is something scientifically impossible to examine and any efforts on scientific studies are therefore useless. D is the strongest position considered closely related to religion or esoteric. But an obvious question is being offered here – where would such an approach lead in the world around and within us? The fact, that it is a phenomenon yet unexplained, or explained only in part, which does not mean that there is reason not to examine it at all.

For the finer distinction between A, B and C, we will use the simple idea of a computer, which over time can make all the calculations, e.g. to learn Chinese in time (Turing machine, linked to the Turing – Church hypothesis, the Chinese room argument of J. Searle). From the point of view of A, we must admit that if a computer controlled robot capable of a certain period of time to act "as if he had consciousness", the robot actually has a consciousness. By contrast, supporters of B would argue that although the robot behaves as if it had consciousness, this does not mean that it must in fact have consciousness. This means, A and B say that the simulation of consciousness is possible, but in this respect they differ from C. C note that consciousness is something that a computer cannot simulate, and therefore the fact that the robot has no consciousness should appear obvious after long enough period of time. We still have to remember that computer simulation is not the same as the simulated situation itself (e.g. simulation of a hurricane is not the actual hurricane).

The author therefore considers that current science including computers and artificial intelligence is unable to either simulate consciousness or satisfactorily explain it. Human mind is capable of much more than just calculations and wins over the very best computers where it appears to be the simplest - the "healthy common sense". What is clear at a glance to a small child, but which requires a certain amount of stepping aside, it appears to the computer as essentially insoluble.

Penrose is one of the authors, which has his own theory of consciousness, which combines knowledge of quantum physics and neuroscience. We will only briefly summarize his conclusions, because his work extends far beyond this contribution of ours. Consciousness is by its nature quantum-physical and is not explainable using classical physics. Its existence and functioning is according to the author linked with the neuronal cytoskeleton (namely microtubules) which, due to its special architecture, allows the temporary presence of several possible states of the system at the same time.

At present, it is clear that the problem of consciousness is very complex and extends beyond the boundaries of a single sector of science. In our point of view synthesis of discoveries so far is needed most. Each of the authors, which has dared to present his own view (and is to be criticized, which is certainly good for the development of science) has his own view and tries to enforce it against competing theories. The result is not constant improvement and superstructure, but rather new and new beginnings.

We think that consciousness cannot be reduced and that therefore must be regarded as a separate phenomenon, despite the fact that we still don’t know enough. At the same time, we agree with Penrose that consciousness is not explicable using classical physics. On the other hand, quantum physics is not the "theory of everything", despite its many achievements so far. However, we should keep ourselves open and constructively critical to new discoveries and theories, although they may seem controversial at the first glance. We must not forget that we are still limited by our culture and social norms and expectations.

6. Reliability and current performance

The Association reactor uses the following SQL query to return the desired table ordered by similarity of associations:

```
select * from (select count(b.Item_Id_Guid) [Count],b.Item_Id_Guid,b.Item_Id from (select * from rdb.dbo.pixels as aa inner join (select Id_Guid as Id_Guid_Of_Item,[value] as Item_Value from rdb.dbo.Items) as ab on aa.Item_Id_Guid=ab.Id_Guid_Of_Item) AS a INNER JOIN rdb.dbo.pixels AS b ON a.Item_Id<>b.Item_Id and a.item_id=@MaxId and b.item_id<>@MaxId and a.x=b.x and a.y=b.y and a.red=b.red and a.green=b.green and a.blue=b.blue group by b.Item_Id_Guid,b.Item_Id) as x Inner Join rdb.dbo.Items as y On x.Item_Id_Guid=y.Id_Guid order by Count desc
```

The result is usually returned after 8 seconds on two millions of rows in the table pixels (that represents approx. 1250 reference images with resolution 40x40 pixels) on one core 3,0GHz CPU with HT technology.

This architecture consumes a lot of computer resources and the larger the reference set is, the more resources are needed for suitable return time for the answer.

Now let’s have a look at the architecture from the reliability point of view. The architecture is deterministic, but very complex, so when the outer feedback circuit is launched, inputs from outer world affect the inner circuit of inner visualisation, we must face the fact that the robot may do from our point of view unpredictable reactions on some input signals. The reactions are deterministic and still based on computer programmes. But when it comes to some complexity level, it may seem to behave in a nondeterministic way, because, we cannot intuitively perceive the complex calculation process to determine the prediction of behaviour. This is similar to humans and their different characters and reactions.

From this point of view the current machines are very reliable and are good for those tasks, where we need repetition of same task. The architecture described here works in another way. It adds signals to its vision about the world and with each signal the whole architecture is slightly recalculated, so with every other signal, we cannot ensure the same reaction.

If the concept of this architecture is right, we might get some more human processes integrated into the architecture, especially a self-learning ability. If this mechanism works it might result in a very dangerous threat. It is our increasing dependence on intelligent (“smart”) machines. Any kind of help that humans learn to use now may become indispensable necessary for humans in the future. Now we need clean water to drink and clothes, but can we escape the dependence on intelligent machines?

References

[1] PENROSE, R. Shadows of the Mind. London: Vintage, 1994. ISBN: 0-09-958211-2

[2] PENROSE, R. Makrosvět, mikrosvět a lidská mysl. Praha: Mladá fronta, 1999. ISBN: 80-204-0780-4

INTELLIGENT ROAD SAFETY USING INFRASTRUCTURE TO VEHICLE COMMUNICATION – A HOLISTIC SYSTEMS ISSUE

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Abstract

Intelligent road safety is more and more sustained by co-operative traffic management systems which are based on I2V (infrastructure to vehicle) communication. These systems are complex networks integrating sensors, actors, communication on different levels and humans as active part, consisting of road-side infrastructure coupled with advanced driver assistance systems and on-board data collection facilities.

COOPERS has the objective of assisting these kind of co-operative traffic management by implementing intelligent services interfacing road infrastructure, highway operators, vehicles and drivers. These services have different levels of criticality and safety impact. Besides the technical aspect such as designing the components for the I2V communication it is important to create adequate business models for the market roll-out using so-called Value Chains.

The paper presents the concepts of COOPERS based traffic management systems, the difference to conventional traffic management systems and the concept of respective Value Chains for safety critical services and convenience services.

1. Improving Road Traffic Safety by a Co-operative Integrated Traffic Management System

In the sixth framework program of the European Commission, one of the thematic main lines deals with road traffic safety. Several projects funded by the 6th IST Framework Program address this topic such as CVIS [3] and SAFESPOT [6], but COOPERS [2] takes a specific position with unique ways and methods to attain a safety improvement through an intelligent network which exploits existing technologies for co-operative services.

COOPERS prepares the way for improving road safety on motorways at an affordable cost. Based on existing technologies and infrastructure, the driver is provided with real-time data on the current traffic situation ahead (see Figure 1). In each car, a receiver for the I2V (infrastructure to vehicle) communication encapsulated in an OBU (on-board unit) and a display [4] offer information about accidents, traffic jams, road construction sites and other location and time related events. Only messages relevant for the driver on his particular road segment are passed on. No irrelevant data about traffic congestions or accidents in remote areas of the country is shown like in traffic radio broadcasting services. The information is accurate and precise both in terms of location and time.

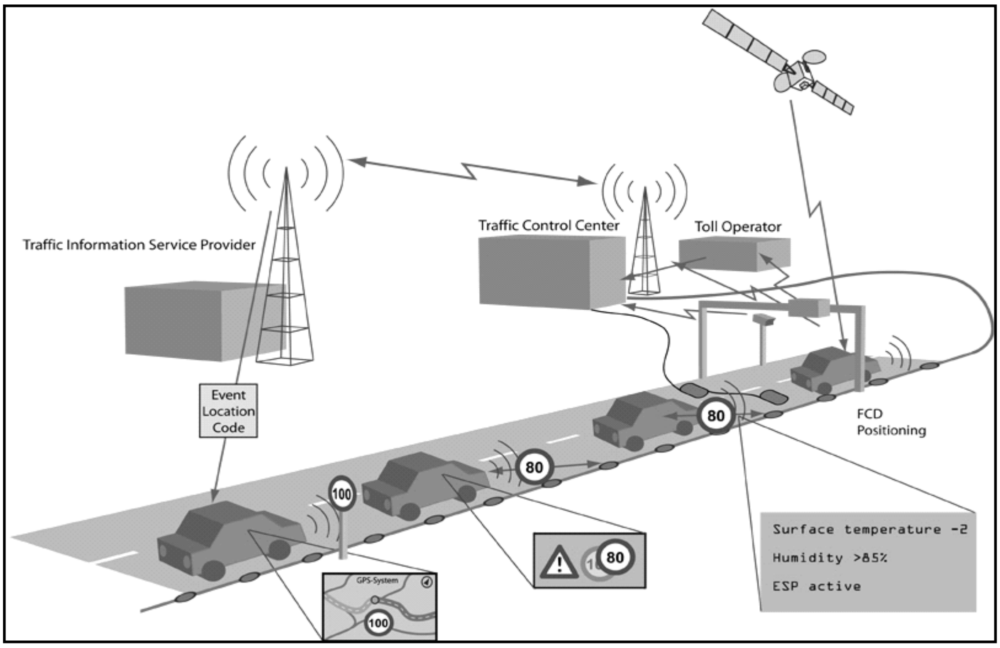

Figure 1: Intelligent infrastructure and smart cars plus individual location based services – I2V and V2I communication.

The services defined in COOPERS include:

- S1: Accident/incident warning (Including wrong-way driver information)
- S2: Weather condition warning (Ice Road Warning, Fog Warning)
- S3: Roadwork information
- S4: Lane utilization information (Lane banning, Keeping in Lane, Auxiliary Lane Accessibility)
- S5: In-vehicle variable speed limit information
- S6: Traffic congestion warning
- S7: ISA (Intelligent Speed Adaptation) with Infrastructure Link
- S8: International service handover
- S9: Road charging to influence demand
- S10: Estimated journey time (Route navigation)
- S11: Recommended next link (Route navigation)
- S12: Map information check to inform of current update for digital maps (Route navigation)
- S13: FCD (Floating Car Data)

In general, Services 1-7 can be grouped under the term “Safety Critical Services”, Services 8-12 can be referred to as “Convenience Services” (see also [7]). Service 13 has a different purpose. It is used to collect FCD from the cars (e.g. speed or temperature data) and in order to provide it to the road infrastructure. It might be used as a source for safety critical services, such as traffic congestion warning or weather condition warning but also for convenience service such as estimated journey time.

2. COOPERS vs. Conventional Based Traffic Management

Then main components of conventional traffic management, as shown in the left side of Figure 2Figure, are the TCC (Traffic Control Centre) and roadside systems, consisting of induction loops, cameras and other sensors, and outstations for data collection and variable message signs for information provision.

In the COOPERS service based traffic management model, presented in the middle part of Figure 2, a link between the TCC and the road side systems is established through the COOPERS Service Centre, which is initially set up as an entity that is separate from the TCC. Traffic management data is exchanged bi-directionally between TCC and the COOPERS Service Centre. In addition, besides the interaction between COOPERS Service Centre and the road side systems (e.g. via VPN - virtual private network or internet), an additional link exists between the COOPERS Service Centre and in-vehicle OBUs, both for the provision of data (services 1-12, downlink) and for collection of FCD (S13, uplink). For this purpose the OBU consists of a display unit (HMI) [4] and a link to the CAN bus in order to receive the FCD from the in-car sensors.

A perspective of the future traffic management model is presented in the right side of Figure 2. In this model the COOPERS Service Centre and the TCC are integrated to one entity.

A COOPERS Service Centre aggregates data from a TCC and other sources and provides the resulting information to in-vehicle OBUs and/or to roadside units (RSUs), while the OBUs provide FCD to the COOPERS Service Centre. The FCD will be processed and refined by the COOPERS Service Centre, and integrated with the above mentioned data from TCC and other sources, to close the loop. The COOPERS Service Centre acts therefore both as a content provider and as a service provider. In addition to acting as a content provider for its own service (or instead of, if it does not act as a service provider), the COOPERS Service Centre may also provide content to other service providers.

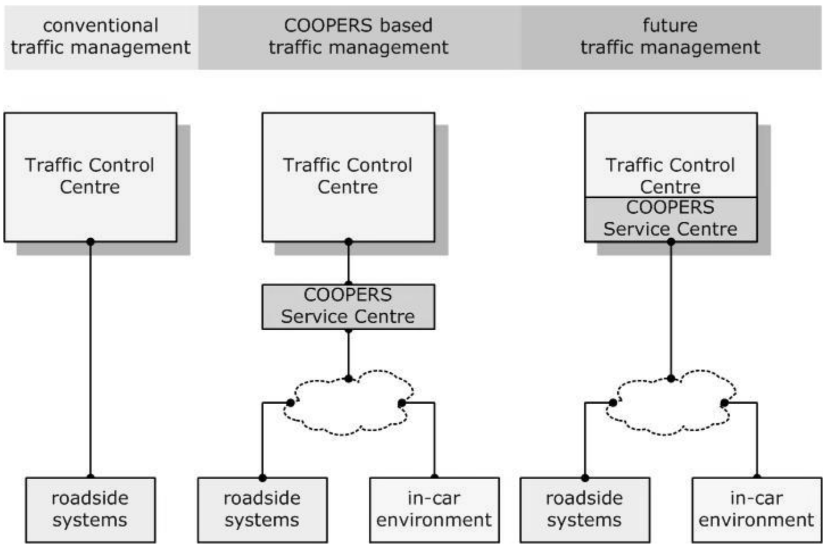

Figure 2: Three models of traffic management

Co-operative systems as researched in COOPERS require deeper investigation into market conditions for its roll-out strategies. One important viewpoint for bringing such systems to the market has been analysed in COOPERS in depth: the development of Value Chains as a precondition for building a business model.

3. Value Chain Analysis

3.1. Methodology

Considerations laid down in this document concerning Value Chains have been derived in the following way. First an in-depth investigation into state of the art literature on Services Value Chains was made. In addition results from research projects dealing with similar topics were analysed and taken into account. The study team then drafted a first Value Chain Model based on the insights from the literature review and know-how gathered in other project settings. This draft Value Chain Model was then used as basis for discussion in various problem-centred interviews with different stakeholders along the Value Chain. After these inputs the Value Chain was remodelled and different scenarios were developed. This again was validated with Value Chain players from different countries.

3.2. Theoretical background

In the context of the COOPERS project an advanced model of the Value Chain is applied reflecting the current requirements of modern economy. To this end, a networked approach focusing on inter-company exchanges in the value creation process is chosen – as opposed to Porter's [5] more single-company centred notion of the concept. This approach also accounts for the restricted autonomy of decisions users are faced with.

In this regard the Value Chain can be described as sequence of value-adding activities in the provision of a service. As such it consists of a comprehensive representation of the various stakeholders involved in service provision. An important point in this context is to provide not only a general listing of potential stakeholders but also a description of their interdependencies and the interplay among them. Thus, the service Value Chain shall illuminate the flow of goods, services, information and money between the different stakeholders on the respective levels of the service creation process. It is made up of several participants who are legally independent but work together to achieve safe and reliable telematics applications. Summing up, the service Value Chain represents a graspable presentation of the whole process of service provision starting from the initial inputs over various refining activities and components to the final output, which is the value-added service delivered to the market.

Organisations are living networks, so it is far more productive to analyse market activities from a living system perspective involving interactions between several market participants in their attempt to serve various market needs. Once organisations are perceived as patterns of exchanges, traditional notions of organisations are due for revision. From a system perspective it is more useful to think of organisations as value networks. According to Allee [1], a value network is defined as any web of relationships that generates tangible and intangible value through complex dynamic exchanges between two or more individuals, groups, or organisations, whether private industry, government or public sector. Today corporations are often organised more like a business network than the traditional company Porter [5] assumes in his model.

Core Assumptions about Value Networks according to Allee [1]:

- Participants and stakeholders participate in a value network by converting what they know, both individually and collectively, into tangible and intangible value that they contribute to the network.

- Participants accrue value from their participation by converting value inputs into positive increases of their tangible and intangible assets, in ways that will allow them to continue producing value outputs in the future.
- In a successful value network, every participant contributes and receives value in ways that sustain both their own success and the success of the value network as a whole. When this is not true, participants either withdraw or are expelled, or the overall system becomes unstable and may collapse or reconfigure.
- Successful value networks require trusting relationships and a high level of integrity and transparency on the part of all participants.
- Insights can be gained into value networks by analysing: 1) the patterns of exchange 2) the impact of value transactions, exchanges, and flows, 3) the dynamics of creating and leveraging value.
- A single transaction is only meaningful in relation to the system as a whole.

The following Chapters reflect considerations about how to form a Value Network for COOPERS services. First basic requirements towards such a Value Network are laid down and described. Then suggestions for a COOPERS Value Network for Safety Critical Services and a Value Network for Convenience Services are described.

3.3. Schema of the Value Chain

The schema in Figure 3 shows the principal flow of data for the provision of traffic information and traffic management information to end users, and defines the Value Chain from raw data to information that is useful for end users and thereby has a value.

Traffic data from traditional sources (sensors like induction loops, cameras and infrared sensors, and other sources like police and drivers reports concerning traffic data; meteorological institutes for weather data) are collected by a content provider, processed and possibly refined (initial refinement). The resulting data are forwarded to a service provider, who may do further refinement, and may bundle the data with other data, to provide the data to end users in vehicles and elsewhere, e.g. via radio bulletin broadcast, Traffic Message Channel (TMC) and the internet. Vehicles may be used as a non-traditional source of traffic data (based on speed and location) and weather data (e.g. wipers on/off, rain sensor, and temperature sensor) in the form of (extended) floating car data (FCD). As these data also need the steps of collection, processing and initial refinement, the entity that will do this is by definition a content provider.

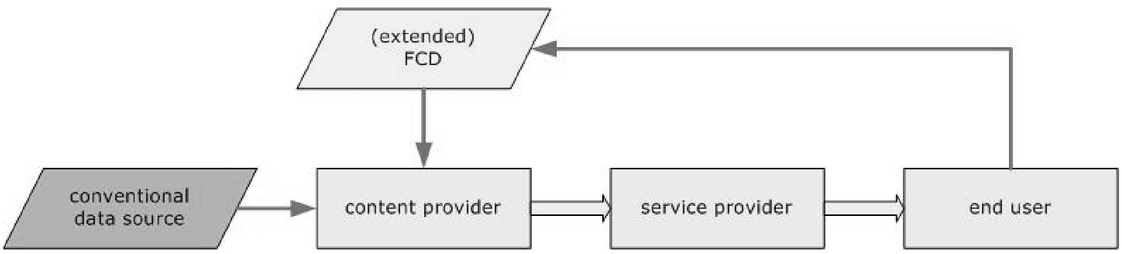

Figure 3: Principal of data flow in the Value Chain

Content provider and service provider are in fact functions that may be performed by different types of entities. A TCC may act as a content provider alone and in addition also as a (public sector) service provider (e.g. by operating a public TMC service, or by providing information via VMSs -

variable message signs, or DRIPs - dynamic route information panels). A private sector service provider may acquire data from a TCC, or from a private sector content provider that for instance has installed its own road side equipment (infrared sensors, cameras), or use data from multiple sources. A private sector service provider may also have own data sources, and then act as content provider and service provider at the same time.

Figure 4 gives another view on the Value Chain in terms of data flow, activities to create this data flow, and participants that take part in creating and using the information.

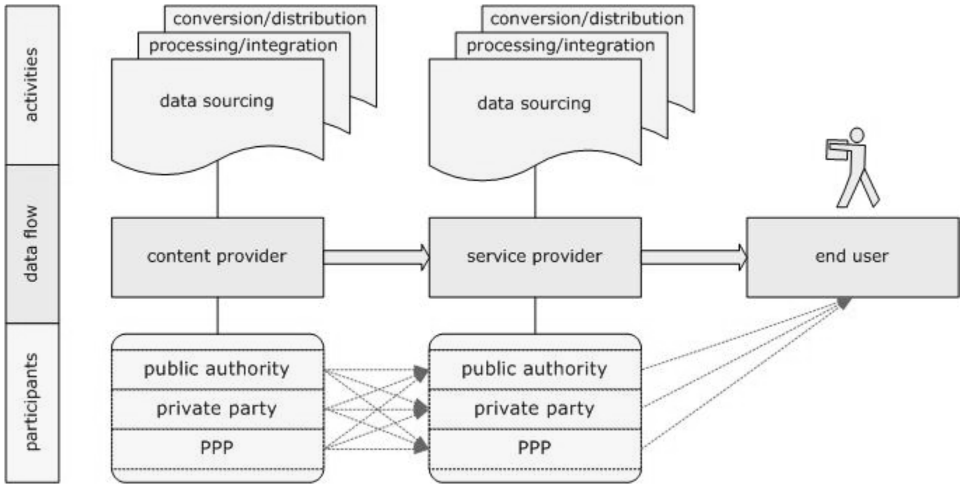

Figure 4: Schema of the Value Chain

3.4. COOPERS Value Chain - Basic Scenario

Figure 5 depicts the general service Value Chain applied to identify and classify potential participants and users to the COOPERS service. To provide for terminological stringency the individual elements of the chain subsume both function and actor involved in the related activity. The grey boxes indicate the basic function, a necessary role to provide a COOPERS service. The white boxes behind the grey boxes show possible actors that can fulfil the attached role. In most of the cases it will be several actors working together, providing a specified role in the chain.

Typical organisation types participating in this COOPERS Value Chain are:

- Public organisations like public authorities, communities, ministries.
- Private companies like profit oriented content providers and telecommunication organisations.
- Public Private Partnerships constituting a joint venture of public organisations and private companies.
- Associations, particularly national motoring organisations.

Various actors work together for the purpose of delivering COOPERS services. The source of all information services is a *Content Provider* who owns the content (e.g. traffic data, weather data, FCD data, etc.) and/or provides the content for service application. This is summarised in the box “Data Acquisition”.

“Data Aggregation” is done by an *Application Provider*, who uses this content to generate information with added value. The information is part of a service and covers not only the adaptation of the original data (from the Content Provider) but also the visualisation of the information (e.g. creation of a thematic map).

The prioritisation of information, the *Data Clearance* is an important and specific role in the COOPERS Value Chain. This role ensures the appropriate classification of information that can go to the specific services.

The *Service Provider* is responsible for "Data Customizing" and is the face to the customer. He publishes the service and is responsible for all marketing and contractual issues with the end user.

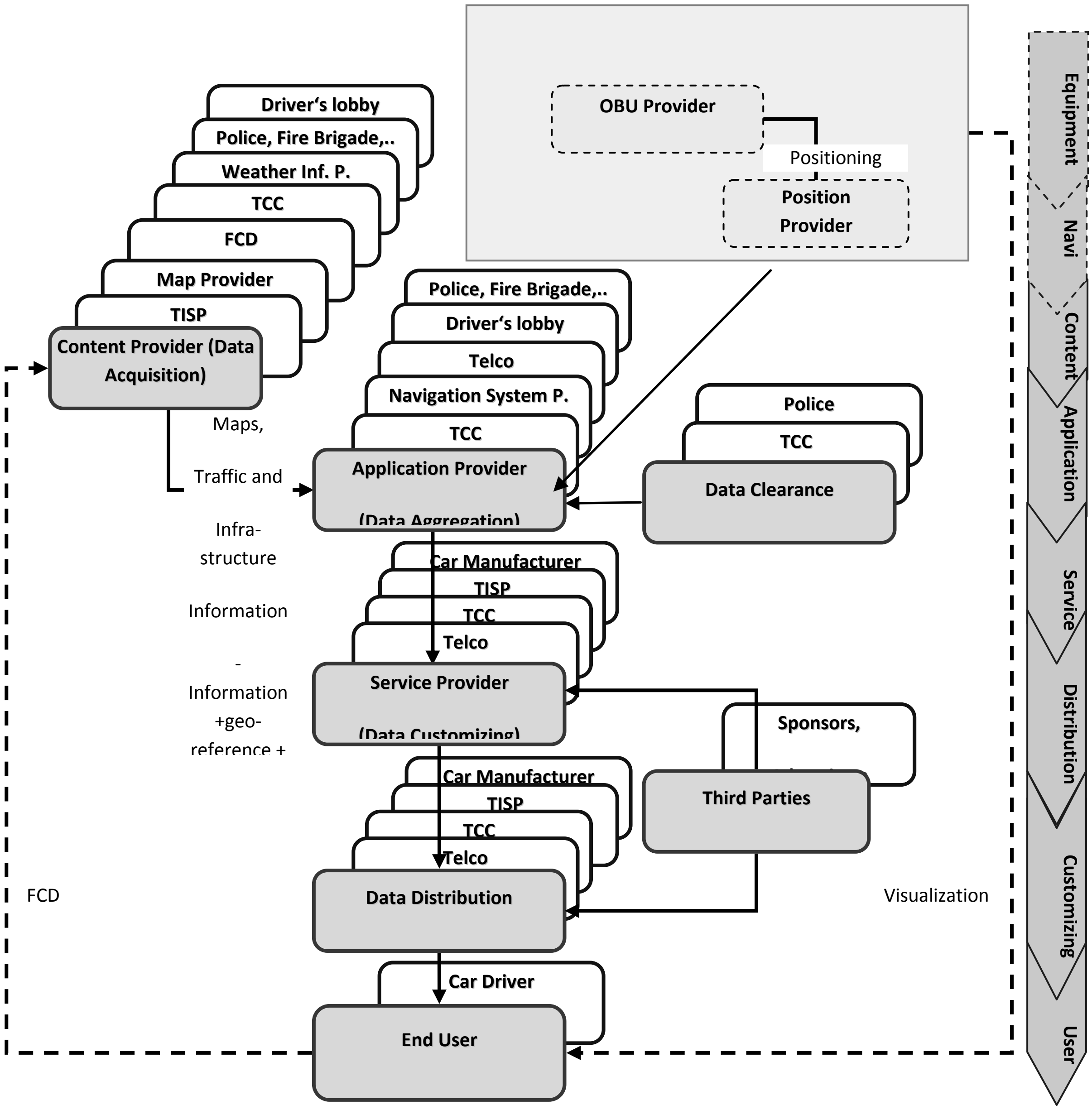

Figure 5: COOPERS basic Value Chain

To publish the service the service provider needs a network provider who supplies the communication network for the service "*Data Distribution*" (like a mobile network or an internet provider).

Third Parties can come into this model as possible sponsors for services.

The *End User* is the consumer of the service.

The COOPERS services can only be realized in the single car with the help of appropriate hardware, the OBU. The hardware can be provided by OBU providers that need to co-operate with position providers.

The following section gives an overview of a scenario using a single service provider.

3.5. Single Service Provider Scenario

The Single Service Provider Scenario is based on a leading role of a single actor, which takes over the role of the Application Provider and the Service Provider. This Service Provider can be a public or private organisation. When it comes to Convenience Services a commercial player can be this Single Service Provider. In case of Safety Critical Information this role will be usually played by the local TCC, see Figure 6.

Safety Critical Information

In our example of Single Service Provider Scenario concerning safety critical information a TCC takes over the lead in the Value Chain. The TCC acts as Application Provider (for the programming and developing of services), as Service Provider (for creating value added services) as data customizer and distributer (via roadside units). Further the TCC may act as Content Provider (data acquisition via induction loops, etc.). In case of a public TCC the Data Clearance is also part of its duty, while in privately owned TCCs this role is usually taken by the police.

To illustrate the complex relationships between the single actors in this Value Chain a practical example is described below.

Example for Safety Critical Services

For this example the Austrian situation was taken, however please notice that the companies indicated are purely assumptive and that of course other companies not named here can replace the mentioned ones.

In the Austrian example, one has to consider the role of the Austrian Infrastructure operator, the ASFINAG which is publicly owned. ASFINAG could take over a leading role in the provision of safety critical co-operative services. ASFINAG with its TCC located in Inzersdorf (Vienna) would take over – together with other actors such as Austrocontrol (Austrian Air Traffic Control Centre) or ZAMG (Austrian Centre for Meteorology and Geoddynamics) for providing weather data and the Austrian Broadcasting Cooperation (Ö3) providing a FCD fleet (the so-called Ö-Drivers which inform the TCC in case of exceptional traffic situations) – the role of the Content Provider. ASFINAG would consider content collected on the infrastructure itself, such as weather information, and traffic data. In the TCC of ASFINAG, these data would be aggregated and processed. Further, ASFINAG can take over the role of data clearance, as it is a public operator that is entitled to do so. Value Added Services are operated in the TCC and the information can be distributed via the COOPERS road side unit road segment specific to the single end users on Austrian motorways. In addition, data can be distributed via alternative channels as well, such as DVB-T or DVB-H. Telcos could as well distribute the information via GPRS for example. Third party sponsors, such as motorway service area providers, can distribute information about the next service area.

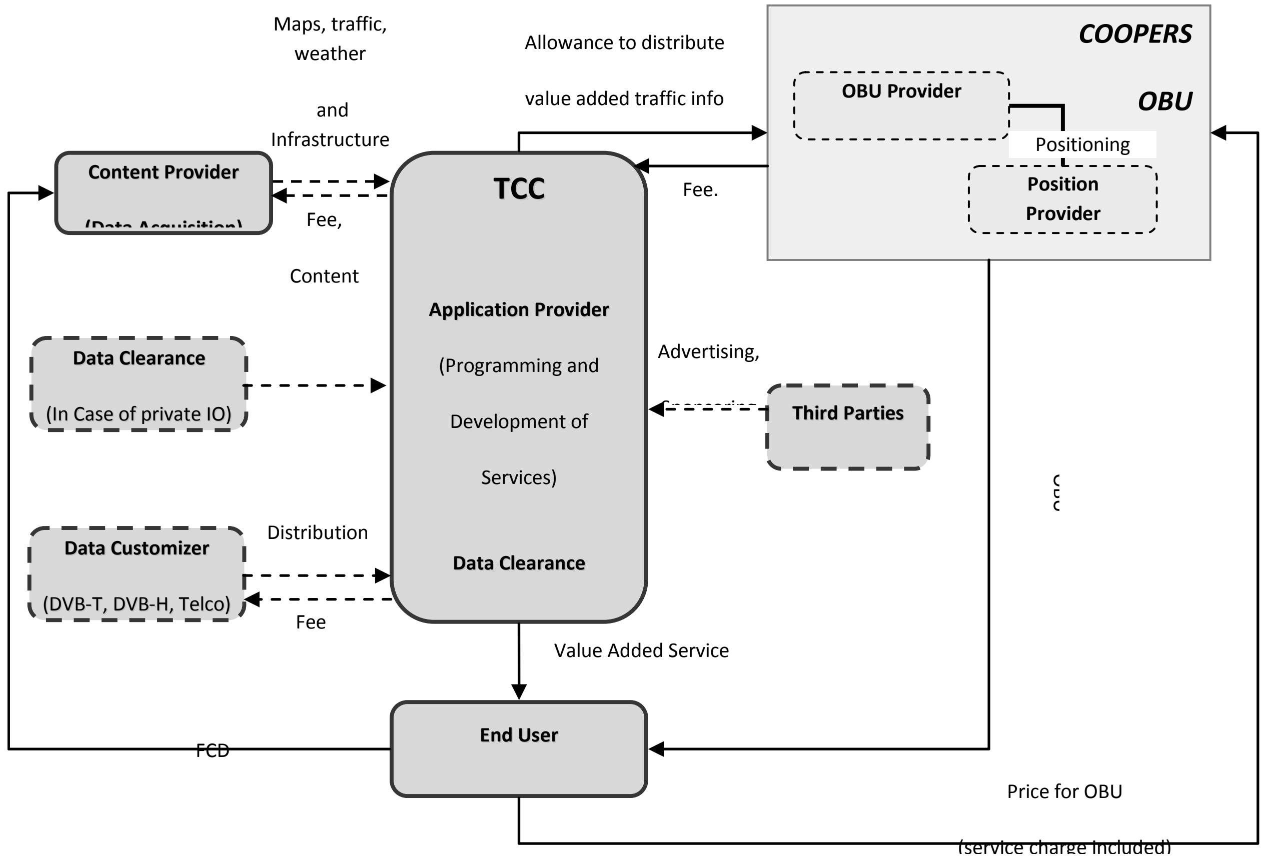

Figure 6: Single Service Provider Value Chain for Safety Critical Services

In this model, OBU providers such as TomTom or Garmin can provide the necessary hardware. The OBU provider would be the interface to the customer. The OBU provider benefits from high quality value added data that he can sell as an add-on of his hardware. The end user buys the OBU and in the price for this unit, the service charge (typically for a certain period of time) for value added traffic information is already included. This means no further payments, such as for example monthly bills for the end users. The OBU receives the allowance from the TCC to distribute the value added traffic information provided from ASFINAG. This allowance can be compensated via financial or other benefits for ASFINAG.

Data Acquisition

One Friday morning, a Content Provider of ASFINAG, Austrocontrol, delivers the information: "Snow expected in the eastern parts of Lower Austria and Vienna for Friday afternoon".

The radio station Ö3, with which ASFINAG has a co-operation agreement, receives calls from its driver fleet (Ö-Drivers):

Friday, 3:05 pm "Slippery road on the Ostautobahn"

Friday, 3:07 pm "Some vehicles stuck on the motorway at the A4 in direction Vienna"

Friday, 3:10 pm "Traffic Jam near exit Schwechat, driving direction Vienna"

Data Aggregation and Data Clearance

In the ASFINAG TCC in Inzersdorf, this information is collected. However, the quality of the information varies. The information can be summarised as follows (see Table 1):

Content	Geo-Reference	Time
Snow expected	Parts of Lower Austria and Vienna	Friday afternoon
Slippery road on the motorway	Ostautobahn	Friday, 3:05 pm
Some vehicles stuck on motorky	A4 in direction Vienna	Friday, 3:07 pm
Traffic Jam	Near exit Schwechat, driving direction Vienna	Friday, 3:10 pm

Table 1: Example for safety critical information

To have a clear picture of the situation, the responsible person in the TCC checks the cameras monitoring the motorways. He decides to check the cameras near the Exit Schwechat in both driving directions. However, due to the weather situation, it is only possible to see that it heavily snows on the motorway in this section. Therefore, all neighbouring cameras on this motorway are checked as well. From this, the TCC responsible can see that there is heavy snow falling between Exit Fischamend and Exit Vienna Airport. Double check with the police reveals that there is a 2 km traffic jam due to an accident after Exit Schwechat.

Data Customization

From the information available, the following traffic message is created:

1. Heavy snow falls in Lower Austria, eastwards of Vienna
2. Slippery roads due to heavy snow falls on the A4 Ostautobahn between Exits Fischamend and Vienna Airport
3. Traffic jam, ending at the Exit Schwechat in driving direction Vienna.
4. Traffic jam length: 2 km
5. Time loss: 15 minutes.

Data Distribution

This information is now distributed along different channels. Information a-c is distributed via TMC and accessible for all users for free. Information a-e is distributed via ASFINAG road side units in the incident area. Only users that have COOPERS OBUs can receive this information.

Convenience Information

In the Single Service Provider Scenario concerning Convenience Information a Commercial Provider takes over the lead in the Value Chain. The Commercial Provider acts as Application Provider (for the programming and developing of services) and as Service Provider (for creating value added services), see Figure 7.

To illustrate the complex relationships between the single actors in this Value Chain a practical example is described below.

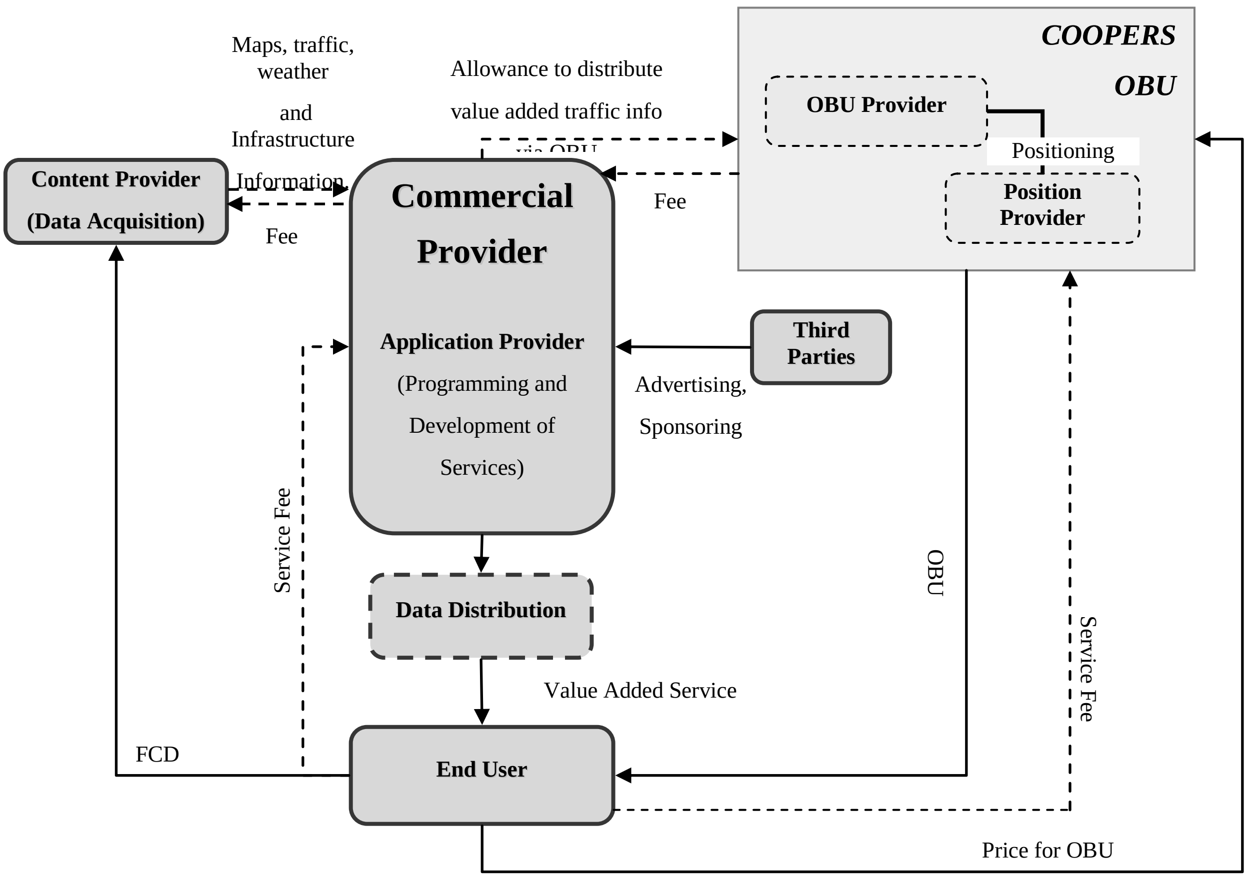

Figure 7: Single Service Provider Value Chain for Convenience Services

Example for Convenience Services

For this example the Austrian situation was taken, however please notice that the companies indicated are purely assumptive and that of course other companies not named here can replace the mentioned.

When it comes to Convenience Services, the Value Chain looks different. Here it is likely that a big Telco or Media concern takes over the lead. Let's assume, A1, an Austrian Telco, is playing the role of the application and the Service Provider. Here, different Content Providers, such as Ö3 (the Austrian Broadcasting Corporation with its FCD fleet), map providers (Teleatlas or Navteq), toll operators, etc. supply raw data to the Content Aggregator. Third parties, such as restaurants near motorways, fuel stations and lots more act as sponsors for such services. Data distribution and customizing is done by A1 itself, being a Telco. It can for example be via GPRS, etc. In addition other data distribution channels can be used, for example DVB-H, DVB-T, radio etc.

The OBU provider only supplies the hardware in this case. Interface to the customer is the commercial provider, A1 in our case. The customer receives the services against a monthly fee that is collected for example with the mobile phone's bill of the end user. The commercial provider and the OBU provider have some sort of agreement, so that the commercial provider can make sure that the services it distributes are displayed on the end-users hardware in an appropriate manner.

4. Summary and Future Work

In this paper the concept of Value Chain for the COOPERS services has been described. The goal of COOPERS services is to provide value added services to the end user in order to improve road safety (for safety critical services) and to improve journey planning and performing (for convenience information). There are different Value Chains for services which contain safety critical information (e.g. accident warning) and those which contain convenience information (e.g. journey time estimation). The concept of Value Chains will further help to develop adequate business models in order to create products based on co-operative traffic management systems such as COOPERS, i.e. to enable implementation of the services in the market.

5. Acknowledgments

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Computer Support of Cooperative Work

CSCW: FOUR LETTERS FOR A BUNCH OF GOALS

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Abstract

Cooperation in teams today is rapidly growing in importance. Cooperation is an interdisciplinary multilevel issue reaching from technical to organizational to human aspects. It combines concepts from Computer Cooperative Work (CSCW), Human-Centered Computing, and Ubiquitous Computing. In this session we want to examine this field from various possible angles and especially investigate these issues in group work including its basic information and communication technologies.

1. Introduction

The rapid evolution of information and the new potentials for communication between people have been of great importance to the success of most organizations. Key aspects were the increased availability of computer networks and the trend towards team work and especially towards computer support for team work. Activities in that domain are known by the notions of groupware or computer supported cooperative work. Ellis [1] defines groupware as "computer-based systems that support groups of people engaged in a common task and that provide an interface to a shared environment." While groupware refers to real computer-based systems, means the notion CSCW the study of tools and techniques of groupware as well as their psychological, social and organizational effects. CSCW reflects a dramatic change in the role of computers from a personal tool to a new medium for human communication. This kind of technology raises new questions about the role and power of computers in daily life. CSCW is more about people than about computers, and applies a truly user-centred approach to the design of CSCW systems. The topic has attracted much attention in the last few years. While the field is obviously still in the process of development, there is a marked ambiguity about the exact focus of the field. A new type of software has entered the workplace: groupware. Despite its promise to support cooperative work, groupware often fails to live up to this promise in day-to-day settings, due to a lack of integration between various types of groupware tools. Working Apart Together presents the foundations for component groupware, a new generation of groupware systems that allows users to pick and mix the right groupware tools for a cooperative job. Groupware allows many concurrent users to work on the same project. Whereas a single user system focuses on the individual, groupware focuses on the group. What makes a CSCW application a CSCW application?

CSCW is the study of how people use technology, with relation to hardware and software, to work together in shared time and space. CSCW began as an effort by technologists to learn from anyone whom could help them better understand group activity and how one could use technology to support people in their work. These specialists spanned many areas of research, including economists, social psychologists, anthropologists, organizational theorists and educators [2].

Technology already plays an important aspect in our everyday lives. From the advent of the first telephone, to the current usage of email and cellular phones, humans continue to be social creatures, who aim to keep in touch, whenever and wherever. In fact, emails and cellular phones are tools of CSCW. In addition, it was found that instant messaging [3] can be seen as a CSCW tool. A more recent tool which has made an impact in the social arena of CSCW is blogging [4]. Blogging is a web based communication tool which allows individuals and small groups with a limited audience to share information. Personal views are placed in the commonplace of worldwide criticism. The aim of these systems is to give us the ability to collaborate and communicate at will. Each system is used under different scenarios.

Computer Supported Cooperative Work is concerned with investigating how people cooperate to solve problems and how that cooperation can be automatically supported. It is an interdisciplinary activity and the research group works closely with sociologists who carry out studies into the cooperative nature of work.

2. Origins and Central Concerns of CSCW

A balancing trend to the technology-led approach has been the significant involvement of ethnographers in CSCW research. They apply techniques traditionally used within sociology and anthropology to understand what it is that people actually do in their work. This can reveal many subtleties about work practice, the handling of exceptions and the problems that can arise with existing computer technologies that can help in the design of more appropriate systems. When trying to build computer systems that will help people to work together more productively we have to take into account a number of factors.

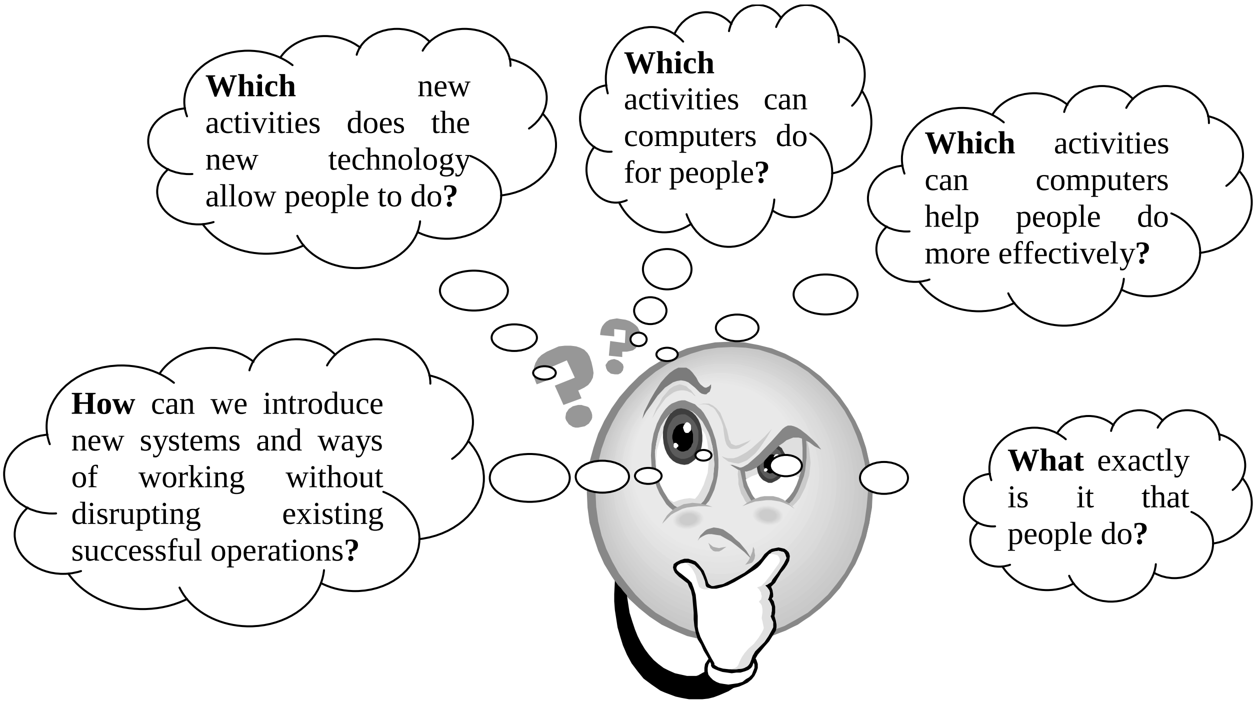

Figure 1 - Factors in the development of CSCW systems

This is known as the socio-technical design challenge. It involves determining what should be built not merely by reference to what is technically possible, but what would be useful to the organisation and acceptable to the organisation. Collaborative work is necessarily social. Thus a system that flouts social rules, norms or customs, even if it does useful things, may fail to be used.

CSCW systems are designed to improve group communication while alleviating negative interactions. However, their developers often focus on the technology, producing highly sophisticated software systems to address problems that may not exist in real-life groups or may not effectively address problems encountered by them. As a result of an extensive review of the literature and a large-scale survey of meeting participants in a University setting, we believe that we have identified the most important problems in group interaction. These are matched with specific features of CSCW technology, as well as with their potential drawbacks. This problem–solution–drawback arrangement is posited as a point of departure for a common knowledge base for future development.

3. Terminology and Research Field

The term CSCW was first coined by Irene Greif and Paul M. Cashman in 1984, at a workshop attended by individuals interested in using technology to support people in their work [2, 5]. CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques. Despite the variety of disciplines, CSCW is an identifiable research field focused on understanding characteristics of interdependent group work with the objective of designing adequate computer-based technology to support such cooperative work. CSCW concepts have largely been derived through the analysis of systems designed by researchers in the CSCW community, or through studies of existing systems (for example, Wikipedia). CSCW researchers that design and build systems try to address core concepts in novel ways. However, the complexity of the domain makes it difficult to produce conclusive results; the success of CSCW systems is often so contingent on the peculiarities of the social context that it is hard to generalize. Consequently, CSCW systems that are based on the design of successful ones may fail to be appropriated in other seemingly similar contexts for a variety of reasons that are nearly impossible to identify a priori [6].

4. Some Requirements for CSCW

CSCW systems have mostly been built using an ad hoc approach to information storage and management. As these systems mature, a more systematic approach will be required and it is already clear that existing database management systems lack a number of required facilities to support effective cooperative work. The CSCW technology has the potential to enable a flexible design of an organisation, as it can be used for making communication more flexible than before. However, we still lack methods for the design process of CSCW systems. The use of CSCW technology has the potential to facilitate the design of an organisation, as it allows for a flexible structure of communication within the organisation. However, we still lack methods and experience when it comes to the design process of such systems. We need methods that facilitate the design of different work organisation alternatives within the CSCW system.

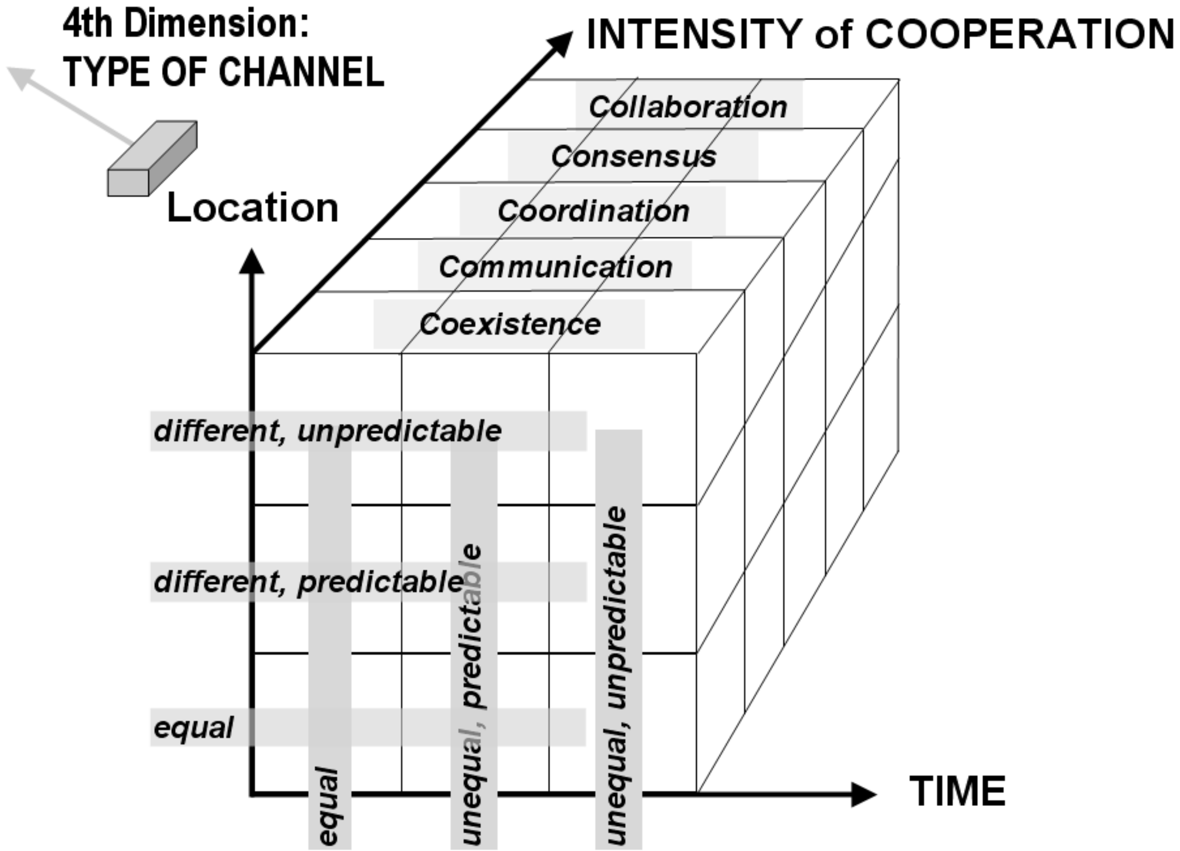

Figure 2 – Dimensions of CSCW Design (1)

5. Where are we Today?

CSCW aims to provide similar improvements for ‘‘multiple individuals working together in a conscious way in the same production process or in different but related production processes. Because it is such a new area of investigation, one might expect significant controversy and fluidity regarding its definition and focus. Surveys of the CSCW literature support this expectation. Most observers seem to agree that CSCW, an emergent interdisciplinary field, entails some combination of computing and social science. For example, Greif [7] suggests that CSCW is an interdisciplinary endeavour encompassing artificial intelligence, computer science, psychology, sociology, organizational theory, and anthropology. Similarly Dourish [8] sees CSCW as a highly diverse discipline involving psychology, sociology, anthropology, network communication, distributed systems, user-interface design, and usability. Beyond agreement on the interdisciplinary nature of CSCW, opinions vary widely about a detailed definition and about an exact focus for the field. One viewpoint is technology-centric, placing an emphasis on devising ways to design computer technology to better support people working together. A second viewpoint is work-centric, placing an emphasis on understanding work processes with an aim to better design computer systems so as to support group work. For example, Suchman [9] defines CSCW as ‘‘the design of computer-based technologies with explicit concern for the socially organized practices of their intended users.’’ Similarly, Bannon and Schmidt [10] believe that ‘‘CSCW should be conceived as an endeavour to understand the nature of cooperative work as a foundation to designing information systems to support the work.’’

6. Key Dimensions of CSCW

CSCW involves a broad, multidimensional scope. Here we aim to distinguish some of the important dimensions inherent in CSCW and to clarify the essential features that must be supported by CSCW systems.

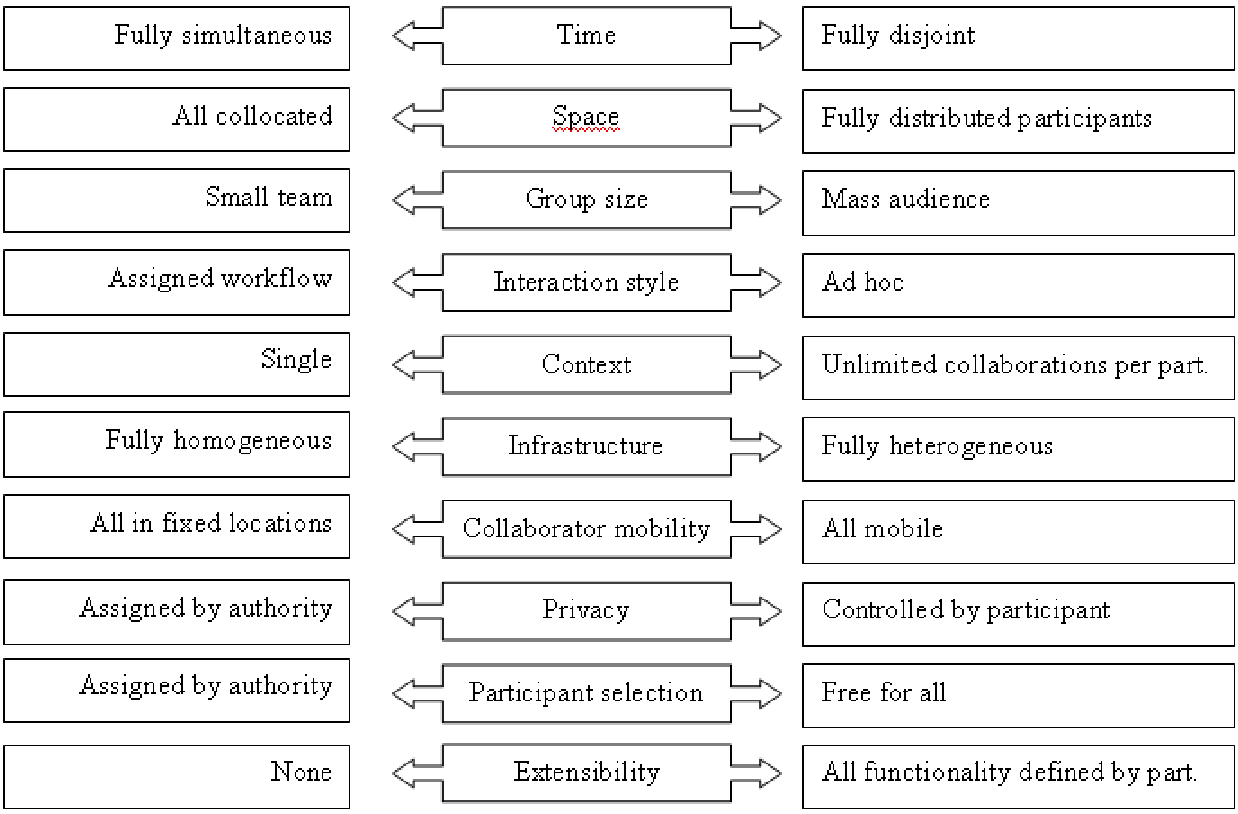

Figure 3 – Dimensions in CSCW design (2)

Thinking about potential dimensions of the design of those systems, a lot of questions come up:

- Must the individual collaborators act simultaneously?
- Must the individual collaborators be physically located at the same site?
- Must the system support a small team, a department, an enterprise, or a mass audience?
- Does the group require support for planned or impromptu interactions or both?
- Do group members participate in many distinct collaborations or do they tend to participate in only one or a few?
- Will the group permit the deployment of homogeneous computing platforms tailored to collaboration, or must the CSCW system operate across already deployed, heterogeneous computing systems?
- Will the collaborators remain at fixed locations or will some or all of the collaborators move among locations?
- How much information can be made available about the collaborators and who should control the release of information?

- Must the group's participants be assigned by existing group members or by some external authority, or can participants self-select or search for additional participants from a larger population?
- Does the CSCW system define the complete functionality available to collaborators, or can the collaborators extend the functionality to support changing needs?

These dimensions provide a rich design space through which the developers of CSCW technology must navigate. Such extreme complexity also presents a great challenge to CSCW researchers. Despite such complexity, CSCW researchers have been able to focus on some essential features that CSCW systems must provide.

7. Essential Aspects in CSCW Systems

Much of the CSCW research literature focuses on providing collaborators with tools to support articulation work: establishing and evolving organizational structure, plans and schedules, standard operating procedures, and conceptual schemes for classifying and indexing information objects [11] In other words, CSCW aims to support the overhead that arises when work is conducted among distributed, independent agents. Articulation work includes two important threads: construction and management of a common, shared information space and workflow management. In the past, designers of workflow systems automated written procedures as maintained by each target organization, which in all cases turned out to be a fictional, idealized version of the real work process. Now, CSCW researchers understand that most work situations entail a continuous renegotiation of task descriptions and allocations. Further, researchers understand that collaborative communication must allow for ambiguity in the negotiation processes surrounding articulation work.

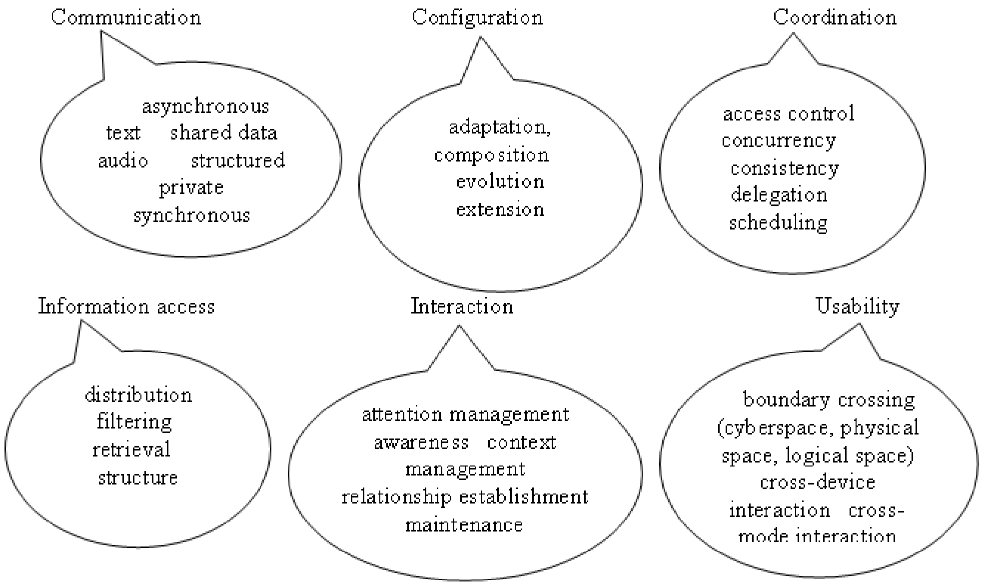

Figure 4 - CSCW design areas and some key design features

Successful negotiation on issues related to organization, planning, and control requires provision of an effective system for communication among the individuals involved. Much of the communication associated with CSCW is used to coordinate work among the disparate, independent parties engaged in a collaborative endeavour. For this reason, CSCW researchers investigate features and mechanisms to help groups coordinate their activities. A major aspect of group coordination involves scheduling, whether of people, processes, or resources. While some CSCW researchers have investigated techniques to more tightly integrate calendaring software with other aspects of collaboration, such as document distribution, situation awareness, and personnel location tracking, more of the research to date has focused on process or workflow scheduling and coordination.

8. The Challenge of CSCW Research

The CSCW research area is concerned with the design, development and use of computer technologies to support collaborative activities, as well as the impact of digital collaboration technologies on users, groups, organizations and society. Relevant research topics include theoretical and empirical investigations of collaborative activity, as well as all aspects of the design, development, deployment and study of computer technology supporting collaborative endeavours. CSCW encompasses all areas of collaborative activity supported by technology – not just "work" in the traditional sense. So, in addition to exploring work places and work practices, we also explore the applications of collaborative technology to areas such as the domestic environment, entertainment, health and education.

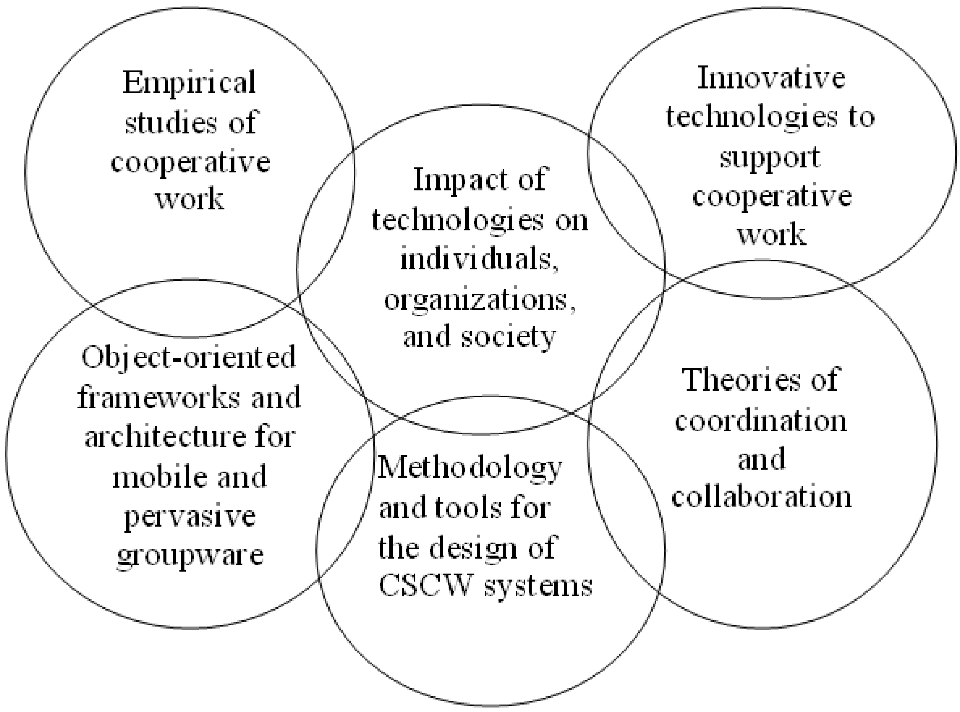

Figure 5- Some CSCW research topics

CSCW is a research domain, which examines ways of designing systems – people and computer systems – that can have significant implications for the way in which people work together. Although the domain initially emerged from the discipline of computer science it can be argued that the CSCW research domain differs from traditional computer science in that it draws on the contributions of various disciplines, all of which support the aim of developing computer systems on the basis of people and their working relationships. Traditional collaboration is necessarily sequential: one individual can only add something after another one has finished. This even applies to real-time meetings or conversations: only one person can talk at a time. In a CSCW environment, on the other hand, people can add information in parallel. Moreover, the collaboration is not restricted to real-time or other physical constraints depending on time or space. The different people collaborating need not be present in the same location or even at the same time. The simplest way to implement this kind of asynchronous and distributed shared workspace is through annotation: different collaborators can add comments to specific parts of a collective document. Moreover, CSCW makes it possible to overcome or control for a number of social constraints: in normal meetings, people who are assertive, fluent or in a position of authority will tend to dominate the discussion, while those who are shy or of a lower rank will find it very difficult to have their ideas accepted or even paid attention to, however good those ideas may be. In a CSCW environment, everyone types at his own speed or in his own style, without needing to wait until the others given him or her the occasion to speak. Moreover, through the use of nicknames or other devices the contributors can be kept anonymous so that the idea of the general manager is considered with the same unbiased attitude as the one of the junior employee. Using the public Internet as communication medium makes it even possible to maximally open up the group of collaborators, and allow virtually every person in the world to participate.

Finally, the inherent computing capabilities of CSCW tools make it possible to overcome cognitive constraints, by processing information that would be too complex to use in traditional environments. For example, different alternatives could be evaluated according to different criteria, whereby each collaborator could give his personal estimate along each of several dimensions. Statistical techniques from Multi-Criteria Decision Analysis can then be used to find that alternative that is most acceptable to the group, or to give feedback on different possibilities to reorganize the alternatives. The ease and flexibility of thus setting up and evaluating different forms of voting in principle allow strongly enhanced forms of democracy.

We can find two examples of successful (but limited) CSCW Systems:

Email is one the most successful groupware applications. But it has some major limitations as a tool for collaborative design. It is typically managed by individuals and there is no shared information space. It is most often stored separately from artefacts. Its contents are more difficult to access for the group. The emails are isolated from the design artefact, users must supply more contextual information along with their message.

WorkFlow Systems seek to coordinate work within and across workgroups. They support scheduling, design verification and reporting.

9. Human Computer Interfaces to CSCW Applications

Today's human-computer interaction debate mainly focus on interface design of single-user work places concerning individual workload, personae maladaptation, cognitive stress etc. Social organization of computerized work with people working together by using computer networks have hardly been considered systematically from an interface design viewpoint up to now. In most cases, design criteria from the, "single-user world" are being transferred to groupware interfaces without any particular concern. But in CSCW systems users are not only dealing with interfaces but more, important they are part of an interaction process. In CSCW systems users act, react, and interact with other users via computers. Therefore We have to design complex, dynamic human-computer-human interaction processes. By developing CSCW systems designers have to leave the narrow viewpoint of "computers being a tool" to solve isolated tasks. They have to enlarge their perspective to the level of "computers being a medium" of cooperative task performance in a complex organizational setting. The knowledge which has been created and applied by researchers in the field of human-computer interaction (HCI) has mainly been derived from disciplines like cognitive science, perception psychology, or ergonomics.

CSCW is a research area that examines issues relating to the design of computer systems to support people working together. This seemingly all-encompassing definition is in part a reaction to what has been seen as a set of implicit design assumptions in many computer applications - that they are intended to support users do their work on their own. In cases where a scarce resource has to be shared; systems designers have minimised the effects of this shared activity and tried to create the illusion of the case of exclusive access to resources. This assumptions hold in discussion of digital libraries as a way of offering access to resources without the need to compete with other library users.

10. Inefficiencies in traditional Face-to-Face Group Interactions

Time-related problems: Scheduling meetings for groups can often be time consuming and frustrating, but a more serious problem is in limiting the meeting-process time itself. Attempts to reduce this time can result in incomplete task analysis and poor decision making.

Distance- and space-related problems: The physical distance between participants acts to impede group interactions on account of the time, cost, and effort involved in travelling to and from group meetings. If meeting space is limited, scheduling meetings becomes more difficult and can result in additional delays. Research on the ergonomics of space utilisation indicates that the traditional fixed-format designs of meeting rooms and tables can lead to problems involving ‘power' seats, line-of-sight interaction, and the need to set up subgroups. Furthermore, smaller meeting space imposes additional constraints on how groups can interact.

Cost-related problems: In attempting to alleviate time-related and distance/space-related problems, increased cost may arise. Expenses are incurred in various ways, including utilisation of space, time spent in arranging meetings, and in travelling to and from meetings.

Behaviour-related problems: Behavioural barriers to effective group interactions arise mostly because of the distortion or loss of information, a lack of common conventions and standards, defects in the decision-making process. All too often, these problems result in process losses, defined by Miner [12] as the “difference between potential and actual group performance”.

11. Conclusion and Outlook

CSCW is concerned with investigating how people cooperate to solve problems. Due to the flexible character of the CSCW technology, there are more organisational alternatives to take into account when it comes to the design of the work organisation than when using more traditional technology, especially regarding the distribution of work tasks, control and co-ordination aspects, social interaction and co-operation. There is a need for co-ordination between the design of the technology and the design of the organisation, as well as a need to integrate such decision-making into the development and implementation process. Different designs of technology and organisation could lead to different consequences for the work situation of the individual and for efficiency and quality aspects. There is a need to integrate a discussion and analysis of these aspects into the design process. Further research needs to be carried out to test and evaluate the use of scenarios in real contexts in order to contribute to the development of relevant methods for the design of CSCW systems in the future.

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COOPERATION IN VIRTUAL ORGANISATIONS: AN INTRA-ORGANISATIONAL CASE STUDY

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Abstract

The concept of virtual organisations has quite some tradition in literature and there is a considerable amount of papers available about the cooperation among the organisations that engage together in a virtual organisation. Nevertheless, there is a lack of practical and empirical results of the actual cooperation among the organisations engaging together in a virtual organisation. In this paper we present a case study of three companies that cooperate closely in a virtual organisation. We characterise its strengths and weaknesses and derive requirements for the successful cooperation in virtual organisations.

1. Introduction to Virtual Organisations

The idea of virtual organisation marks the organisation discourse since it was first formed by Davidow and Malone in 1993 [5] and is strongly associated with an increase of flexibility, innovation, and globalisation as well as with a decrease of costs and organisation [1].

Meanwhile there are numerous characterisations about what are the main characteristics of a virtual organisation, but "there is not yet a commonly agreed definition of the virtual enterprise" [3, p. 8]. In fact, the terms 'virtual organisation' and 'virtual enterprises' are often used synonymous in literature. For Camirinha-Matos and Afsarmanesh the essential distinction between both lies within the market orientation, which is defined as a necessity for virtual enterprises. For Martinez et al. the structure of a virtual enterprise depends on three groups of characteristics: the market characteristics, the production process, and the strategic objectives of the association [16, pp. 226]. For Jaegers et al. [12] virtual organisations are characterised by the following attributes: a complementary of core competencies and the polling of resources; the equality of the participants and their changing; the geographical dispersion; the crossing of boundaries; and finally the use of electronic communication technology [12, p. 69]. For our approach we refer to Camirinha-Matos and Afsarmanesh and their conception of virtual enterprises that "materialise through the selection of skills and assets from different firms and their synthesis in a single business entity" [3, p. 8].

Even if there is a lot of theoretical work on virtual organisations and enterprises [2, 4, 6-9, 11, 13, 15, 17, 18] we found a lack of practical and empirical results in the literature. Virtual organisations cooperate in a dynamic and project orientated environment, and therefore it is difficult to identify the cooperation behaviour. Nevertheless, in our project TransKoop [10] we found three enterprises, which act as autonomous units in the media sector and also representing attributes of a virtual organisation. With an explorative single-case study focused on their inner cooperative structure and their strategic occurrence on the market, we explore that these three entities are acting as one virtual organisation.

In this paper we present an empirical study of a virtual organisation consisting of three companies. We describe the method the general setting. We, then, report on the findings and particularly on the structure of the virtual organisation, its strengths, and its weaknesses.

2. Method and General Setting

Implementing qualitative data involves pre-deliberations about the kind of material that we want to capture. We decided to make an explorative qualitative single-case study [19]. For this we interviewed a member of the management of a corporation in the children's media sector who is at the same time executive director of two corporations in the media sector.

This includes that we need to become clear about different types of *subjective experience* that can be explored by qualitative data mining. First, we are interested in information dealing primarily with a recollection through descriptions about organisational cooperation. Second, we want to discover how this organisational cooperation is performed between each of its units as well as on the market. This includes the procedural and special knowledge of the test-person about the sequence of inner organisational cooperation. For this we need to ascertain concrete experience knowledge in form of explanations of the interview subject.

These pre-deliberations about the quality of the data brought us to the decision for an *interview technique* to be used: an exploratory interview in form of a semi-structured and guideline-based expert interview. The 'expert interview' is a common type of qualitative interviewing in Germany. In the Anglo-American literature rather the notion 'elite interviews' can be found. Both types of interviews have commonalities but also distinctions. For a good overview about the common characteristics and also the considerable differences of both types see [14]. For our expert interview we use the following definition of the interviewee as "a person, disposing of special knowledge and decision-making power" [14].

The *semi-structured guideline* allows on the one hand a structured procedure focusing on the questions of interest and on the other hand a possibility for the interviewee to contribute own topics. The guideline was generated through an intensive literature research as well as a secondary market analysis of the children's media industry in Thuringia, Germany. The contact to the interview person was made during an acquisition process for the ongoing TransKoop project for which we successfully detected for potential transfer partners located in the children's media sector.

The interview was executed in the middle of June 2009 and given in German. The quoted interview fragments were therefore translated and paraphrased from German to English for this publication. The subsequent quotations we took from the interview are presented anonymously in the form (06-11-09-#1, l. x), which offers the interviewee the advantage of anonymisation and at the same time allows the interviewer easy and direct access to the respective part of transcript. The one-hour conversation took place in the workaday-environment of the interviewee and was set in a collegial-neutral ambience. The interview was performed in a neutral sympathising style. Because of the semi-structured configuration we avoided closed and suggestive questions. The talk was documented by a digital record and afterwards edited by using the transcription-software Transcriptions. The data analysis was managed with the Computer Aided Qualitative Data Analysis Software (CAQDAS) MaxQDA. We worked with a coding-system that was generated from the semi-structured guideline as well as on an inductive way from the data material itself. Several revisions and iterations led to a finer granularity of the material and the coding schemata.

3. Findings from the Interview

The findings from the interview can be distinguished into intra- and inter-organisational aspects to understand the structure and behaviour of the virtual organisation. In this paper we focus solely on the intra perspective of the virtual cooperation. This gives us the possibility to get an insight about how the three investigated companies are geared within each other and how they strategically act on the market. For a better distinction and for data protection we use pseudonyms that semantically represent the original label name.

3.1. Short Overview of Each Enterprise

The first enterprise, which we rename as "World-Solutions", is located in the media market and was founded in 2001. "World-Solutions" is specialised in Web applications and corporate design, as well as in e-learning solutions. The enterprise has a broad client base ranging from economic companies to tourism organisations. The second enterprise subsequently called "Animations" is also focused on the media sector and concentrates on character-design, story-development, and animation. It has a rather small client base and is primarily working on an international animated cartoon project in cooperation with a German television broadcaster. While "World-Solution" and "Animation" were differing strongly in their specialisations, the third enterprise in the following called "Media-for-Children", unifies all these competencies. It focuses on the target group children, and originated at the end of the year 2007.

3.2. Structure of Cooperation

As mentioned above all the three enterprises are from the media sector, and one is specialised on children's media. In this case study we show how the cooperation as a virtual organisation is historically grown out of strategic consideration about how to get advantages on the market.

With the establishment of "Media-for-Children" there is, besides the synthesis of competencies, the phenomenon of pooling all co-operators and assistants in this company. The consequence is that "World-Solutions" and "Animations" have been "adjust[ed] to zero" (06-11-09-#1, l. 21), what means that both firms neither work on a project nor have staff members anymore. This phenomenon influences directly the kind of the production process and gives a good insight to the structure of cooperation (cf. Figure 1).

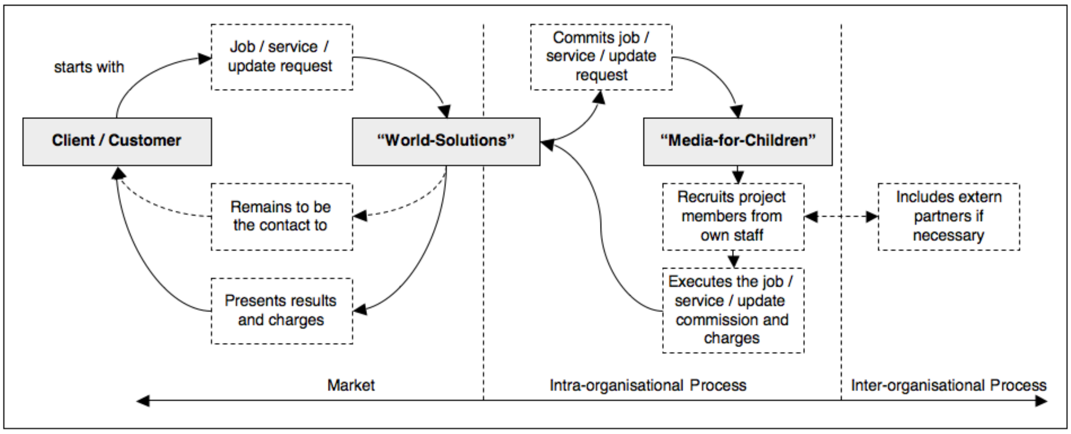

Figure 1. Market appearance and production process.

If there is a job request to one of these firms, the project members are recruited from the "Media-for-Children" staff, so that all projects are centralised in only one company. For instance, when "World-Solutions" gets a job request, the project members of "Media-for-Children" execute the service commission, while "World-Solutions" remains to be the executor in the outside view of the client.

From this it follows that outsiders, like potential clients, recognise each of these three enterprises as autonomous actor, while they are actually always concerned with the same enterprise. In fact there is only one real producer ("Media-for-Children") while the other two exist primarily for acquisition ("World-Solutions" with its long year market appearance and his broad of regular clients) and as a reference label ("Animations" has been working for several years on an international movie, which functions as reference to get access to the international market).

3.3. Strengths

This synthesis of skills and specialisation in one enterprise unit ("Media-for-Children") besides maintaining the labels of "World-Solution" and "Animations", functions as enormous market strengths. Figure 2 summarises these strengths.

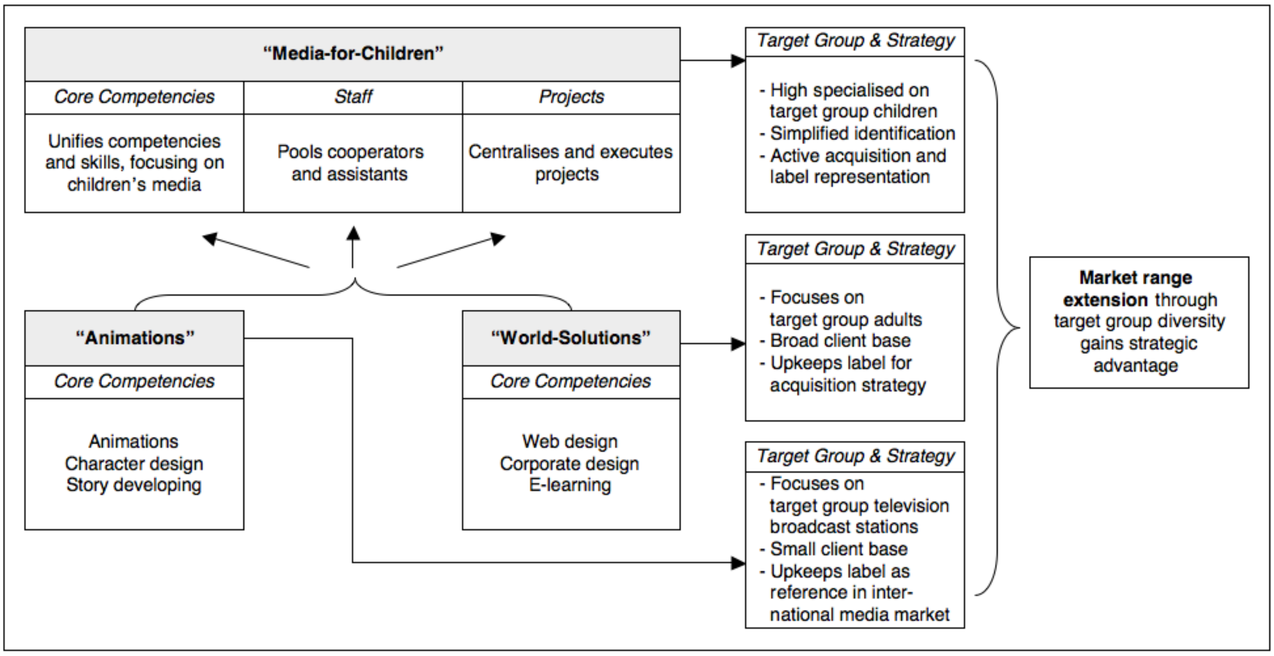

Figure 2. Intra-organisational structure—market range extension.

With establishing "Media-for-Children" one advantage that is given is the clear and simplified identification of the offered core competencies, services, and products:

'Well, that is the advantage. The term "World-Solutions" is neither fish nor fowl, you can imagine a lot under this company name. With "Animations" it is similar. On "Media-for-Children" everyone knows immediately what is going on, and this is in fact the positive thing, that sharpens the profile, which is (...) superior for our position on the market. If the people immediately knew what this is all about, it is much easier to carry along the message of our company.' (06-11-09-#1, l. 39-40).

Moreover, this specialisation manifesting in the label name leads to a market range expansion. While clients from the media branch were confronted with a company that deals with highly specialised and individualised products, potential job offers from outside the children's media sector still can be handled. So diverse target groups can be maintained:

'We want to carry on to participate in tendering procedures, for example in corporate design for firms, what we can do definitely, but where you will fall through the cracks with a label like "Media-for-Children". Because a firm making funny colourful things for children and (...) e-learning doesn't seem to be the right one to make a product marketing. (...) and that is the reason why we are appear with both labels concurrency.' (06-11-09-#1, l. 13)

The strategic objective to get a more specialised target group through "Media-for-Children", besides maintain a broader client base, influences the structure of the three enterprises, which evolutes through the synthesis of skills, staff, and projects to the more flexible form of a virtual organisation. Besides this possibility to serve a larger target group, we found an easier identification and an increased trustworthiness in the skills and expertise of the enterprise given by the specification on children media products.

We saw that the reputation and the market appearance influence the costumers' expectations:

'This specialisation is an absolute advantage. (...) through this specialisation, also in the brand, we got the feeling that we got a lot of trustworthiness, we appear there and we get recognised as experts and if we present ourselves with the stuff we have done, then the people believe us. Then we have a very high reliability.' (06-11-09-#1, l. 41)

Furthermore, the possibility to serve a diversity of target groups by different labels also gains a strategic flexibility that affects the market appearance as well as negotiations with clients. So, "Media-for-Children" gains the opportunity to refer to the core-competence of one of the other labels "World-Solutions" or "Animations" to get an advantage in negotiations. This requires a consideration process depending on the relation to the client as well as on the required service that could satisfy the client:

'That depends on the kind of confidence that you have of the client. If it is necessary to tip the scales with the animation and comic competencies of "Animations", to show him that we can do more than shown on the "Media-for-Children" homepage (...) if I want to show an example (...) as a strategic advance.' (06-11-09-#1, l. 37)

3.4. Weaknesses

Since the three enterprises in which the interviewee is involved have a good tradition of successful cooperation, the interviewee pointed out that he preferred to report on key challenges that can become problems and weaknesses when not addressed properly.

The historically grown structure of the cooperation fulfils the requirements of a successful and long-time market appearance, and of a minimal critical mass of reference projects. This is a precondition for the development of a virtual organisation structure as presented in this single-case study:

'We have built up a regular clientele with "World-Solution" where, of course a lot of things in the children's media field accrued. So in fact we founded "Media-for-Children" with this expertise.' (06-11-09-#1, l. 13)

Nevertheless, besides this specified requirement we can spot out that it is very important for a successful virtual cooperation to build up consistence and reputation to avoid confused clients. An inconsistent market appearance by offering to many core-competencies and specialisations from the different labels may evoke overburden clients. In order to evade a loss of potential clients there has to been a selection of specialisation and references leading to a consistent self-representation of the enterprise as one requirement besides the historic preconditions (cf. Figure 3Figure 3). For instance, in negotiations the kind of self-representation has to be set in connection with the clients target group as well as with the clients' expectations:

'But when I am going to talk to an educational publisher (...) where educational operations are rather important than characters and stories, then I keep this whole topic "Animations", TV-stations, comic movies in background. Because that would confuse the people, perhaps they have any kind of figure and they have an [educational, the authors] book, that certainly we could design and make better, but that would confuse the people.' (06-11-09-#1, l. 37)

While we were pointing out the advantage of a larger target group there are other requirements based on the special characteristics of the two sectors of the media market, the two labels "Media-for-Children" and "Animations" are engaged in. Both sectors, the children's media market on the one hand and the national German animation market for television-broadcasting stations on the other hand, are very compact:

'This scene is so small, the decision-maker in these [television-broadcasting, the authors] stations and publisher-houses are so close to each other (...) so you can't do anything obscured, that wouldn't work (...) that is such a small scene.' (06-11-09-#1, l. 9). And: 'So we were extremely focused on this television broadcast station, that we go so far to say we can't work for another television broadcast station, because they are the two directly competitors' (06-11-09-#1, l. 3).

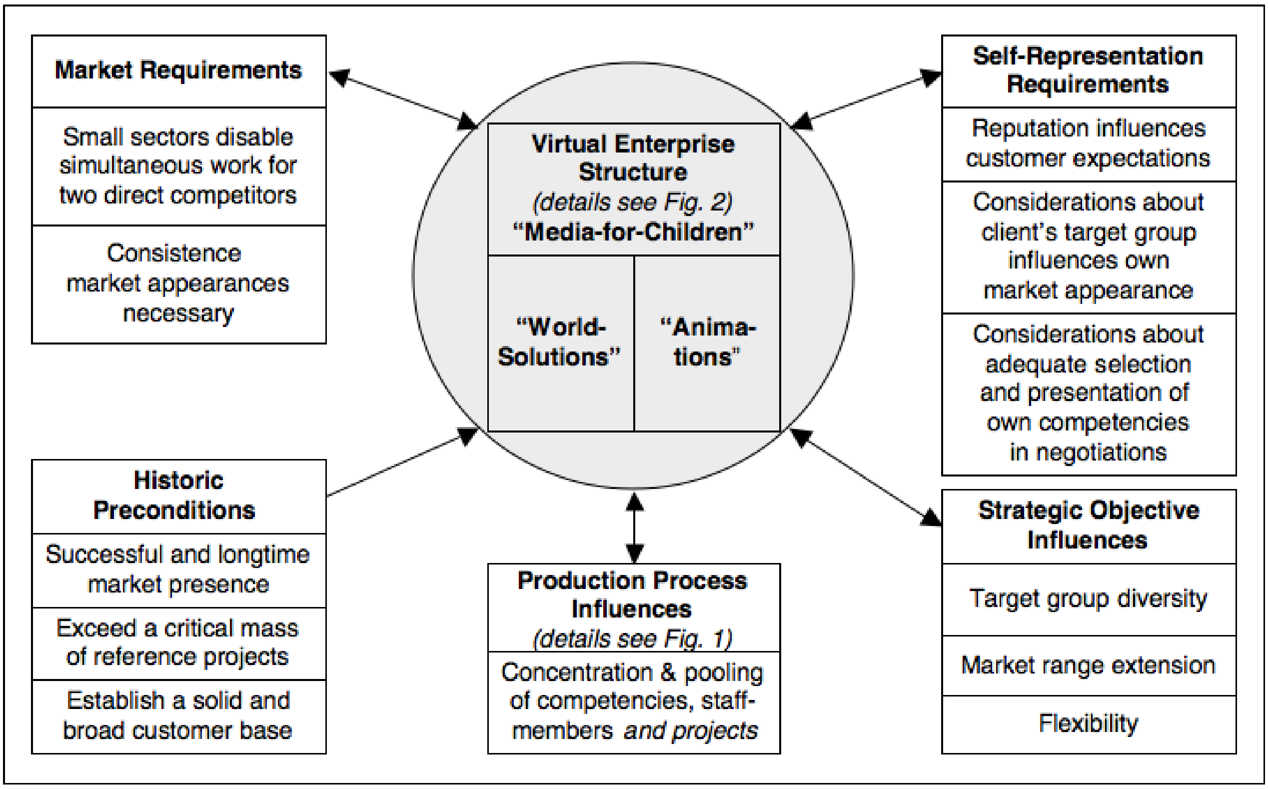

Figure 3. Requirements and influences.

From there it results, that even acting with three autonomous emerging enterprises doesn’t give the possibility to work simultaneously for two clients who are in competes with each other even under different label names.

4. Conclusions

In this single case study we concentrated on the inner structure of three enterprises cooperating together as a virtual enterprise, that materialise through a synthesis of skills and specialisations in a single business entity as defined in [3]. The strategic objective and production process compared with special market characteristics influences the structure of the virtual organisation we presented here and as mentioned above in [16]. We spotted out that the organisational structure and their potential to act as a virtual enterprise is depending on historic preconditions. Also self-representation requirements influence the success of the virtual-enterprise.

Furthermore, we showed the advantages and requirements that are gained in this virtual cooperation: The possibility to maintain different labels and to bring them in action carries the potential to gain advantage by market expansion. The specification and concentration on core-competencies on the one hand and the maintaining of a broad client-base on the other hand increases the flexibility for different and individualised market appearances depending on an analysis of customer requirements. With the high specialised and individualised products and services that are represented by an easy to identify label like “Media-for-Children” an increase of trust in the skills and expertise of this enterprises arises on customer’s side. Furthermore, the flexibility is increased with the opportunity to refer to another core-competencies to win a client. However, with the given flexibility also arises the possibility to confuse clients by inconsistent and overloaded market appearances. The challenge is to keep up a consistence self-representation through authentic, credible and trustable behaviour. This includes respecting special market characteristics, restriction and requirements that trace back to the two small sectors the enterprises are engaged, like avoiding work for direct rivals.

Further research should focus on how the presented virtual enterprises cooperate with external partners and on the organisation technologies are used as well as needed in such aggregations.

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DEVELOPMENT OF E-HEALTH AS A FUNDAMENTAL CONDITION FOR RADICAL CHANGE TO THE CZECH AND EUROPEAN HEALTH SYSTEM

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Abstract

This paper focuses on the e-Health situation in the Czech republic from the perspective of which conditions are necessary in order for there to be improvements for patients/citizens, health professionals and the general management of public health. These areas are described from a technological viewpoint as well as organizationally and examples are given of problems, projects and solutions.

1. General

e-Health describes the application of information and communication technologies across the whole range of functions that affect the health sector. It can improve access to healthcare and boost the quality and effectiveness of the services offered.

e-Health plays a clear role in the European Union's eEurope strategy, and is key to achieving stronger growth and creating highly qualified jobs in a dynamic, knowledge-based economy - the vision set out by the Lisbon European Council in March 2000. To move ahead, action is required within several important policy areas that range from research and development of broadband networks in telecommunications, to development in public health, and work in Member States that promotes mobility and assesses the implications of European ageing on healthcare systems.

As a public sector service industry, around 80% of the costs incurred by the sector are in human resources. In both the old and new Member States, 75% of all expenditures come from public sources. [1], [2], [3]

2. Areas of the solution

The e-Health concept requires development and interconnectivity in three areas. Each area has its own technological and organizational particulars as well as different challenges. Of course in each area, the human factor plays a significant role. Therefore, individual technological tools as well as organizationally precautions, that can be extremely complicated, have the ability to give support to all parties involved. Important aspects in each area are continual education and training of patients and citizens as well as medical personnel.

6. *Patient/citizen* – We attempt to resolve problems connected to the individual's medical treatment and health insurance, such as identification, electronic health cards, health records, prescription medicines, personal accounts, access to information, etc… This area is not technologically complicated but organizationally it is very complicated. The legislation involved, the coordination and unification of organizations and individuals, standardization, and cataloguing are all parts of the organizational component.
7. *Health professional (health specialist)* - This area is technologically very challenging. The most important aspect is to ensure the high quality of data transfer (i.e. files, images, laboratory results) and diagnostics. The exchange of this data is necessary for consultations and learning. What is significant in this part is telemedicine, telediagnostics, e-learning, etc. Organizationally, this area is not very complicated.
8. *Health management* - This area includes the support of health management, i.e. information systems for securing health care and managing health institutions (statistics, accounting, finances, reports, health insurance, registers, etc…). Neither the technology nor the organization is very complicated in this area.

These areas have different technological and organizational difficulties connected to their realization (see Table 1).

Area	Technology	Organization
1. Patient/citizen	Relatively simple	Very complicated
2. Health professional	Very complicated	Relatively simple
3. Health management	Medium level of difficulty	Medium level of difficulty

Table 1 Areas, technologies, organizations

These areas are being addressed not only on the national level (in the Czech Republic Ministry of Health, Ministry of Social Affairs, the non-profit, non-state organization MEDTEL, a Czech national forum for e-Health, and citizen associations) , but also on the EU level. Joint strategies as well as rules and principles of standardization are being prepared. Within the EU there are committees for e-Health, where the Czech Republic is also participating.

2.1. Patient/ Citizen

The patient/citizen needs accessible information about his own personal details and medical history, health and illness, possibility of self-care, and treatment abroad. This area does not have complicated technological problems; the individual components are technologically accessible and have been tested in other spheres of life.

Addressed problems

- Electronic identifiers
- Dedicated device for reading patients' records
- Internet portal
- Access rules and regulations
- Authorization of records
- Authentification of users

- Electronic signature
- Interface with EU
- Security

The organization of the entire project is very complicated.

(Examples are listed below)

- Legislation (laws that affect health care, protection of personal data, laws related to prescription medicaments)
- Unification and standardization of the ICT field in the Czech Republic and in the EU
- Unification and cataloguing of diagnoses, medicaments, laboratory items in the Czech Republic and in the EU
- Mobility of citizens
- Code of ethics
- Training, staff development
- Management

Examples of currently addressed problems in the Czech Republic and in the EU:

- Electronic health records
- Electronic identification
- Electronic prescriptions
- Citizen mobility
- Citizen health
- Border regions
- Decisions of the European Court of Justice
- Legal and moral aspects of e-Health
- System of record keeping for patient's information
- National electronic registries
- National medicament registries
- List of health institutions
- Geographic information system

Examples of actual projects in the Czech Republic:

eHealth			
Target group	**Type of interaction**	**Technology**	**Examples of aplication in CR**
patient/citizen	EI (electronic identifier)	Chip cards, read/record device, card management	VZP
medical officer and patients	Tele-consultation in conservative care — Tele-dermatology, Tele-psychiatry Tele-robotics — Tele-surgery, „Tele-mentoring“	Video-conference thru PSTN- ISDN, remote-controlled robotic devices. Perspective: technology remote-broadcast, haptic input (haptic feed back)	The hospital Homolka, Prague
medical officer, citizens and patients	Information about Health and health system, consultation in the area of home care, style of life	Video-telephoning, and video-conferencing through PSTN, ISDN or Internet, interactive TV, multimedia e-mail. Perspective: integration of intelligent monitoring devices, inclusive information transfer from micro sensors and micro systems, PDA	IZIP, Association of home care in CZ

2.2. Health professional (health specialist)

This very technologically complicated area includes health services that utilize image searching methods in addition to telemedicine, teleconsulting, teleworking, telerobotics , teleconferencing, and e-learning..

Examples of the technology supported are:

- Distance evaluation of results (pattern recognition, sound recognition, laboratory results)
- Distance consulting by making decisions about subsequent treatment, surgery, patient selecting the provider and the type of health care
- Distance consultation during surgery
- Distance patient monitoring
- E-learning

Examples of current problems being addressed in the Czech Republic and in the EU:

- Interoperability
- Emerging e-Health applications might stop at European borders, thus blocking cross-border communication
- Cross-border communication
- Health ICT market fragmentation
- Policy drivers for e-Health interoperability
- Health ICT industry
- Pressure from stakeholder groups
- e-Health in the Health management field
- Perspectives, national and international collaboration, research and development
- Services and interface (interface of different systems, outliers, malfunctions)

There are maximal requirements on transfer clarity and error elimination, as well as strict guidelines related to technology (powerful computers, perfect transfer techniques, elimination of errors in images, security). Organizationally, this part is not complicated.

Examples of actual projects in the Czech Republic:

eHealth			
Target group	**Type of interaction**	**Technology**	**Examples of aplication in CR**
medical officer	Safety electronic communication, expert consultation, i.e. teleophtalmology, teledermatology, telepathology, teleradiology	Videoconferencing, multimedia e-mail thru ISDN and Internet, safe technology. Mobile device satellites, use of virtual reality media, PDA	Metropolitan PACS, JM region
medical officer and patients	Teleconsultation in conservative care — teledermatology, telepsychiatry. Telerobotics — telesurgery, „telementoring“	Videoconferencing thru PSTN - ISDN, remote-controlled robotic devices. Perspective: technology remote-broadcast haptic input (haptic feed back)	The hospital in Homolce
medical officer, other professionals and patients	Teleconsultation in urgent care	Videoconferencing, mobile telemetry of records of vital functions. Direct information from micro-sensors and micro-systems	Masaryk Hospital in Ústí n.Labem, 1.LF UK
medical officer medical management	„Teleworking“ — teleradiology, telepathology	Videoconferencing, multimedia e-mail thru ISDN or Internet. Mobile technology, use of satellites	IPVZ Prague, 1.LF UK, Masaryk‘s Oncology Institute in Brno
medical officer - „virtual university“	Teleconferencing, extramural training a teaching	Videoconferencing, video transmissions, Internet or satellite, use of virtual reality, „data-mining“	IPVZ Prague, 1.LF UK

2.3. Management of health system

Management of this area concerns the development of the information infrastructure and the improvement of information systems for health institutions and the health system field– in most cases standard systems are needed (SAP, Microsoft, etc...). Via these improvements, there will be an ensured standard of conditions as in other sectors for enterprise management (statistics, financial reports, personal record keeping, stocking, invoices, orders, etc…). It considers of great scope of information and data, but on the technological and also organization part - it is the standard problems. [6], [5].

Examples of addressed problems in the Czech Republic

- Economic aspects of eHealth
- Information systems for Hospitals (HIS)
- Information systems for Laboratories (LIS)
- Information systems for generel doctors

Examples of actual projects in the Czech Republic:

eHealth			
Target group	**Type of interaction**	**Technology**	**Examples of aplication in CR**
medical officer	IS for Hospital	SAP	hospital in Ústí nad Labem
medical officer	IS for Hospital	SAP	Masaryk hospital in Ústí nad Labem

3. Benefits of introduction of e-Health

E-Health tools or solutions include products, systems and services that go beyond simple internet-based applications. They include tools for both health authorities and professionals as well as personalized health systems for patients and citizens. Examples include health information networks, electronic health records, telemedicine services, personal wearable and portable communicable systems, health portals, and many other types of information and communication technology-based tools which assist prevention, diagnosis, treatment, health monitoring, and lifestyle management. When combined with organizational changes and the development of new skills they can deliver significant improvements to the access to treatment, quality of care, and the efficiency and productivity of the health sector. A recent large-scale survey identified the very different ways in which different forms of e-Health can help deliver better care for less money within citizen-centered health delivery systems. It thus responded to the major challenges that currently exist in the health sector. A very important aspect addressed by the survey was the effective use of financial resources.

In the Czech Republic e-Health projects are a focus of the non-profit, non-state organization MEDTEL and a Czech national forum for e-Health, which try to create a politically friendly foundation for the national conception of e-health development [4].

The non-profit, non-state organization MEDTEL, founded in 2003, has experience in managing health projects (telematic and e-Health). Their basic activities relate to:

- Monitor and supply of trends in the EU (committee EHTEL – EFMI collaboration)
- Support national and international collaboration
- Create basic network of e-Health in CR
- Training and skill development in the e-Health area
- Collaboration between projects and e-Health initiatives with EU partners
- Foundational studies for the Ministry of Health
- MEDTEL International conference: every two years this takes place in Prague to discuss situations in the areas of e-Health in different member states of the EU and suggest solutions to different dilemmas. The content of the conference is focused on user aspects of e-Health tools and services, stressing motivation issues and presenting new proposals of National e-Health projects. The selected European e-Health policies and projects will be presented as well as successful forms of e-Health implementation.
- Workshops – national seminars in Litoměřice

Each Member State of the EU is to develop a national or regional roadmap for e-Health. This should focus on deploying e-Health systems, setting targets for interoperability and the use of electronic health records, and address issues such as the reimbursement of e-Health services.

4. Strengths and weaknesses of e-Health in the Czech Republic

The strengths can be summarized in the following points:

- Long-term tradition of quality information application in public health (there exists many health institutions with a high quality of information application)
- Quality controlled health registers
- Long-term tradition of collection and processing of health information
- Expansive and organized group of health specialists and a high rate of adaptability
- High number of suppliers of HW and SW for the health sector

The weaknesses can be summarized in the following points:

- Long-term absence of e-Health policy
- Uncoordinated collaboration of prestigious health subjects, insufficient coordination and collaboration
- Low level of communication in the public health arena in CR and in EU
- Absence of systemic motivation for increasing quality health care
- Inharmonious distribution and quality of e-health applications
- Relative low ICT literacy of health specialists
- Challenging to orchestrate project integration of health systems in the CR to the complex information systems of the EU [1]

5. Conclusion

Promoting health telematics and e-health applications will allow us to offer quality effective health care, orient the patient to the health care process, and fortify his role as a citizen, policyholder, and patient in the health system and make effective use of the financial resources. A fundamental question is how to promote the learning all participants. Part of the government's role is to create a legal framework, publish of standard recommendation, international coordination.

e-Health systems and services combined with organizational changes and the development of new skills are key enabling tools Member State systems and enterprises are addressing how the e-business aspects of e-Health can become key drivers for change and productivity gains, in such areas as infrastructure and skill development, internal business processes, procurement procedures and supply chain management, marketing and sales, as well as functions of the extended business.

Without the realization of e-Health it is not possible to bring about a radical reform of the Czech Republic's health system.

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PDF/H AS AN ALTERNATIVE EHEALTH IMPLEMENTATION IN THE CZECH REPUBLIC HEALTH INDUSTRY CONDITIONS

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Abstract

This paper focuses on the way of mutual supplementation of the two approaches within the eHealth field, IZIP and PDF/H. The main advantages of the new PDF sub-format as XML scripting will be presented. The key attributes and elements of PDF/H and IZIP will be analyzed in detail along with their possible interactions compared. Also the interaction on the system level will be emphasized and possible substitutability solutions on the low (database) layer will be explained.

1. Introduction

One of the first and successful Czech approaches to the eHealth field is the system of Internet Access to the Patient's Health Information (hereafter "IZIP"). Despite the background how IZIP was originally created and who bankrolled the whole project, the overall idea plus the technical and system implementation is exceptional. However, IZIP was accepted by the foreign vocational public wider than in the country of the origin. On the other hand, there is no system out there which could be called as "perfect", therefore also IZIP has several drawbacks. Some of them could eliminated, or to be more precise replaced by adopting PDF for Healthcare, or PDF/H.

PDF/H is still under development and is coordinated and maintained by AIIM International[28]. Implementation Guide For The Portable Document Format Healthcare: Best Practices Guide has been issued and is designed to help facilitate implementation of technical items mentioned in the Best Practices Guide that defines a means by which information is captured, exchanged, preserved, and protected among consumers and the other participants within the healthcare system using PDF as the electronic container of the information. [1]

PDF/H, is a file format based on the proven advantages of the original PDF[29]. This is done by adding special attributes commonly used within the health industry. PDF/H is also the newest sub-category of the ancestral PDF and inherits a few major features of the other ISO maintained sub-formats as PDF/A[30] or PDF/X[31].

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[28] http://www.aiim.org.

[29] PDF version 1.7, standardized on June 4th 2007 as ISO 32000.

[30] PDF/A: PDF for archiving, standardized as ISO 19005.

The objective of a PDF/H is „to develop a secure, electronic container that can store and transmit relevant healthcare information, including but not limited to personal documents, clinical notes, lab reports, electronic forms, scanned images, photographs, digital X-rays, and ECGs, important for maintaining and improving one's health." [4]

2. PDF/H as an ideal IZIP complementary

Scenario	Description
Enterprise to Enterprise	Large healthcare institution sends records to another
healthcare Institution	Clinic to Clinic
Clinic to Clinic	Clinic or medium sized practice sends records to clinic or medium sized practice
Clinic to Enterprise	Clinic or medium sized practice sends records to enterprise
Employer to Patient	Employer health and wellness program sends medical records to patient/employee
Enterprise to Clinic	Large healthcare institution sends records to private clinic or practice
ISV	Independent software vendor creates medical record data from medical provider software
PACS System to Enterprise/Clinic/Provider/Patient	PACS system sends digital image to any downstream recipient using secured PDF container
Patient Record to Emergency Responder	Emergency responder accesses patient's Emergency PDF health record
Patient to Educational Facility	Patient sends child's immunization records to school
Patient to Employer	Patient sends medical records to employer health and wellness program
Patient to Insurer	Patient sends medical records to insurer
Patient to PHR	Patient sends selected health care data to their PHR
Patient to Physician	Patient sends medical records to physician or other healthcare provider
PHR to Patient	PHR sends medical records to patient
PHR to Recipient in Healthcare Universe	PHR sends medical records to any approved recipient in care universe
Physician to Physician or Provider to Provider	Physician or healthcare provider sends medical records to another Physician or Provider
PHR to Patient	PHR sends medical records to patient

Table 1: Sample Use Cases for Transporting PDF (Source: [1])

The original purpose of IZIP was to enable patients look into their health records and in case of emergency (or need). However, if he doctor wanted to or had to look into the health card, prior permission granted by the patient was required to do so. PDF/H focuses on the hand-written manuscripts and their usage within the document. In contrast, PDF/H is mainly focusing on the secured exchange of the patient's health records among health institutions, doctors and other concerned sides (see Table 1). Of course, patient's permission to view the records is also included, but this wasn't the main objective. Overall PDF/H is more focusing on the gradual replacement of the traditional papers in a way of manners that doctors are used to.

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[31] PDF/X PDF for printing, standardized as ISO 15930.

One big advantage of PDF/H over IZIP is, when the output document is created it cannot be changed (taking advantage of one of the essential PDF features) afterwards. This means, that every inaccurate diagnosis or decision can be back-traced easily. While IZIP has solved remote internet access almost perfectly, it lacks unification. This covers external applications records entries, problematic sharing of the individual records with different permissions, unified printing format and standardization. Also PDF profits from the electronic signature with time stamping capabilities which guarantee non-repudiation. Another big advantage of PDF and XML is, that they are well documented open standards, which means big transparency. On the other hand, IZIP is commercial project, supported and financed by one public healthcare insurance institution. Therefore, IZIP was in the beginning developed for this institution only, by its guidelines and requirements.

3. PDF/H XML Forms Architecture (XFA)

Since the PDF version 1.5 XFA was implemented and it represents a tool with, which perfectly fits healthcare field needs. XFA is similar to PDF interactive forms introduced in PDF 1.2, which is also known as AcroForm, with the following differences:

- XFA can be used in XML-based workflows.
- XFA separates data from the XFA template, which allows greater flexibility in the structure of the data supported and which allows data to be packaged separately from the form.
- XFA can specify dynamically-growing forms.
- XFA can specify Web interactions, such as HTTP and Web Services (WSDL). Such interactions can be used to submit data to a server or to request a server perform a calculation and return the result.
- XFA works with other XML grammars. [7]

Because it uses the benefits of the eXtensible Markup Language (hereafter “XML”) provides also large amount of variability within the stationary set of XML rules. XFA was originally created by JetForm Corporation, the W3C member [6]. XFA is fully compatible with XML 1.0 specification. It could be said that, it represents specific scripting language within the XML marking scope.

XFA forms can be anything from simple static PDF forms that mirror their paper counterparts, to highly interactive and dynamic forms with flowable content and direct support for industry XML standards. One of the main benefits of XFA is its support for direct integration with XML standards like the CCR. Integration with XML standards means that the visual elements of XFA forms can be mapped to the data structures of an XML document. [1]

Plainly could be said that XFA mainly focuses on the interactive forms appearance and behaviours using various types of templates, which are all based on XML of course. These templates are using many predefined XFA elements, which could be found in [7] in greater detail.

XFA follows a declarative model in which elements in an XFA template describe the components of the form. That is, an XFA template does not need to include any procedures. However scripts may be included to provide enhanced or custom functionality. [7]

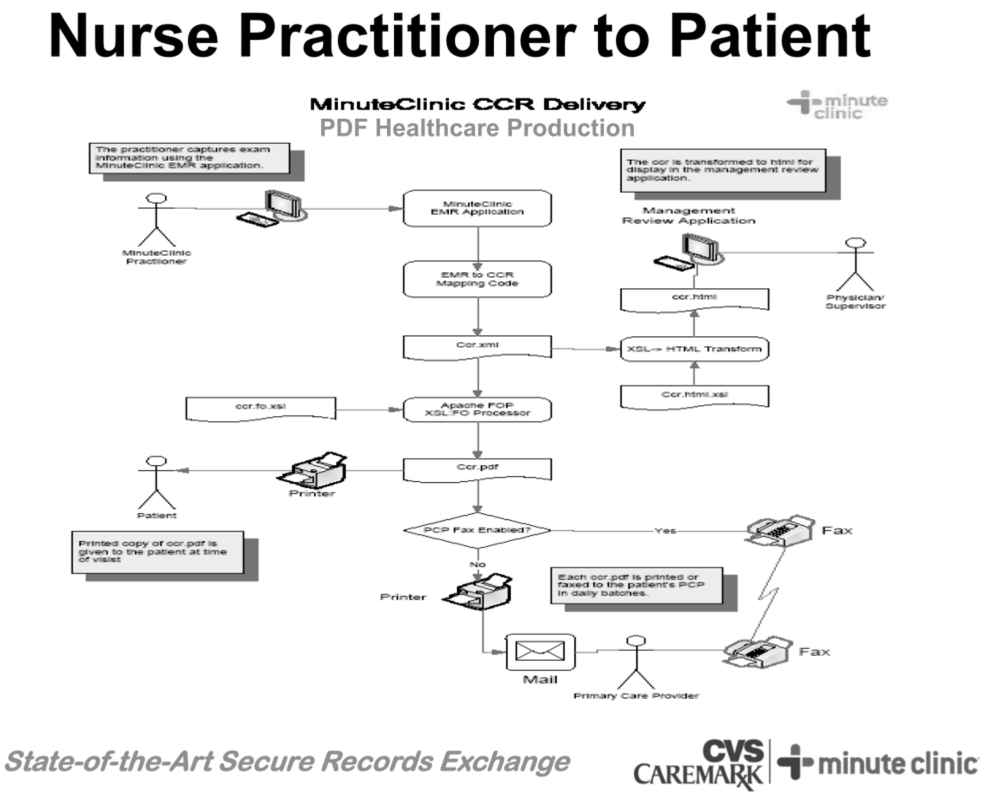

Figure 1: How PDF/H is created using XML (XFA) (Source: [5])

The essential feature of the XFA is data binding using XML elements. These elements are well documented in [1]. Another powerful attribute within XFA is scripting possibility along with the forms exporting in XML format.

3.1. Data Binding and XFA Process

As [6] defines both, XFA support both, static[32] and dynamic[33] forms. For the usage in healthcare environment, both can be utilized. PDF/H itself uses XFA plug-in, which allows previously created forms to be connected with the PDF. To let the form be dynamic the template used has to have structure similar to the following general example:

```
<template……>
<subform name="Members">
<pageSet …>…</pageSet>
<field name="Date" …>… </field>
<subform name="Member">
```

---

32 Such forms have a fixed appearance, maintaining the same layout, regardless of the data entered in them.

33 Dynamic forms have the ability to dynamically add containers and rearrange layout depending on the data being entered.

```
<occur min="1" max="20"/>
<field name="First" …>…</field>
<field name="Last" …> … </field>
</subform>
</subform>
</template>
```

Typically, XFA variable content is the patient's XML data, matching the patient's schema. Data could also come from a database, an HTTP POST response, a web service interaction, and default data supplied by the template or other source. Often, form data elements are plain text, but may also include rich text and graphics. [7]

XFA uses XML DOM[34] standard to work up with data expressed. The DOMs used in XFA share the following characteristics:

- They are strictly tree-structured.
- A node may have mandatory children. In all DOMs except the Form DOM, mandatory child nodes are created at the same time as their parent.
- The non-mandatory children of each node in the tree are ordered by age. That is, the DOM is aware of the order in which the non-mandatory child nodes were added.

The data loading process stages:

- Data is loaded from the XML data document (or any other source) into the XML Data DOM. From there the data flows to the XFA Data DOM. The XFA Data DOM provides a view of the data that has much of the XML-related detail abstracted away.
- When changes are made to data in the XFA Data DOM, the changes are passed back to the XML Data DOM to keep the two views of the data synchronized. When the data is unloaded (saved) it is written from the XML Data DOM to a new XML data document. [7]

Finally the XFA form has to be bind to the PDF itself. Major part of the binding process is embedded to the PDF. However a few attributes has to be set to make the binding successful.

1. *Flags* – rendering flag used by the PDF viewers when generating the output.
2. *Resources* – used when another document is associated with the generated document (e.g. another PDF document is references within XDP).
3. *Field & Field name* – used when the form includes interactive fields.

3.2. Data Connection between XFA and external applications

XML data documents are handled by XFA processing and the connection is made through XML DOM objects. Applications data is mapped to an object model known as the XFA Data DOM and

[34] Platform and language-neutral interface that allows programs and scripts to dynamically access and update the content, structure and style of a document.

then presented in the forms. Even though XML data documents are mainly concerned as external applications, it was a design goal that the same object model could also be used to represent data from non-XML sources such as a database or other data formats such as comma-separated values. For this reason the XFA Data DOM does not interact directly with XML but instead goes through XML Data DOM. Custom processors can replace the XML Data DOM with a DOM appropriate for their non-XML data formats.

3.3. Interacting with Databases

Not only XML documents are supported and our primary focus of this chapter will be database-oriented connections to interact with records previously created by IZIP. XFA uses ADO API to connect to the database records. This of course requires some scripting skills using database connectors, which are represented by the following elements:

- The *sourceSet* element
- The *source* element
- The *connect* element
- The *connectString* element
- The *command* element
- The *query* element
- The *recordSet* Element

The *recordSet* object in the source set DOM has many important properties:

- The *cursorType* property
- The *cursorLocation* property
- The *lockType*
- The *max* property
- The *bofAction* and *eofAction* properties
- The *select* element
- The *map* element
- The *bind* element

From the set of elements above sample template could be created to connect to the database and provide two binds. This example could be found in [7], page 442.

For each data item two bindings are necessary, one from the data base into the XFA Data DOM and another from a field into the same node of the Data DOM.

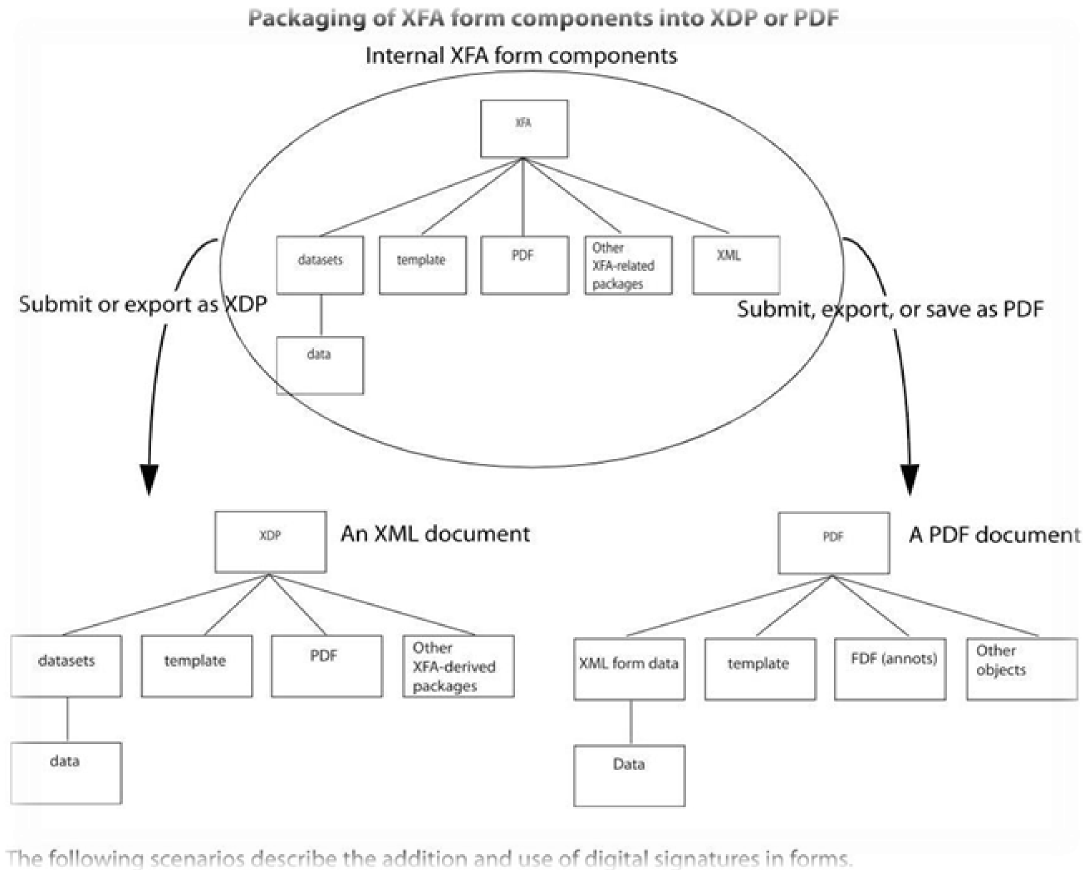

Figure 2: XFA to XDP or PDF (Source: [7])

A detailed description of the particular elements can be found in [7], pages 442 to 444.

4. Security, Reliability, Privacy

It is important to understand what security XFA does *not* support. XFA does not guarantee that a form will look the same to everyone who looks at it. Indeed the relevant attribute exists purely to make the form look and/or act differently under different circumstances, for example when printed instead of viewed on a display.

Similarly XFA does *not* guarantee that an archived form will still be accessible and identical when it is retrieved in the future. This is true of PDF generally. However there is a subset of PDF called PDF/A which is reliably achievable. PDF/A is an ISO standard, defined by [ISO-19005-1]. PDF/A omits all XFA content except, optionally, the XML Data Document. When a form using XFA is converted to PDF/A for archiving both the boilerplate and field content are flattened into a PDF appearance stream. This guarantees the appearance of the form but it also voids all digital signatures and removes any evidence of why the form looks like it does. [7]

XFA processors used in interactive contexts should endeavour to protect the user from sneak attacks that depend upon misleading users into authorizing some action that they would not have approved, or giving away data to someone that they would not want to have that data. The latter are known as phishing attacks.

A digital signature can be used to authenticate the identity of a user and the document's contents. It can store information about the signer and the state of the document when it was signed. The signature may be purely mathematical, such as a public/private-key encrypted document digest, or it may be a biometric form of identification, such as a handwritten signature, fingerprint, or retinal scan. The level of security and integrity associated with a digital signature depends upon the handlers and algorithms used to generate the signature and the parts of the form reflected in the signature.

Another application of digital signatures is to authenticate data which is submitted from a client to a server. Starting with XFA 2.5 such submitted data may be signed.

4.1. IZIP

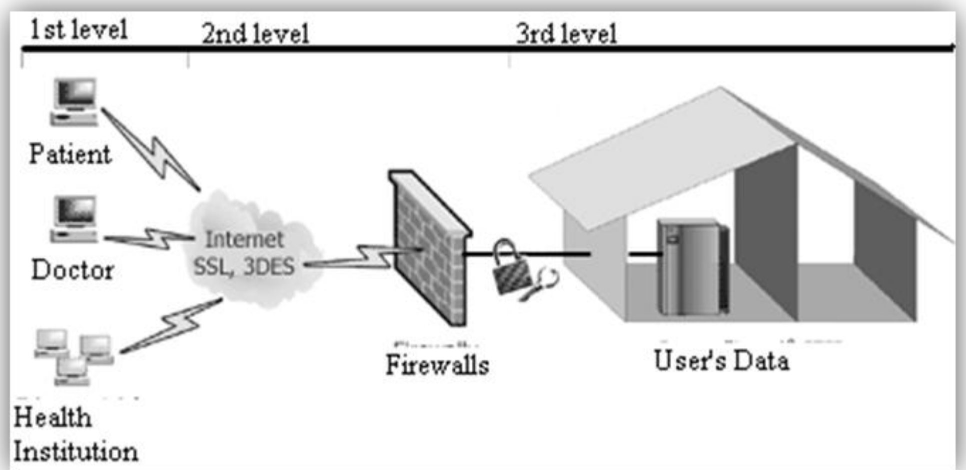

Figure 3: Original IZIP Security Hierarchy (Source: [2], Author)

According to the Figure 3, IZIP offers 3 levels of security:

- *1st level*: Doctor and patient security – patient chooses who can access his health card and records. Both doctor and patient has to enter their access username and password. In case of emergency and patient disability, doctors should be able to watch patient health records anyway. However more detailed description has not been released to the public yet. This security level is more privacy oriented, than real security of the records themselves.
- *2nd level*: Software and system security – claims that uses similar security system to the bank transactions. System level utilizes bidirectional firewall and software level checks if username and password are correct. Data themselves are stored in encrypted form and private and health information are stored separately. One unique key pair them together again – this could be patient's username or PIN.
- *3rd level*: Physical security level of the data servers – servers should be placed deep in the underground on unknown place with high level of security. This involves fire resistant doors and complementary dual key system.

4.2. PDF/H Security

Security of the PDF/H focuses mainly on the records non-repudiation, authenticity rather than on physical server security like IZIP does. Next few paragraphs will describe the PDF/H security options in greater detail.

4.2.1. Timestamps

The XDP representation of XFA includes a Universally Unique Identifier (UUID) and a time stamp. The UUID is kept with the template throughout its life and the time stamp is updated whenever the template is modified. The presence of the UUID and time stamp allows XFA template designing and XFA form processing applications to track and control XFA templates.

4.2.2. Encryption

Starting with XFA 2.5, data submitted via HTTP or e-mail may be encrypted. This is more secure than SSL/TSP because it is not subject to man-in-the-middle attacks. The SSL/TSP approach only ensures that the conversation between client and server is private, not that the server is who it says it is. For maximum security the form must also be certified (that is, signed by the form creator). This prevents a form of man-in-the-middle-attack in which the blank form is intercepted by a third party and the third party tricks the client into submitting data to a forged URI.

4.2.3. Signing Submitted Data

Starting with XFA 2.5, data submitted via HTTP or e-mail may be signed with one or more private keys. This provides the host with a way to ensure that the data was provided by a trusted source and has not been tampered with along the way. Encrypting and signing may be combined for maximum security. XFA supports the following signature mechanisms:

- XML digital signature. One or more signatures can be inserted into a form using the mechanism defined by the W3C for an XML Digital Signature[35]. This mechanism is selective in regard to what portion of the form is included in the signature. It can be used to sign any or every portion of the form which is expressed in XML, including the template, the configuration document, and/or the data.
- PDF digital signature. A form which is embedded inside PDF can use the PDF signing mechanism.

The PDF signing mechanism may sign the whole of the XFA form and in addition may sign non-XFA content of the form. Hence a PDF signature can generate a document of record.

XML digital signatures are used to achieve various levels of security. Next section discusses those different purposes and how XML and PDF digital signatures can be used to achieve them.

[35] http://www.w3.org/TR/xmldsig-core/

4.2.4. Differences between XML and PDF Digital Signatures

There are substantial differences in the capabilities of XML and PDF digital signatures. This specification defines XML digital signatures that support only data integrity; however, XML digital signatures could conceivably be designed to achieve the same level of integrity and signer authentication as PDF signatures. These comments apply only to situations in which the form itself is signed. It is also possible to generate a separate document wrapped in a PDF envelope or an XML envelope and sign the contents of the envelope.

Both XML digital signatures and PDF signatures can optionally cause the entire form to be locked upon signing. There can only be one signature on such a form, although there may be multiple signature fields; the first signature applied locks out any others.

PDF signatures, but not XML signatures, support a finer-grained control over locking. A PDF certified signature allows the document author to specify which changes are allowed in the form. A PDF viewing application such as one of the Acrobat family of products then detects and prevents disallowed changes. A certified signature must be the first signature applied to a form. To provide the same functionality for an XML signature requires the use of scripts triggered by the *postSign* event. XML digital signatures can include part or all of the XFA form; however, they cannot include resources such as fonts, referenced images, or other attachments. In contrast, PDF signatures can include such resources.

Digital signatures enable recipients to verify the integrity of an electronic document used in one-way or round-trip workflows. For example, when a digital signature is applied to a final diagnosis, recipients have more assurance that the diagnose information has not been altered since it was sent.

The main differences between these signatures lies in what portions of the form are covered by the signature and what supplemental information is provided about each signer or signature. XFA provides all the necessary grammar to express any of these types of signature. However what types of signature are supported by a particular application is entirely application-defined. Individual XFA applications may support any, all, or none of the above types of signatures. For example, a non-interactive application might verify signatures but would probably never generate signatures.

4.2.5. Using XML digital signatures for integrity

XML digital signatures can establish the integrity of a form, by incorporating relevant objects in the signature. For example, if there is a concern only about the integrity of a form’s data, the signature would incorporate only the form’s data. If there is a concern about other aspects of the form, the signature would incorporate those other aspects, too. An XML digital signature can incorporate the PDF object used in a form, but this is useful only for archiving.

It is not useful in a workflow where other individuals subsequently validate the original signature. This limitation applies only to forms whose signature manifests include a PDF object. This limitation exists because PDF objects contain volatile information, such as date and time. If a PDF processing application such as Acrobat reopens and saves forms whose signatures include the PDF object, those signatures are voided, even if no changes are made.

4.2.6. Using PDF digital signatures for integrity

A PDF digital signature can incorporate the XFA stream used in a form, provided the XDP is packaged inside the PDF, but this is useful only for archiving. It is not useful in a workflow where other individuals subsequently validate the original signature. This limitation applies only to forms whose signature manifests include the XFA stream. This limitation exists because the XFA stream is in XML and there may be changes made to an XML stream which are defined as not significant by the XML standard.

The creation of hash code (or other representative binary number) that reflects the portions of the form specified in the *signData* manifest element. This code is then stored in the signature property created when the form is actually signed. Therefore simply writing the XFA stream out again using a different XFA processor (or a different version of the same processor) may invalidate the PDF signature even though there is no substantive difference in the form.

Starting with XFA 2.5, a client can apply one or more to the data that it submits to a host. This allows the host to verify that the data has not been modified in transit. This is stronger than simply submitting via SSL/TSP because it is not susceptible to man-in-the-middle attacks. It also ensures that the signature travels all the way to the host application rather than being stripped off at the communications layer.

4.2.7. Authenticity

Authenticity provides confidence that a document or part of a document does not take on a different appearance after being signed. The XFA grammar and the PDF language provide a number of capabilities that can make the rendered appearance of a form or PDF document vary. These capabilities could potentially be used to construct a document that misleads the recipient of a document, intentionally or unintentionally. These situations are relevant when considering the legal implications of a signed XFA form or PDF document. Therefore, it is necessary to have a mechanism by which a document recipient can determine whether the document can be trusted. Achieving this purpose results in a "trusted document" or a "document of record".

4.2.8. Using XML digital signatures for authenticity

XML digital signatures can establish the authenticity of a form, by incorporating in the signature relevant parts of the form (including the template) and certificates that identify the sender, and by using private-key encryption.

4.2.9. Using PDF Digital signatures for authenticity

Authenticity includes ensuring the integrity of the form and verifying the identity of the sender. With forms intended for fill-in, authenticity may be required in a form that is then fill-in and signed.

4.2.10. Non- Reputability

Non-repudiation is a document security service that prevents the signer of the document from denying that they signed the document. Such a service is often driven by authentication and time-stamping from a trusted third-party. Non-reputable security is the same as document of record, with the additional verification that the person signing the form cannot deny signing the form. Using XML digital signatures to establish non- reputable documents is beyond the scope of this specification.

5. IZIP and PRH/H System Interactions

Both IZIP and XFA will have the mutual interaction on the database level. However, while IZIP uses database as is primary data resource for both, patients and doctors, PDF/H can use data from several resources. For example XDP could be this data source. The Figure 2 shows how the interactions of the whole system could work out on both, patient and doctor sides.

5.1. Cooperation between the Sides

Since IZIP was introduced, the cooperation between the doctors, patients and other concerned parties was one of the main goals. IZIP[36] is continually cooperating with the developers of commonly used healthcare software to support IZIP, or to develop connectors from the third party software to be able to connect to the IZIP. Reading and searching is available through the internet using web services and secure protocols. On the other hand, reading permissions are given by the patient, so in creation scenarios health record accessibility could be problematic.

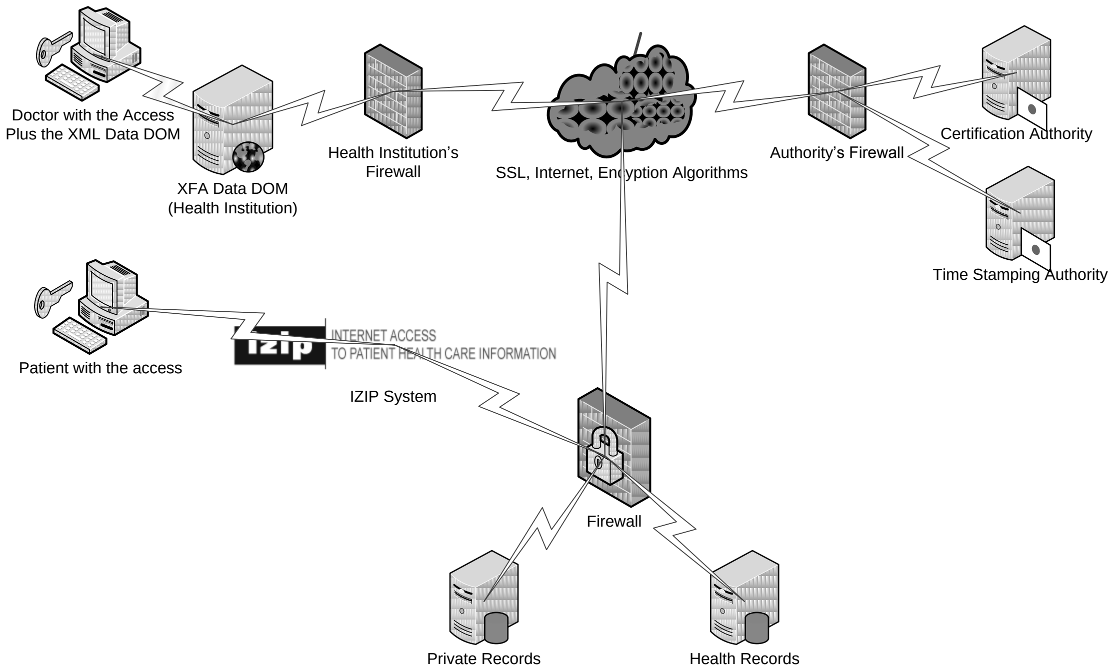

Figure 4: System Interactions (Source: Author)

5.2. Standard Data Extraction and Handover within the Health Environment

Medical devices operating within the healthcare environment utilize standards for ensuring that patient specific data such as lab results and medical images are properly labelled and identified, i.e. the data has a “clinical context.” This context specifies patient demographics, collection conditions, and unique reference identifiers. For radiological devices, this information is generated by the hospital or clinic’s Radiology Information System (RIS) using the DICOM standard. For

[36] IZIP is also name of the company which provides and assures IZIP services.

pathology data, clinical tests, and non-image related data, the context is taken from the Hospital Information System (HIS), which uses the HL7 standard for communication. As a large amount of patient-centric documents, such as consent forms and notes taken by doctors, nurses, surgeons, and technicians is still paper based, moving this data into digital form means that a clinical context must be applied to the corresponding electronic files.

From the previous paragraph could be seen that gathering the data from the healthcare equipment to the XFA using appropriate connectors is quite easy.

6. Conclusion

From the pages above can be concluded that PDF/H is more like complement to the existing IZIP approach to the healthcare industry. While IZIP is more appropriate for viewing the data, PDF/H is more suitable to store/print the data. IZIP is great for the patients because of the internet access to the records, whereas PDF/H excellent for the doctors thanks to the universal, proven, well documented and standardized PDF background support. Also PDF/H excels with its strong security and data privacy protection, including different types of electronic signatures and time stamping services.

7. Shortcuts

Used within the definitions from references.

CCR - Continuity of Care Record

PACS - Picture Archive Communication System

CDA - Clinical Document Architecture

PCP - Primary Care Physicians

PHR - Patients Health Record

XFA – XML Forms Architecture

DOM – Document Object Model

XDP - XML Data Package

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OPERATIONS IN THE NETWORK-CENTRIC ENVIRONMENT

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Abstract

Network-Centric Approach as an idea of activity has become a measure of effectiveness in military operation objectives achievement through its wide application of modern information acquisition, transfer and management systems. NCA allows situational orientation on a current basis during its developmental changes and rational management of capabilities that are at one's disposal in achievement of military activities objectives. Integral elements of Network-Centric Environment include: objective, man, armed warfare instruments, organization and operation environment perceived as geospace.

1. Introduction

The concept of armed warfare has always been perceived as the organized actions taken by armed forces of opposing parties striving for the adversary's defeat. Conclusions drawn from the evolution of armed warfare prove that in order to discuss the term in contrast with combating crime it is justifiable to identify the conditions of its occurrence. The conditions necessary for the armed warfare occurrence include:

- existence of at least two opposing entities presenting hostile intents to each other;
- opposing parties have armed warfare capabilities;
- opposing parties intend to achieve the armed warfare objective by physical, electronic, and psychological neutralization or elimination of their adversaries;
- the crux of armed warfare is the armed confrontation which results in one party's victory;
- armed warfare takes place between/among armed forces of opposing parties/entities in the international arena or against an armed organization of unrecognized entity presenting political objectives that indicate recognition aspirations;
- armed warfare is conducted in accordance with the rules of international law of armed conflicts;
- armed warfare is always directed against entities of a given organization representing armed force, not against civilians and public service institutions.

The state of war between/among entities in the international arena does not require additional explanations because countries applying physical violence against each other/one another use their armed forces. Whereas in peacetime and crisis, when crisis response operations are conducted, it becomes problematic to determine whether acting armed forces, usually representing only one party, are engaged in the “armed warfare”. During crisis response operations, also terrorists-orientated, armed forces conduct armed activities with the respect for the international law of armed conflicts. The opposing party that may be a terrorist organization does not apply the rules of armed warfare targeting objects most vulnerable to the effects of their attacks. Therefore no criminal organization can be conceded a status of legality that a country has in terms of applying force in order to achieve its goals. Despite the same or even higher level of danger and uncertainty than in a war operation, combating a criminal organization, or more precisely its members, cannot have equal legal status concerning forming their objectives. And thus armed warfare may be considered as a legally recognized application of force only if an organization using such methods is a carrier of rights.

The causing of maximum losses has been the key determinant of victory in terms of armed warfare until now and the level of the loss achievement described success. For six thousand years the paradigm of armed warfare has included causing maximum adversary losses and keeping own ones at the minimum level. It has meant that we destroy whatever we can within the limits of our capabilities. The concept: “target acquired = target destroyed” has been the determinant of modernity and efficiency in armed warfare. Nowadays such an approach is not valid anymore because applying modern reconnaissance and combat assets, even highly precise ones, we would cause mass losses. The paradigm of contemporary Art of War, and armed warfare at the same time, is achievement of operational objective causing minimum (necessary) losses on both sides of conflict.

Although contemporary perception of the term ”armed warfare” has not changed, the requirements of the adversary’s defeat also described as armed warfare victory requirements have. The ”victory in war” assumptions determined by Carl von Clausewitz include necessity of destroying the enemy’s army, breaking his will to fight and occupying his territory which used to be perceived as the subject matter of dispute[3]. Meeting the ”victory in war” requirements was conditional on the political goal of a war. Whereas in terms of armed warfare, which was not defined by Clausewitz, there was a necessity of destroying the adversary’s army and breaking its will to fight. In modern conflicts, peace-oriented in fact, the territory is not the subject matter of dispute and thus its occupation is not one of the requirements anymore. It is necessary in the next stage of campaign when crisis response operation takes place. The ultimate criterion of modern operation should be the assumption connected with achievement of the operation objective without “bloody dimension of armed warfare”. Nowadays we should wider perceive recommendations of Sun Tzu considering the necessity of the operation objective achievement without fighting a battle[37]. The necessity results from the political goal of the operation which is not the annexation of a territory. The opposing party’s army is not perceived as an element posing a threat but as an instrument of non-democratic performance of a country in the international arena. Therefore the opposing army is not the main object of interest but the causative force directing its use is. Thus during future operations leaders and crucial elements of their organization[38] should be the subject of precise engagement in the first

37 „(…) the acme of skill is to defeat the enemy’s army without fighting a battle, capture his cities without a siege and occupy his country without invasion.” See [15].

38 According to the model of COL John Warden, payoff military targets, which should be destroyed or neutralize in order to approach achievement of the political goal of conflict, are as follows: leadership of hostile organizations; organic/system essentials; infrastructure/territory being their operational base; population providing them with moral support; fielded military forces as an instrument of their anti-peace policy.

place and subsequently their instruments of military influence (armed forces) should be taken into consideration.

Modern armies need to notice dangers other than classic ones and to learn how to eliminate or neutralize them. Classic military imminences result from methods of operation and applied forces comparable to the opposing party. The classic of military operations consists in use of comparable means and methods of operation by parties of armed warfare. Comparability of means and methods follows from comparable objectives of armed warfare. Such an approach results from assumptions of organized and efficient operation. Nature and content of the objective determines the way of operation and requires selection of corresponding means. Classic dangers and methods of countering them follow from the necessity of accomplishing traditional political goals of conflict. Therefore, till the end of 20th century, in traditional conflicts military operations used to be reduced to destroying the enemy, seizing and holding the area or object of dispute. Today, if a territory is not the subject matter of dispute then it is not justifiable to seize it. The armed forces of the opposing side are not the object of main engagement because in modern conflicts they are only a passive element, not an active agent, in the process of forming their political goals.

Changes in politics and culture of people and nations forming them make conflicts similar to those of the first half of the 20th century very unlikely. In future operations application of modern means in conjunction with information should fast and smoothly enable achievement of their military objectives. It means that information and modern assets provide precision of operation. Modern methods of conducting armed warfare describe Network-Centric Approach as a system of information connecting capabilities and effects of all participants' operations in order to focus their efforts on the main objective. The concept of NCA should be noticed early, at the level of forming concept of operation, being the result of the political goal of conflict. Taking the idea into account during future operations will enable reduction of losses on both sides of conflict and fast settlement of dispute by integration and precision of combat assets applied. There are four key levels distinguished by the concept of NCA:

- intent level – stage objectives and their effects necessary for main objective achievement should be determined here;
- human activity level – focused on organizational sphere of human being, his abilities in terms of synchronization and co-ordination of human and weaponry involvement;
- systems level – includes tools supporting decision making and development, and monitoring level of performed tasks;
- material level – consisting of material assets necessary for execution of a given task, results and effects of sensors, platforms and weaponry activities organized within one system [13].

Despite introduction of modernity contemporary armed warfare assumptions confirm previous relations resulting from principles of armed warfare. The principles indicating that course and result of armed combat depends on: relations between method of combat and characteristics of weapon platforms; characteristics of the environment where the combat is conducted; method of command and control; cooperation between assets of a participating party; concentration of efforts [19]. Contemporary interpretation of armed warfare principles requires a different perception of their considerations in terms of a modern paradigm of victory. The basis for modern perception of armed warfare principles is informing about the results of operation and ability to utilize the effects of other participants for own operation objectives. Generalizing from the abovementioned assumptions one can describe the determinants of armed warfare in the Network-Centric Environment which are as follows: achieved objective; man as an active agent and passive element of armed warfare;

weapon and warfare instruments/platforms; organization which achieves given objective by application of its potential and cooperation ability; operation environment perceived as geospace (fig. 1).

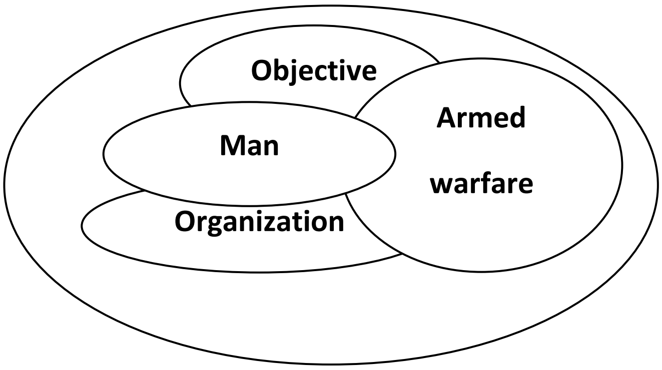

Figure 1. Considerations of armed warfare Network-Centric Environment (Source: own development)

2. Armed warfare objective

A contemporary objective of armed warfare has evolved. The objective is no longer defined by the category of causing maximum losses. However it does not mean that the objective is achievable without causing any losses or risk of their occurrence. The objective defined as the enemy's defeat and thus achievement of victory is still valid but requires another definition of victory content. Nowadays and in the future armed violence will be acceptable ,and even justified, only on condition that its use not cause mass damage and losses. The basis for planning armed actions in Yugoslavia (1999), Afghanistan (2002) and Iraq (2003) was achieving armed warfare objective without causing excessive losses [17]. Such an assumption was possible because of remarkable technological superiority of one side. Whereas in conflicts where armed warfare instruments applied by the sides are alike the abovementioned approach and possibility of objective achievement are controversial.

One should not equate war objective with armed warfare objective because the latter results from the former. Prognoses concerning external security of the country indicate that a global or regional conflict of totalitarian nature is very unlikely. It does not mean that we can exclude war, including also armed warfare, as a method supporting achievement of state policy goals from politics. Armed warfare being a method of armed forces' activity is stall applicable but its objective must be achieved at the minimum (necessary) level of losses. It means that armed warfare objectives and methods of achieving them must be changed. So far man has remained the target of destructive impact and in spite of application of different euphemisms the idea has been to take his or her life or to force him or her to surrender by use of threat of death. Systems managed by man should become targets in contemporary armed warfare. Taking into account the necessity of opposing parties' encounter, one should plan their activities in the way placing man outside of destructive impact area. Generalizing, the idea is to destroy or neutralize armed warfare instruments of opposing side before or in the course of the main battle. In modern armed warfare "destruction" should not mean "causing an impact subject to cease to exist. Using modernity we should bring a given subject to such state that for a required time it loses its features or cannot use them to cause losses of opposing party. One should realize that many machines, due to their capabilities, will not stop functioning unless their operators are eliminated. It still indicates the necessity of taking man's life or making him or her incapable of operating the combat means in armed warfare. A sphere of disruption introduction and temporary exclusion of the enemy from activity in the battlefield is possible on condition that actions take place between armies of information age, not industrial or agrarian one. On the one hand asymmetry of armed warfare assets enables unlimited application of modernity, on the other it may turn out that modernity can prove to be hardly efficient against primitive combat means.

It is not justifiable to perceive armed warfare objective meaning defeat of the enemy only as functioning of individual systems but as a comprehensive exploitation of effects of numerous armed warfare participants' activities. It is required to strive for putting a pressure on and posing a threat to the enemy by the skill of other armed warfare participants' capabilities and operation effects utilization, which should not only result in destruction but show the opposing side the pointlessness of its efforts as well.

During armed warfare costs of achieved victory are counted for soldiers' lives, used supplies, combat service materials and damage done to the surrounding. This is the price that cannot be easily estimated because of the first factor – a soldier's life. Therefore it is necessary to use all reasonable endeavours in order to make military operations efficient, which means achieved at minimum losses.

Effective activity requires precise determination of its objective and the understanding of its crux - the state that should be achieved. In conditions of armed warfare planning it is necessary to analyze the objective because it determines a method of operation. The content of the objective analysis is determination of its achievement feasibility in terms of a potential that remains at one's disposal. Beginning the achievement of armed warfare major objective it is required to determine stage/phase objectives or tasks that bring the operation agent closer to its achievement. It is necessary to determine the conditions of the objective achievement by specifying what will bring the operation agent closer to their implementation. As the result of the objective analysis one should identify what needs to be accomplished and make an optimal selection of means. It needs to be determined whether the objective may be achieved by own potential. If its achievement limitations resulting from own limitations occur, then one should seek for cooperating agents. In no case activities should be given up. Optimal solutions need to be looked for within and outside an organization. In case of limitation occurrence a procedural prerequisite for cooperation arises. Having planned an activity and begun its accomplishment, one should perceive effectiveness in the process of coordination. It is necessary to integrate operation effects of independent active agents within organization in such a way that they do not hinder one another's actions and are able to benefit from the effects of joint activities.

One can advance a thesis that combining maximization of effects with minimization of costs is not possible because they are mutually exclusive. They are irrational – one cannot expect that reduced costs will cause heightened effects. The thesis is justifiable if we consider only one factor - potential. Whereas in order to effectively attain a given objective one should take all the factors into consideration: potential, place, time, and even sequence of stage objectives' accomplishment. All that results in the fact that something apparently absurd becomes possible. Implementation of the above-mentioned assumptions is feasible in multidimensional combination:

- First – we achieve heightened effects with a change in the way of operation and unaltered costs.
- Second – we achieve the same effect with a change in the way of operation and reduced costs.
- Third – a change in the way of operation and increased costs result in effects better than those achieved only with increased costs.

- Fourth – a change in the way of operation and decreased costs result in lowering effects by less than costs were reduced.
- Fifth – a change in the way of operation without any change in potential results in heightened effects. It requires consideration of place, time, potential and sequence of events. It results in the fact that we benefit from the effects of operation of various armed warfare participants, which is an outcome of activities coordination. It brings on occurrence of synergy effect which is available by modification of events sequence.

The above-mentioned assumptions show that many factors have impact on the objective and its effective achievement. The most important include information as knowledge about environment, the enemy and own potential in relation to the major objective and selection of an appropriate method and means to achieve the objective. The modern Art of War pursues the development of such methods of operation where the objective will be met at minimum (necessary) losses (casualties) on both sides of conflict and at optimal costs.

3. Man as an element of armed warfare

All conflicts are related to man as their perpetrator, organizer and participant. Armed warfare is not conducted by instruments, modern combat assets, but people who attempt to solve problems using armed violence. Man plays two fundamental roles in armed warfare: an active agent and a passive element [10]. As an active agent he or she is an armed warfare organizer and coordinator. But as a passive element man is a target and a combat asset engaging other targets. On the one hand man as a soldier is a commander or is commanded by other soldiers, on the other he or she is an object of the opposing side's actions.

Commander has always played a special role in armed warfare because his or her decision has resulted in the operation objective. The consequence of the objective includes gaining victory by destructive influence on the enemy. Importance of each decision of the commander is defined by the value of responsibility for lives of other soldiers. Therefore the commander needs to be an Art-of-War professional characterized by high level of physical resistance to the armed warfare effects. No manager working for a civilian organization intentionally and necessarily organizes his or her activities on the basis of taking other people's lives and for sure the range of caused destruction is not a measure of his or her success. In the modern considerations of the battlefield man, being at the same time the primary active agent organizing and coordinating armed warfare activities and a passive element of armed warfare, is still the major object of the enemy influence and actions.

The term ”morale” is usually understood as awareness of duty performance, fierce determination to act, will to fight and conviction about victory. Duty awareness is the effect of internal motivations – human being gets involved in a given activity because it generates his or her interest and results from belief concerning legitimacy of the activity and not from external compulsion [2]. A soldier's participation in armed combat and his or her motivations may be perceived in terms of internal and external motivations. The internal ones result from conscious membership of a given organization and acceptance of its goals achievement. Whereas the enemy creates the external motivations by perceiving us in terms of armed warfare object category. Only one side may win a victory in armed warfare. Therefore aspirations of the parties for the same objective (victory), though characterized by opposite effects, raise the external motivations.

The phenomenon of armed warfare is connected with manifestations of human behaviour resulting from the danger of loss of life and awareness of taking the enemy's life. It causes constant tension and carrying out tasks in a stressful situation. Stress is an inseparable element of the tasks performed by a soldier in the battlefield, causes nervous tension and results from constant threat posed by the enemy. Therefore in order to learn how to deal with stress it is required to be aware of its appearance, to know its cause and to learn how to control the factors causing stress [2].

Stress in armed combat is inevitable but its consequences can be mitigated. A soldier properly equipped with combat and protection means may demonstrate a favourable stress level, not a high and long-lasting one that causes biological degradation of organism and psyche. Knowledge of the warfare crux and scale of accompanying strain enables development of a preparation concept for soldiers operating in the stressful conditions of the contemporary battlefield. Preparation of a soldier for coping with stress is not completely feasible because of too many variables characterizing the contemporary battlefield. However it does not mean that one should give up preparing him or her for operations in conditions that cannot be precisely determined. Creation of a contemporary battlefield vision may and should be formed during training process in near-combat conditions. It will enable preparation and immunization of a soldier's imagination against various stressful situations. It is essential to identify the situations that are stressful for soldiers. Such situations may be caused by awareness of real danger, lack of information or operating in isolation. Especially operating as a member of independent team or task force may result in conviction that one is forlorn and nobody provides support in case of emergency. Modernity of combat assets and their availability on call from the battlefield eliminate the conviction on condition that such a support is provided. In terms of Network-Centric performance of tasks the conviction that a given team or task force is isolated does not occur because all the system participants are able to and should benefit from operation effects of other combat participants.

Morale has always had a remarkable importance and as a factor positively affecting victory it has been considered by commanders. It has been counted among the most important elements of war. Morale is the spirit which permeates the whole element of war, and which fasten themselves soonest and with the greatest affinity to the will which puts in motion and guides the whole mass of powers, unite with it as it were in one stream, because it is a moral force itself [3]. According to the NATO views there is a prevailing belief that overall human features (subjective, personal, biological) related to culture and tradition of a nation, nature of its armed forces and characteristics of its state influence the morale of its armed forces. It is usually emphasized that the crux of morale includes: system of accepted values, motives of operation, attitudes and needs of soldiers. It is justifiable to classify, among other things, all the factors motivating activities, and above all need of performed task security as belonging to the main needs affecting morale. The theory of the issue emphasizes that the crux of morale manifests itself in relations between internal state of each soldier and external aim – task [8]. Factors creating a high morale level are: knowledge, skills, motives and possibilities of operation targeted at respective objects of attack.

Each soldier's ability to subordinating oneself is crucial in armed warfare. It is due not only from institutional obedience but mainly from conviction about correctness of a given activity. Obedience does not mean blind subordinating oneself because then in spite of biological substance and minds we would fulfill only the function of tool. In contemporary conflicts obedience and subordinating oneself should fall within the framework of activities allowed by the law. Nothing releases a commander and a soldier from their liability for violating the law of war. Ability to subordinate oneself with a view of the main objective or the idea of cooperation is one of the factors bringing one side's participants of armed warfare nearer victory. In armed warfare subordinating a subordinate is usually dependent on a superior's behaviour. Therefore the authority and fluffing leadership functions is of a crucial importance. A soldier is obedient to his or her commander when he or she is convinced that the commander wants the common good, is able to properly conduct combat, does the right thing. And thus leadership as appropriate relation between the commander and the subordinates nowadays becomes an element moulding morale. Man is the main factor of armed warfare and knowledge of man's adaptabilities, operational motivation and resistance to stress is one of the major factors conditioning victory in armed warfare.

4. Armed warfare instruments

Armed warfare instruments are a concept very frequently used in literature but there is no unambiguous definition describing them, therefore one should notice the necessity of specifying the concept. The instruments include weapons, materials and substances applied for engaging the enemy in all the environments of his activities. They strike the enemy using kinetic energy, shock wave, heatwave, ionizing radiation, radioactive contamination, toxic chemical and bacteriological effect, and today electromagnetic wave. Combat means are technical instruments, materials and substances having a destructive effect on objects by means of deferent energies and factors. The idea of using and applying combat means has evolved from annihilation of the enemy to temporary exclusion of a soldier from battle without taking his or her life and destruction of material goods [16]. Many factors including level of knowledge (scientific thought), possibility of production (modern technology and access to raw materials) and the opposing party's Art of War have influenced development of combat means. Analysis of combat means development indicates their development is affected by political, technological, economic factors and battlefield requirements.

Political factor means a given country's situation in the international arena, which results in the necessity of, or only enables, a new combat means to be developed. Such factors include: international law restrictions, membership of military alliance, international agreements. International law restrictions affect prohibition of producing, stockpiling or improving prohibited types of weapons[39]. Membership of military alliances has a great influence on future shape of combat assets. Compatibility of operations between states of the same military treaty is necessary, which results in combat means standardization. International agreements make another political factor playing a significant role in development of contemporary combat assets. Economic relations of the contemporary world are a barrier for ones and a progress factor for the others.

Until recently the basic problem of battlefield was so called armour-missile race. Today such a statement that there is an armour-missile race is not justifiable anymore [7]. Nowadays the race is against time and quality of transferred information in relation to time of decision made and time of precise action. It is not enough to produce a missile that is able to penetrate each type of armour. It is required to develop weapon systems that on the one hand will protect their operators, and on the other hand are able to precisely eliminate a given adversary. These days one seeks such a weapon that will precisely and at minimum side effects eliminate those elements of the enemy defensive system that are crucial for the own objective achievement. The contemporary battlefield requirements include: precise effects of engagement, minimization of losses and short term effects

39 Geneva conventions prohibit development, production and stockpiling of bacteriological (biological) and toxin weapons (1972), chemical weapons (1993). Moreover they prohibit or restrict the use of booby traps (protocol II – 1980 and 1996), incendiary weapons (protocol III - 1980), blinding laser weapons (1995 - protocol IV to convention of 1980).

of destructive impact. Therefore modern weapon means precise weapon that destroys only given target and does not cause extensive damage.

There is an interdependence between development of combat assets and battlefield requirements, which means that on the one hand battlefield gives a reason for development of a new weapon, and on the other hand introduction of a new means results in battlefield changes. New combat asset causes decline of old one, less effective, and occurrence of a new countermeasure. At the same time it implements changes in the Art-of-War area, which requires new methods of operations.

Considering issues of armed warfare in war one should be aware of the fact that war is first of all a legal category determined by policy and war instruments used in support of political goal achievement are subordinate to war itself [3]. Therefore combat assets as war instruments are developed in response to the requirements of solving dispute situations by means of violence in accordance with the goals defined by a state policy. War, as a subject to common reason, does not have to be waged till one of the sides is ultimately destroyed. Assuming that if motives and tensions are weak; little, hardly felt probability of defeat is enough to induce the opposing party to make concessions [3]. Therefore nowadays we should not forget that the objective of armed warfare is victory that does not have to be won at the cost of mass damage.

Development of combat assets depends on many factors including: battlefield requirements, technological, economic and political factors. There is an interdependence among them, which means that they affect one another. Introduction of a new weapon results in a change of the factors that formed perpetrating force of its occurrence. Interdependence relations existing among the above-mentioned factors bring about invention and development of new combat assets. Development of new combat means is a complex process requiring comprehensive consideration of all the factors that affect the process and are mutually related. Equipment and weapons of both soldiers and military organizations change as a result of scientific and technological achievements, and above all because of changes in nature of war and armed warfare which is conducted within that war. Weaponry of the 21th century in many cases differs from weaponry of 20th century in technical parameters but new combat means have been invented as well. Changes in quality of combat assets during 100 years resulted in changes in methods of their application and tactics of operation. Quality of technology is very frequently credited with the perpetrating force initiated only by man's decision and methods of a given means' operation. A combat means and its quality influences the nature of battlefield but is not its creator.

Combat assets demonstrating relevance of their application in global war evolve, which means that we still, in most cases, think using traditional categories of war. If global wars and hundreds-of-kilometres long frontlines are very unlikely, and fundamental objects of political and military activities will not include the pursuance of taking sovereignty away from other countries, then combat means should undergo revolutionary modifications in respect of assumed political and military objectives of war. Conclusions drawn from analysis of present combat means show that they are modernized relics of previous wars. Such an approach will not allow building appropriate basis for Network-Centric planning, operations of man and various systems used to support and monitor given objectives' achievement and merging results and effects of different weapon systems. Nowadays it is not enough to modernize because the pace of changes taking place in the battlefield makes an introduced modernization insufficient. Fundamental requirements concerning modern combat assets should still include: mobility; effectiveness and accuracy of strike connected with autonomous system of acquisition and guidance; resistance to detection and strikes; compatibility with other modern systems of combat; multipurposeness of applications in the battlefield; standardization of spare subassemblies. One can advance a thesis that forces possessing combat systems of such values should meet the requirements of the future battlefield. It should be also emphasized that the main environment, where achieving political and military objectives of a conflict takes place, will remain the land environment being a place of social activities of human – originator of all conflicts.

In spite of comprehensive approach to determination of combat means development directions one can propose a thesis that policy is the key determinant of their development. In democratic world quantity of funds allocated to research activities depends on political decisions. Introduction of a given combat means to military units is also dependent on such decisions. Other factors such as level of technology, economic conditions, and battlefield requirements enable combat means to develop.

5. Organization as a determinant of armed warfare

Organization means two or more persons cooperating within certain structure of relations in order to achieve a given objective or a set of objectives [14]. Determinants of an organization include: objective, structure and relations among its members. Armed forces are one of the oldest organizations in the history of mankind. They form a specialized state organ designated for protection and defence of its interests by means of deterrence against aggression or, if necessary, conduct of armed warfare till the requirements of a political goal are met [21]. Common concept of armed forces includes soldiers – armed, designated for combat and organized in numerous units. Nowadays permanent structures are of great importance in the process of training organization and conduct. They are also crucial for military activities in peace time. Performing tasks in war and crisis, more and more frequently requires establishment of task forces that are adequate to objectives to be achieved and methods of operation.

Basic features of armed forces as a social organization include:

- superiority of formal relations over personal relations,
- bureaucratic nature and hierarchical structure,
- own system of stratification,
- organizing for winning victory in armed combat [18].

The last characteristic shows the purpose of armed forces. At the beginning of 21st century the purpose undergoes a change resulting in their missions being broadened. Methods of activities used in peace operations and crisis response operations do not always require application of armed warfare methods. A crisis response operation and peace operation end state is not defined as a victory but a certain status of changes in social or political relations. In peace and crisis response operations somebody or something is not an object of influence. A situation that requires changes makes such an object. It means that a created organization’s paradigm of purpose has changed. Therefore tasks forces are formed for the purposes of crisis response operations and peace operations. They do not match permanent structures of units and subunits. Because of the changes in achievement of armed warfare objective, task forces are also formed for the purposes of war operations. Whereas permanent structures of units and subunits make modules used for establishment of task structure. The above-mentioned assumptions indicate that permanent structures do not meet requirements of armed forces’ functions in armed warfare.

Armed forces perform prophylactic, control, humanitarian, peace and defensive functions in the system of state defence [20]. Prophylactic function in the national dimension expresses itself in sustaining capability of operational activity and thus the idea of strategic deterrence is implemented in conjunction with system of collective security. Control function in the national dimension consists in monitoring integral areas of sovereign country in air, at sea and in cyberspace. Whereas the function manifests itself in the international dimension as participation in various commissions and consists in controlling provisions of agreements concerning level of armament and security. Humanitarian function consists in taking part in non-military actions that aim at protection of population or its property in situation of catastrophe or natural disaster. Peace function has been fulfilled since 1953 in the form of active participation in peace operations under the auspices of the UN. Whereas defensive function consists in organization and conduct of war operations in order to defend sovereignty of own country or an ally. The performed functions demonstrate the necessity of organizations' establishment in respect of tasks to be carried out. Creation of universal structures for so many different tasks is simply impossible. Therefore ”panacea” for organizational structures' requirements seems includes task forces formed on various levels of operation.

Task forces, in both theory and practice of Polish Art of War, are not an invention of the 21st century. At the beginning of the 20th century one used to create tactical groups, operational groups, tactical group formations and operational manoeuvre groups. Their tasks and ways of their performance were the basis for the establishment of the groups [6]. It means that objective and method of operation were the fundamentals for temporarily formed organizations. The most important determinants of task force formation are as follows: objective and method of operation; challenges and threats; technological progress and development of combat means; development of military thought; changes in organization of troops and combat environment.

Forming task forces on different levels of troops' organization, we deal with the group formation of organizational cells into larger modules. In theory of organization and management, considering organizational links, one distinguishes so called classic organizational structures: linear, functional, staff-linear [11]. The crux of linear structure is the subordinating of a subordinate to only one superior. In functional structure a subordinate is subordinated to numerous superiors, which results in dispersion of organizational authority. Both of the features are merged within staff-linear structure where a principle of command authority unity is in force. There are also staff cells present in that structure. They play an advisory role. Continuous search for new structural forms forced the occurrence of squadron structures. Their crux is the establishment of separate segments for performing specific tasks.

Determination of task force purpose is the initial point for its creation. It allows defining key objectives and tasks, type and range of decision making, and respective level of command and control, degree of tasks fulfillment, general framework of task force organizational structure. If one considers internal factors, then size of organization, style of command, type of performed tasks, traditional organizational patterns (established in armed forces) are of significant importance. External factors include: legal, social, geographical, scientific & technological, and political aspects. Not every structure is influenced by external surrounding to an equal extent.

Task forces' creation shows the development of Art of War that departs from common schemes of activities conducted by structures designed for waging a war of the past. Another aspect is diversity of tasks which cannot be performed by a universal organization. Therefore in the area of efficient activity the objective can be gained by the proper operating of potential and method of its application. In theory of the issue one can specify many types of task forces (group formations) operating on different levels. In an operation the determinants of task force structure include:

political goal of conflict; political, geographical, space, material and time restrictions; military objective of operation and method of its achievement. Composition and number of components of operation are changeable and depend on operation's objective and conditions of its achievement. Troops placed at disposal of an operational commander make component force. Responsibilities of service commanders include handing over an equipped and combat-synchronized component. In fact service commanders form task forces designed for operations in their environments. Composition of detached tactical group formation depends on similar factors as all forces in operation do. Political restrictions come into special prominence in multinational crisis response operations. Task groups should be included in compositions of particular components. Number and size of groups in individual components is not limited but their forming should not have a negative impact on efficiency of command and performance of tasks. In considerations of Network-Centric battlefield, task groups should cooperate with one another in horizontal dimension because of the necessity of optimal fulfillment of a task. Formation of organizations for performing various tasks should be based on combat, combat support and combat service support modules. A battalion should play the role of basic combat module and make the core of task group. It does not exclude possibility of a manoeuvre company being an organizational basis. Establishing a task structure one should remember not to lose efficiency of operation.

Concluding, it is necessary to say that operational group formations, being the whole of forces in operation, are formed in order to attain the main objective of an operation. In order to achieve stage objectives in particular environments of an operation, tactical group formations are created. They are formed in accordance with methods of the stage objective's achievement and make composition of particular components' force. Whereas task groups are established for direct performance of tasks in the framework of stage objectives.

6. Geospace as an environment of objective's achievement

The concept of operational environment means geospace that is geographically determined and has its physical and geographical characteristics. Every physical phenomenon takes place in geospace. Importance of operational environment in Art of War has been recognized since its origin. Nobody has had to be convinced that terrain and weather matter a lot in carrying out armed activities. Throughout ages thesis indicating significance of environmental conditions for the course of armed combat have been formulated, for example get to know terrain and weather conditions and your victory will be complete [15]. Terrain affects armed combat as an obstacle to movement, as an obstacle to observation and as a way of concealment from fire [3]. Each feature of terrain should be respectively exploited for gaining victory. Therefore commanders and planners have demonstrated a need of getting to know the area of future operations. The need has always had a high position in the Art-of-War theory and practice.

Till the end of the 19th century the environment for military purposes used to be perceived in two dimensions – width and length with terrain features. Appearance of modern combat and reconnaissance means in the first half of the 20th century made combat environment accept the meaning of geospace. Combat environment, having land and sea surface dimensions so far, was expanded into airspace and area of underwater activities [4]. Moreover one noticed an information space in the expanded environment. In the second half of 20th century the information space became not only an information carrier but a battlefield as well. Therefore significance of information has assumed the proportion of operational factor. Information has always been of great importance but nowadays relations between identification of information and time of its exploitation give information the leading position.

Modern means of reconnaissance and operation allow breach of the obstacles that were movement, observation, fire and reconnaissance barriers for Clausewitz. Nowadays physical relief of the environment does not present such a great obstacle as products of activity created in order to improve quality of human life. Forests and mountains are no longer obstacles but urbanization of area of operation. Each armed conflict will be conducted in social and physical environment of human functioning. It will target the enemy's state and security management institutions that are located in urban areas. Modernity accepts such challenges and today even unmanned aerial vehicles are able to operate in built up area. However it requires different organization of activities and assets that meet battlefield requirements in urban environment. One of crucial factors affecting transformation of US Army is a conclusion that future operational and tactical tasks (offensive, defensive or peace support operations) will be performed in built up area [1].

In spite of being aware of the fact that operations will also be conducted in information environment, one should admit that it is the least penetrated part of geospace. If information is a basis for any activity, then lack of information results in inertia. Nowadays the basis for efficient achievement of objective is not air, land or maritime supremacy but supremacy in cyberspace. The cyberspace supremacy provides us with basis for application of combat assets, which in consequence enables gaining supremacy or domination in a given environment.

Considerations of armed activities' conduct will be situated in a certain theatre of war activities that will have own properties adequate to occupied fragment of geospace. A theatre of war will contain administrative geospace of countries involved in conflict. In high intensity conflicts a theatre of war may comprise one or a few theatres of war activities. A theatre of war activities should be perceived as a part of geospace[40] that has been boxed off a theatre of war. Military objectives of conflict may be attained there. A theatre of war activities may include one or a several theatre of operational activities. A theatre of operational activities is a boxed-off part of theatre of war activities designated for achievement of operation's military objective. In system of area-of-responsibility allocation that is applied in low intensity conflicts a theatre of war usually directly overlaps with a theatre of war activities that comprises one theatre of operational activities. The theatre of operational activities is usually understood as an area of responsibility allocated to a military commander where he or she has the authority to plan, conduct and coordinate activities. Depending on specific character of activities carried out in area of responsibility, one distinguishes the following areas of operations: deep, close and rear. Close operations area is a geographically designated part of geospace where main objective of an operation is achieved. In deep operations area the enemy is denied efficiency of operation and possibility of influencing the course of operations in close operations area. Whereas in rear operations area one should defend own centres of gravity and create conditions for performing tasks in close and deep operations areas by constant supplying. Particular functional areas of operations and areas of operation's objective achievement mutually affect one another by effects that are achieved in them. In each of the mentioned areas stage objectives are attained by task group formations mutually supporting one another by achieved individual effects. Ability to exploit effects of task group formations' activities in separate areas has an impact on optimal achievement of operation's major objective. Specifying close, deep and rear

40 Geospace of a commander's responsibility is an integrated (land, air and maritime) area and electromagnetic space where an operational commander organizes and achieves military objectives of an operation.

operations areas is justifiable and feasible in war operations. In crisis response operations and peace operations it is not possible to unambiguously define areas of objectives' achievement because of operational and tactical situations' mutual permeation and achievement of various objectives that are spatially disposed.

Knowledge of operational environment, where areas of responsibility are spatially situated, should be a factor recommending method of operation in relation to achieved objective. Therefore knowledge of environment and ability of affecting its character or leveling its features by appropriate equipment of troops, their organization and methods of activity enable making optimal decisions.

Generalizing, it is necessary to emphasize that knowledge of contemporary armed warfare and its determinants enables the understanding of its crux and conditions of its objectives' achievement.

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The Magic of Open Everything: Open Source, Open Communities, Open Access?

BOUNDARIES OF OPENNESS IN THE IT AREA

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Abstract

The Magic of Open Everything: Open Source, Open Communities, Open Access is often evoked as the cure for most current problems in the IT area. E.g. proprietary software as well as bugs will die out because of Open Source (Microsoft vs. Linux; better quality through intensive reviews). Similarly, Open Communities, e.g. Wikipedia, hope for contributions of everyone, but have reduced their openness lately. And while Open Access to scientific papers possesses obvious advantages, nevertheless its success has not been very widespread to date. Obviously this "Openness" is not limitless, but some boundaries exist. Several of them are investigated in this paper categorized according to the type of the boundary: Technical, legal and economical.

1. Introduction

Openness is partially seen as the solution to everything: Open source will revolutionize software production and replace proprietary software. Similarly, open communities (loosely organized collaborative efforts where anyone may join and the results of the common goal are available for free) revolutionized for instance the encyclopaedia market: Wikipedia "destroyed" many large and reputed others (e.g. Microsoft Encarta will be closed down on 31.10.2009 [13]). Another "open" area are scholarly publications: Open access journals become more important and prominent, with funding societies increasing the pressure to publish there.

But is openness always the best or only solution? Wikipedia for instance is often criticized for its unreliability: Anyone can change (almost) any data. This has been used e.g. during elections to "modify" the biography of candidates [4]. However, every kind of openness possesses some limitations which cannot be avoided in real life. Some of them will be discussed here as examples, to show that openness in projects is not always that open as it seems to be at first. Rather it is more open than conventional approaches, but often still quite narrow and limited in other aspects. Although other, like psychological, limits exist, only the following are discussed here:

1. Technical boundaries: These can be subdivided into systemic limitations, like everyone can read the Linux kernel source code, but only few computer scientists and no laymen can actually understand it, and intentional ones. An example for the latter is the so-called Tivoization [21], where hardware is used to prevent exercising the rights coming with open source software.
2. Legal boundaries: Currently disputed is for instance the possibility of the eBook reader Kindle to read aloud electronic books by speech synthesis. Authors protested against it as an infraction of their rights, so it can now be disabled by the eBooks publisher. Laws can require some limits to openness, so either we have to live within these fences or change them.

3. Economic boundaries: Not every “open” approach is economically feasible. Some persons might donate their work, but everyone has to make a living. As the dot-com bubble showed, a valid economical model is a requirement for all durable undertakings. This might be very small (numerous contributors of small elements for free; little general costs), but could also be quite large (like the Linux kernel: Many persons are paid by companies for contributing because these obtain an indirect benefit).

2. Technical boundaries

Some boundaries are based on technical issues: It can (or should) not be open, because then some additional features become possible.

2.1. Linux kernel

The Linux kernel [11] and many other open source software may be technically free in the sense that everyone can see the code, modify it, compile it, or suggest modifications for inclusion into the “official” version. However, very few people can actually understand the code. Even most computer scientists would have trouble understanding the source, especially at the lowest level where assembler code is intermixed with C code. Therefore the openness is in reality very often rather a theoretical openness: If you invested enough effort (and perhaps money) you could exploit the openness, but in reality you do not. This is exemplified by the Linux distributions: Although there are numerous, only very few of them are actually widespread. They closely resemble proprietary software: Instead of installing Microsoft Windows you install Suse Linux or Redhat Linux. In all three instances you have to trust the “manufacturer” to have written/assembled a valid and good package of software.

Still this is only a weak boundary: As alternative distributions do exist you can rely somewhat on the openness. It is just something done rarely and needing a lot of effort. But having the option can be extremely important. For instance, if you must use Windows 95, there is no possibility to modify it or close security holes because of the lacking source code. If using a Linux kernel version 2.4 or even older, you can do it, it’s just an economic decision whether it is worthwhile doing so – but technically it’s not impossible.

A related aspect here is trust: You have to trust a proprietary software producer that their product is secure. This might be realistic for large ones with a dedicated focus on security, but for smaller ones – who knows? But still there is at least the possibility to identify this person (see also below in section 4.4) and the option of bringing legal action in case of malfunctions. In open source software neither a specific company or person can be assessed on their trustworthiness (Novell just packages most of the code) nor exists someone to start legal proceedings against (see also 3.2), as many developers are quite "anonymous" and difficult to find and possess to few funds to pay damages or reimburse for attorney or court expenses.

2.2. Tivoization

The TiVo [18] is a hardware product for recording TV programs. It contains open source software (Linux Kernel and Gnu software), which is made available as required by the license, and anyone can modify it. However, to run any software on this specific hardware it must be signed by a cryptographic key, which is kept secret by the manufacturer. This means that the code may be (re-

)used everywhere else, except on the specific device. The result is that only “original” TiVo’s are in circulation. Here a loophole of the GPLv2 is exploited by providing the software, but keeping the necessary data (the private key used for signing) secret (the public key is embedded in the hardware sold). So although running open software, technical measures prohibit using one of its fundamental ideas.

While divergent opinions exist on whether this is (or should be) allowed [19], openness is obviously limited here by design. A similar measure is employed in the OLPC project [15] with the intention to prevent the use of stolen laptops. Here the restriction can be removed in a complicated way and after some delays (to allow for checking whether this specific piece of hardware was stolen). These limitations could easily be expanded to other areas, e.g. for implementing DRM schemes. Only with a matching signature (created upon selling a specific media file), including a unique number of the hardware it is intended to be used upon, it will actually be played. The advantage is that no online verification is needed, increasing privacy. The drawback obviously is, that no transfer to other devices (or only those approved by the seller) is possible anymore. In this way openness can be reduced almost to non-existence: While providing the source code (and the possibility to recreate the binary and therefore verify it is actually this code running on the TiVo) for inspection (learning, security etc.) still has some advantage for end users, none such exists in the media example: The media file might be shared with whoever you want, but nobody else could play it. This closely resembles the legal protection of protection measures, which can be used to practically abolish all free uses.

2.3. Open access journals

Open access journals (see [12] for a directory) are scientific publications which are placed online and can be accessed without payment (sometimes the author is required to pay to cover costs). One reason is, that subscriptions for similar printed journals have become so expensive, that many universities can no longer afford them. Additionally, as much of the research published in them has been funded by public money (via universities, science foundations etc), the results should also be available to the public for free. The basic premise is, that publishing on the Internet is very cheap as opposed to requiring printing machines, postage etc. to produce and distribute paper journals. So this kind of openness wasn’t really possible before the Internet. But some boundaries for open access journals exist:

1. If there is no income, persons responsible for it must donate their work (see 4.2). Such persons need to be found and kept for continuity. With good software support the task can be automated heavily and the role of editor is already often performed for free even for conventional journals.
2. Reviewers cannot be paid for their effort. But in the scientific community this is extremely rare in any case, so no difference exists.
3. Trust is harder to achieve: If a reputable publishing house starts a new journal, good quality can be assumed. But for open access journals no such trivial assessment is possible (compare section 4.4).

2.4. Security by obscurity

In general, security by obscurity is not a good idea and explicitly repudiated. This applies especially to encryption algorithms, but for all other security measures as well. However, there are situations where this is the only possibility, e.g. given a situation where potential attackers have administrator rights on the computers the software must run on by definition (already in requirements). Then the only possibility to secure this system is trying to keep as many details hidden for as long as possible and rendering access to them as expensive as can be made.

Obscurity is not seen as a valid security principle, because at some point in time the details of software programs will become known (absent hardware security, like tamper-proof modules). This is inevitable, as the program must be executed. If it can be executed, this can also be simulated and studied. Then any weaknesses that may be discovered can be exploited. Really secure are therefore only systems, where everything – or at least the algorithm or source code, but note: not the data, i.e. the keys! – is openly available, for example encryption algorithms or security procedures (like Kerberos).

The limit to openness is here introduced artificially: We know we can't keep it secret, but we try to hide it for as long as possible to achieve at least some degree of security. This limitation is only the second-best solution, but it is all that is available.

3. Legal boundaries

Boundaries may also be based on legal regulations. Sometimes these are only perceived, but nevertheless actual barriers do exist.

3.1. ASP2PHP

This is a decision from the Austria supreme civil court (OGH 16.1.2007, 4 Ob 198/06f) regarding the copyright of software programs. The basic scenario was software for a web shop written in ASP. This software was developed specifically for a single customer, but who did not receive the source code. Later he employed another company to produce a new and equivalent version in PHP. They had no access to the source code, only to the web output. Parts of the HTML code generated was reused in the new program. It was decided by the court that no copyright violation took place, as the program was not accessible (→ no source code copying) and what was taken (some trivial JavaScript) was not eligible for copyright protection. However, reusing the effort of the first company (some lines of HTML code for tables) was deemed an act of unfair competition. This decision is strongly debated, as almost a new intellectual property right was invented: Even though the program is not protected by copyright, you cannot reuse any part of it. You have to expend the same effort again, although you (or your employer) had already paid for it previously.

This is very problematic for open source, as it severely reduces possibilities for building up on other's work. This would mean that even if the source code had been available and any copyright waived, you could still have not used it to produce a competing product. If this decision continues to be valid, openness would be severely restricted: Additional clauses would be required to remove the danger of such proceedings

3.2. Liability for problems with open products

Open source severely limits the liability for problems of it, like bugs. One of the reason is, that it is usually free, the other that the actual author who introduced a specific problem can be very difficult to identify. This non-existence of any guarantees, see e.g. the BSD license [3], theoretically limits the usefulness of software severely. For instance in high-security or –reliability installations (like defence or medical systems) open source could therefore not be used. However, this boundary is comparatively weak: Closed source software comes only rarely with any kind of guarantee; see for instance the limitation of liability for Microsoft Windows [14], paragraphs 15-18. Conversely, if you buy a system including open source software, some kind of guarantee for fitness of purpose will always exist, just not by the authors of the software but rather the system integrator.

Also a similar problem exists in reverse: In many countries not all liability can be disclaimed. This can be a problem for open projects, who may find themselves under legal threats without the possibility of some kind of insurance. Commercial companies can take out an insurance and limit liability to the company, but for individual open source developers this is much more difficult.

So legally this is an actual limitation of open systems: It is difficult to identify who might be liable, and any liability is usually excluded as far as allowed. Practically there exists little difference to non-open software.

3.3. Open source licenses

Open source licenses (e.g. GPL or Creative Commons) are used often and appear very open. Seen from the legal point of view they are however rather closed and contain very hard limits. For instance it was decided that the GPL is explicitly no waiver of copyright [10]. A really "open" license is the BSD license, which roughly grants you the rights to do with the work whatever you want and is almost equivalent to placing the work in the public domain.

These boundaries can be seen best by the example of the LGPL: It allows using libraries in non-GPL software, as long as modifications to the library remain under GPL, i.e. are published. But the main software may remain closed. The Free Software Foundation, who developed it, itself actively tries to discourage [9] developers from using it, as it is too open for them! From this example it becomes apparent, that from a legal point of view open source licenses are very closed, as they set hard limits what you can and cannot do with the software, enforcing a certain philsosophy. Creative commons is a bit more open in this aspect, as it lets you choose several options, but at the core the same boundaries exist. Both just define a different set of boundaries as compared to proprietary software.

3.4. The Kindle controversy: Transferring rights

The Kindle is an eBook reader by Amazon based on open source software. Note that the Kindle itself hardly qualifies as “open”, as it depends heavily on DRM to secure the digital content. One of its features is the ability to read aloud the book (or newspaper, article etc.) through speech synthesis. Authors protested against this feature as Amazon only possesses the rights for written books, but not for audio books. The background is, that audio rights are sold separately and are usually much more expensive than eBook rights. The authors requested that this function be removed or the appropriate rights were obtained, reducing the functionality.

Legally seen this is a dubious claim because audio rights are only required for public performances, i.e. if a kindle was put on a stage and used to “read” a book to an audience (whether paying or for free would not matter). Private reading aloud, for instance to your children, is covered by fair use. A counterargument is, that the quality of the read-aloud function might not yet be useful for a public reading, but in the near future probably will be, rendering the scenario above realistic.

Related to this dispute is the concept called “Zweckübertragungstheorie” (Theory of the purpose of transfer). This theory about intellectual property rights (accepted at least in in Austria, Germany and Switzerland) states that in a contract on IPR only those rights are transferred, which are necessary for the envisaged use (absent any explicit other language). In Germany it was legally impossible (§ 31 para 4 copyright law) between 1966 and 2008 [20] to transfer the rights of uses yet unknown. This means, no rights for DVDs (contract before 1979) or the Internet (before 1994) could be transferred and therefore remained always with the authors, even when "all rights" were transferred. The reading feature of the Kindle could be seen as such a new use previously unknown. With the second part of the copyright amendment Germany changed this retroactively, so authors had the possibility to decide until 1.1.2009 whether to object to this or remain silent: Then the owner of the main rights would receive them for free. In Austria no such explicit provision exists, but the purpose theory is executed even more strictly than in Germany and usually a similar exception is assumed [17]. This leads to an uncertainty for open access content (less for open source software: new purposes for program code are unlikely!): Is it possible to “open” old content, for which an exclusive print license has been granted? And can new content be opened up so much, that currently unknown uses in the future will be included? For the Creative Commons licenses in the Austrian version ([5] at the end of section 3) such a transfer was included in doubt [16], but whether it would hold cannot be said yet.

3.5. Software patents

One reason for graphic card drivers for Linux for advanced 3D graphic cards to not be available as open source but only in binary form is the software patent problem: In this area numerous patents exist, which it is very hard to circumvent. Here open source software is severely at a disadvantage: Everyone can access the source code and therefore quite easily check, whether a specific patent is violated, for initiating legal actions. Closed software would have to be decompiled (but see obfuscation) to allow such identification. Therefore neither AMD nor nVidia publish their driver source code to reduce the danger of patent infringement proceedings.

Open source software is disadvantaged in this context in another aspect: Software patents are quite expensive, so they are no option for such developers, only for large companies acting as distributors. So they have no own patents, but are more easily pressured through those of others. This is one reason for the intense dislike of software patents by open source proponents. Only one limitation exists in the opposite direction: As open source software is freely published, it is immediately state of the art and therefore prevents any further software patents. Opposed to this closed source software is only a publication regarding the visible aspects, e.g. the process performed by it, but not its internal implementation. Therefore open source is more successful in preventing patents [6].

This difficulty is increased by the lack of special provisions for software: Copyright was modified because of the special properties of software to allow e.g. decompilation or backup copies under certain circumstances. Currently no such provisions exist at all for patents and it is not likely that they will be included (although some were proposed for the – finally failed - EU software patent directive; see article 6 on interoperability in the form amended by the parliament [7]).

3.6. (Registered) Marks

A registered mark actually must be defended or it is lost. This means, that even if it was desirable to allow some people to use it, this cannot be done. As marks are an extremely valuable part of intellectual property – they potentially last for eternity - this is a real problem. The only option available is an actual license of the mark (which might be free). This must however still be tied to the product or service the mark is registered for. If the license allows using it for other things, e.g. software from someone else performing a different action, this is equivalent to not defending it.

An example could be a service provided by some software. It might be patented or not, but it is generally known by a registered mark. If open source software is written to be a functional equivalent, it can never use the mark to describe it: This would be a violation of the mark and would have to be prosecuted. And giving a license to everyone using a certain software (as e.g. the GPL would require by analogy) would be the equivalent of loosing it: The mark would become a general descriptive term and it protection would be lost. This is a rare example where openness is legally impossible.

4. Economic boundaries

Economic boundaries are not as hard as the ones discussed above, but nevertheless very important: If it doesn’t make sense to open up a project, it will remain closed. Altruism is a powerful motivation, but earning a living is as well. Although "openness" is often equated with free, the FSF [8] puts it differently: "free as in free speech, not as in free beer". This means, people might do something without compensation, but usually there is the need for remuneration in some other way. This ties in with a change from products to services: The economic background remains, only the way to achieve income shifts, like from writing and selling software to adapting, configuring and maintaining an otherwise free (often as in free beer!) software.

4.1. From product to service

Products can often be mass-produced cheaply, especially in low-wage countries (compare the problems with product piracy: If something sells, a cheap copy will be manufactured in the east very soon), and in the IT area copied, but outsourcing services like local installation or configuration is much more difficult. Similarly, a music recording (=product) can be downloaded from the Internet, but a live concert must be attended personally. This can also be compared to the transition of software from a shrink-wrap product you buy to a service you subscribe to: online activation limited in count, Software as a services (SaaS), Service oriented architecture (SoA), or subscription schemes (online role-playing games). Similar approaches are mobile phone manufacturers providing additional services, as the income from the connection itself declines continually.

One reason for this is that services are unique: They have to be performed each time again and cannot be copied as easily as products (so music subscription schemes rely on DRM to ensure this uniqueness and remain a service and not a product model!). They remove the limits of uniqueness of things, but replace them with the uniqueness of the action performed with/on it. Note that this is only correct in the current economic situation: If access to the European labour market would be opened up to everyone in the world, many services would be copied very fast and very cheaply. This danger is especially large in the IT area, where e.g. system administration could be (and already often is) outsourced to countries far away. Therefore the “openness” is actually quite limited: Who is allowed to provide the service is at least in some areas severely limited. This can also be seen with the increase in Linux certifications (see [1] for an overview of Linux certifications). Such certificates often serve as artificial restrictions for services: Unless someone holds the “XYZ” certification, he is not eligible for providing specific services (or just not hired). They impose artificial limitations, so the competition in the services area is reduced. Overall, limited physical objects are replaced by (at least at the moment; consider expert systems) limited services.

4.2. Generating revenue and the importance of large numbers

An important aspect of open projects is generating revenue. If not the whole project is supported by external gifts, some kind of income must be provided. The dominant options in this are donations and selling fan articles or advertisements. These are very tenuous and unpredictable sources of income so most open projects are constantly in dire need of money. Therefore they tend to be operationally cheap, i.e. requiring as little actual money as possible. Instead they try to attract persons donating some effort. For open source software: Donating money in the disguise of providing a patch developed in two hours of time (each worth € 50) is much more likely and attractive than giving € 100 in cash. Not going into details, one of the reason for this is taxation. You have to work many more hours than mere two to earn € 100 in cash. Additionally, when spending money it is gone, but providing a digital creative work leaves you still in its possession, albeit perhaps at a lower value for selling it. But e.g. for patches or small programs no real market exists anyway or building a business on them would be quite cumbersome: So you give away only what has no "value" to you anyway, but might be helpful for others.

But this dependence on small donations of work by numerous people shows an important boundary of openness: Unless there actually is such a large number of donators, it does not work. For example, if the Linux kernel were still developed by Linus Torvalds and perhaps three or four others alone, it would never be comparable in functionality to Windows and be completely irrelevant as an operating system. As any significant piece of software requires a lot of effort in total, large numbers of participants are required, which must be recruited, inspired, retained and replaced. As soon as this process fails, the open development will fail. While closed projects depend on direct monetary funding, open projects require large numbers of volunteers. With the number of open projects increasing, this will become very difficult. For instance starting a new open encyclopaedia competing to Wikipedia will be very difficult, as several project have already had to notice: The number of people working for free and their effort are limited, and winning them over from a competing project is very difficult. One consequence of this is that very often the first project wins, and if a large size has been reached, it is very difficult to bring down. In this way open projects are even more vulnerable to build monopolies than closed ones. Obtaining even a very large amount of money for a competing closed project is possible, e.g. with venture capital, and ways for assessing the chances of success exist. But acquiring and predicting the final and stable number of volunteers for a new open project competing with an already existing one is much more difficult. As can be seen from the example of the X-server ([2], see 1.1. The Politics) regarding the split between XFree86 and X.org), rather a divergence occurs: The code is split and two competing branches may start. In the end this is not a new development, but rather a discussion about the future direction. Real new developments from scratch become therefore very difficult in open projects, a significant limitation.

Another aspect more pertaining to open content than open source is the possibility of alternative sources of income. For instance musicians might give away their music for free and still make a living from live concerts. This, however, does not apply to all kinds of digital works: Producers of a film have much more difficulties (cinemas are an option, but increased screen size of TVs, beamers etc. in private homes become a competition). Authors are in for real problems: Giving lectures from a book and book (printout) signings are not a real option to selling the written work itself, whether in physical or digital form. Additionally, these works are not suited to being generated by a large number of contributors. Novels might provide a good income for a writer, but it is unrealistic to expect an interesting novel or a song being written by dozens or hundreds of persons, each supplying a single paragraph, line, or melody through collaboration.

4.3. Application areas for open source software

Not every kind of software is suited for open source: For instance a software useful only for a single customer will almost never be available as open source: If it is open source and exactly matches the needs why should the customer pay for it in any way? And if it is usable for a single person only, why should someone develop it? No fame or money can be earned from it! This ties in with the pervious section: Unless a large number of contributors exist, the result is often not very useful.

Therefore open source software is usually limited to rather general software. It is not a coincidence that the "biggest" and best known open source projects are operating system (Linux) and servers (Apache webserver, Samba fileserver). However, many individual projects are built up on open source libraries or parts. This means, the general building blocks are usable for many applications (→ open source viable), but the integration and customization is "proprietary", i.e. developed for the individual customer. Because of legal requirements it might be open source too, but often not useful for others, unless a new or better building block can be extracted from it. Therefore this boundary is actually an advantage, as it ensures paid work for developers.

Regarding open content the economic balance might be directly opposite: Providing small elements (e.g. graphics) usable only for rare cases might serve as an advertisement to buy the mass-needed ones or be contracted for producing special others ones. But in contrast to software there is little need for constant service or updates of works. Only new developments (pictures, texts, movies etc) are needed and reuse of parts is much more difficult. Therefore an economic limitation exists for open content as no equivalent model currently exists. This seems to be at odds with e.g. open access journals. But it should be noted that there an economic incentive doesn't actually exist: The producers have already been paid for by public money and don't expect additional income, so the advantage should be available to the public as well. But with works paid for by private companies this does not apply: They were paid for by a single entity, and – as opposed to scholarly articles – are very often not very useful for the public anyway, only potentially for competitors.

4.4. Role of the guarantor

Somebody should guarantee for the validity and correctness of data, like the content of a scientific book or an encyclopaedia. This can either be the author (very well known expert in this area) or the publisher (reputable publishing company which ensures high quality through excellent staff and external reviews). However, if everything becomes open, there is no equivalent guarantor. Take wikipedia as an example: Everyone can add or modify content anonymously or under pseudonym. As no official review process exists, the content may be (deliberately) incorrect. Additionally a single excellent article from one person is no guarantee at all that a second article by the same person is equally reliable: The author might be knowledgeable on the first topic but not the second or the second article was defaced/modified by someone else.

Openness therefore brings often with it anonymity: This might be desirable (privacy), but removes the guarantor from the picture. Some information may be "good" or not, but it can become almost impossible to assess it. Compare this e.g. with the Linux kernel: Everyone can submit patches so it is extremely unreliable. But openness is severely restricted there, as a very small core team must approve all patches going into the kernel (and many are rejected, even if coming from well-known experts). So there the openness is reduced to re-introduce those guarantors. Inclusion is rather based on merit than on source. Similar approaches have started in Wikipedia: Some articles might be locked to prevent modifications and final deletion is only possible by administrators.

5. Conclusions

Openness is an interesting new concept, and usually based on the Internet. However, it is often misunderstood as being gratis and without restrictions or limitations. This is not true. Openness is just a different approach as opposed to the previously predominant closed one, but it has boundaries too: they are just different ones. This can best be seen in the economical limits. People still need to make a living, so income must be generated in some way – it may just be a different one than before. Overall seen it is still a decline of limitations or moving out of boundaries: These shift in open projects, but typically to the outside and only in very few and small instances new limitations are built or existing ones strengthened.

In some areas real new options arose, which were not possible before. The best example for this are open encyclopaedias. Without the Internet such a thing would have been impossible; now it is the predominant source of such knowledge. With all its shortcomings and limitations it is still a fascinating new approach: Creation and explicit representation of a large body of knowledge through a collective effort. This is the current endpoint of a change which has started several hundred years ago. Then a person could expect to make significant progress in a chosen area or discipline in their lifetime alone, but today this is much rarer, as most new developments will require numerous experts cooperating to offset the requirement of long education to reach the peak of the current knowledge even in a small area alone. Therefore cooperation becomes more important and reducing the boundaries limiting it a necessity. These limits are therefore (or will have to be) shifted to still allow the society to remain workable and stable, but reduce restrictions on and encourage collaboration.

The most important problems with open approaches are trust and economic viability, while the legal boundaries often seem to be lagging behind. Especially in some areas current stakeholders seem to be successful in even hampering this change in their own interests (see e.g. the extension of the protection for music production, which almost exclusively benefits the big media companies and extends existing boundaries into the future). However, opening up will be a necessity in the future. In which form or which direction and who profits/looses by it will yet have to be decided or become apparent from large-scale practice.

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THE CHALLENGES OF TACIT KNOWLEDGE SHARING IN A WIKI SYSTEM

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Abstract

The article discusses a possibility of sharing tacit knowledge via a wiki system. The first part describes tacit knowledge as opposed to explicit knowledge, its characteristics, strong and weak points and related issues. An attention is dedicated to the knowledge conversion and externalization of tacit knowledge; discusses known troubles related to the tacit knowledge sharing. The second part of the article deals with the wiki system and its possible uses as a knowledge sharing tool. The conclusion is that to some extent wiki system can facilitate tacit knowledge transfer and storage.

1. Two faces of knowledge – tacit and explicit

Other division of knowledge can be into explicit knowledge and tacit (implicit) knowledge. The distinction between tacit and explicit knowledge was first achieved by Polanyi [8]. Tacit knowledge denotes knowledge that can't be easily articulated, and thus exists primarily in peoples' hands and minds, manifesting itself through actions; explicit knowledge refers to the knowledge that has been captured and codified into manuals, procedures, and rules, and is easy to disseminate [12].

1.1. Explicit knowledge

Explicit Knowledge

- is easy to codify, document, transfer, share, and communicate (mostly through ICT)
- can be precisely and formally articulated
- is well structured
- can also be quite easily learned (typically some facts), while this is much more difficult for tacit (abilities).

We should bear in mind, that founding father of tacit/explicit division pointed out in 1966: „While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied, hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable"[8]

1.2. Tacit knowledge

Tacit knowledge:

- is difficult to articulate
- is difficult/impossible to codify, transfer, share,...
- subconsciously understood or applied
- developed from direct action and experience
- shared through conversation, story-telling etc
- highly individual - involves intangible factors embedded in personal beliefs, experiences, and values
- difficult to learn (typically skills, abilities) as opposed to tacit knowledge.

Polanyi [8] points out that tacit knowledge is personal, context-specific and therefore difficult to articulate. It may be compared to skill acquisition - for example swimming or bicycle riding. It may be possible to read the 'how-to' manual but such manuals do not embody the full reality of the experience in context.

As Davenport and Prusak [4] observe, tacit knowledge ‘incorporates so much accrued and embedded learning that its rules may be impossible to separate from how an individual acts’. One typical example is the difficulty of a baseball batsman to describe explicitly to someone about how he knows to hit a ball. Remarkably, it is tacit knowledge that informs and governs our daily activities, without the need of us to think of it as, or recognize it as, knowledge. For instance (as mentioned in the paragraph above), it is effortless to think of how to ride a bicycle.

Tacit knowledge is distributed in the totality of the individual’s action experience; tacit knowledge is ‘relying on tactile cues registered by the human body interacting with its environment’. Facing difficulty to articulate tacit knowledge is thus common to most people. To transfer such skills, the master and the apprentice must – during periods of internship – share experiences through actions [12].

Nonaka and Takeuchi [10] support Polanyi’s [8] findings by saying that tacit knowledge is knowledge that comprises experience and work knowledge that resides only with the individual.

With respect to the wiki system, of course it contains mainly the explicit knowledge (for example the facts saved in Wikipedia). However, as will be later argued, the social network, which is inherently constructed between a wiki users, allows us to expect, that also explicit knowledge can be shared via wiki (to some degree).

2. Individual and shared knowledge

Generally speaking, knowledge could be broadly divided into two main distinctive categories: individual and shared (often called organisational) knowledge. Individual knowledge could be expressed through personal creativity and self-expression. Any knowledge creation typically begins with the individuals who develop some insight or intuition into how to do the tasks better. Even though knowledge gained by individuals is essential for the shared knowledge development, it isn’t shared with others easily.

Shared/organisational knowledge is not just a simple sum of the individual knowledge. Therefore, one of the most important tasks for knowledge enabler (teacher/manager) is to facilitate the process of interactions between knowledge holders (students/employees) to make them sensitive toward environmental stimuli so that their individual knowledge is amplified and externalised to contribute to the general knowledge base [9]. The question we try to answer with this paper is, whether Wiki system can be useful enabling tool for that.

3. Knowledge conversion and externalization of tacit knowledge

Nonaka and Takeuchi [10] distinguish four different knowledge conversions between either of two forms or models of knowledge:

- Internalization – explicit to tacit
- Combination – explicit to explicit
- Socialization of knowledge – tacit to tacit
- Externalization – tacit to explicit

The key to a knowledge creation lies in the externalization process – the main role of knowledge enablers is to provide the proper context for knowledge exchange.

Externalizing tacit knowledge ensures that knowledge is made available to others for both knowledge sharing and application. According to Nonaka and Takeuchi [10] in their widespread model of knowledge creation, the process of externalization tacit knowledge occurs when tacit knowledge becomes explicit, for instance a sharing of metaphors and analogies during social interaction. It has been widely acknowledged that tacit knowledge has enormous value, however it is very tricky to share it.

The importance of diffusing tacit knowledge has been one of the highly stressed points by most of the researchers in knowledge management field. Selamat and Choudrie [11] summarize the arguments in supporting the tacit knowledge diffusion as below:

- The explicit knowledge of “know-what” requires the more tacit “know-how” to put the “know-what” form into practice;
- The efficiency of making decisions, serving customers or producing goods is improved by the use of tacit knowledge.
- The diffusion of tacit knowledge to resolve the problem of “reinventing the wheel” which occurs when one staff leaves the company.
- Coded information is unusable without the augmentation of tacit knowledge.

Due to its inherent elusiveness, securing the precious value of tacit knowledge is a thorny problem. This is due to the inability to express the things that build up the body of knowledge. As Polanyi [8] notes, ‘we can know more than we can tell’, since we can often know more than we realize.

Externalization is both difficult and costly, and the fact that tacit knowledge must be externalized before it can be exploited limits its usefulness [12].

Despite that, as the loss of nuances and details are common during the exchange of physical interactions, externalization can lead to serious problems. As a result of this, organizations face enormous difficulty to fully exploit the tacit knowledge that resides inside people.

4. Troubles related to the tacit knowledge sharing

According to Stenmark [12], the troublesome aspect of tacit knowledge is its elusiveness, which derives from at least three sources:

1. We ourselves are not fully aware of it;
2. There is no personal need to make it explicit on the individual level; and
3. There is a potential risk of losing power and competitive advantage by making it explicit.

First and foremost, the elusiveness of tacit knowledge is due to unawareness of its formation. As a result, such knowledge can be only with grave problems represented outside its owner's mind or be described explicitly enough for someone else to learn.

Secondly, since tacit knowledge can be used to govern our daily activities without the need of thinking, there is entirely no personal need for externalization. This main reason is that externalization would not be beneficial to the owners themselves but for the good of others in organizations. As it has been convincingly argued, situations in which one person is forced to do the work while another gets the benefit very often result in failure.

Thirdly, the source problem causing the elusiveness of tacit knowledge is well explained by the argument of Leonard and Sensiper (1998). Both the authors argue that making tacit knowledge explicit is not always beneficial at the individual level; if the tacit knowledge provides an important competitive advantage, there is little reason to share it with the rest of the organization. On the extreme side, extensive knowledge sharing by externalization may create a situation in which a member of an organization 'automates away' the reason for his or her existence in the organization [12]. Unless knowledgeable people no longer perceive the risk of their knowledge being tapped and replaced by a database, their reluctance to contribute would persist. Therefore appraisal and reward systems as well as expert recognition can be useful tools to encourage knowledge sharing.

To sum up, the capability to diffuse tacit knowledge is critical to ensure successful knowledge transfer. Notwithstanding, with its inherent tacitness, externalization is tremendously complex but possible. It is wise for organizations to disseminate the tacit knowledge of experts via face-to-face meeting or the use of ICT. The question we would like to answer in the second part of the paper is, whether storing the knowledge in Wiki system can in any way foster tacit knowledge transfer. The point is that good wiki encourages and fosters a knowledge sharing culture. This in turn will ensure everyone that sharing his or her knowledge could be sensed as a personal need.

5. Wiki as a knowledge sharing tool

The concept of coding and transmitting knowledge through ICT tools is not novel. There are even documented studies that measure and try to statistically calculate the difference between less successful and more successful enterprises in this area [2]. Knowledge management have been focusing on computer-aided development programs coupled with developing of organizational policies, routines, procedures, reports and manuals for a number of years. It is the exciting potential offered by web 2.0 technology that brings the new appearance in the area today.

Extraordinary success of group-oriented/by-group-created projects like Wikipedia (or Facebook, YouTube and other user-generated content projects of the last years) demonstrated the critical role of ICT in its ability to facilitate and support communication, collaboration, collaborative learning and the search for knowledge, regardless of geographical constraint. The usefulness of the internet and internet-based technologies is that they provide cost-effectiveness consisting of access to systems; platform independence; access to multimedia data formats; a uniform and easy-to-use, point-and-click interface; and the capability for easy multimedia publication for knowledge sharing (Alavi and Leidner) [1]. It is noteworthy that not every web 2.0 project is considered primarily a knowledge oriented effort, but the usage of web 2.0 technology often assists in accessing and exchanging of knowledge.

In their study of "Knowledge Management Systems: Issues, Challenges, and Benefits" Alavi and Leidner [1] defined three perspectives, namely information-based, technology-based, and culture-based characteristics, which play vital role with knowledge management and transfer (see Table 1).

Information-based	Technology-based	Culture-based
External • Customer information • Client information • Competitor information • Product / Market information ***Internal*** • Activity-based costing • Human resource information • Financial information	• Suitable infrastructure (Wider bandwidth and global IT infrastructure) • IT tools (e.g. consistent suite of e-mail and web-based products, search engines, intelligent agents, and, navigational tools) • Interoperability of existing data systems • Fast retrieval	• **Teamwork** • Practical guidelines • **Knowledge sharing.**

Table 1: Capabilities needed for Knowledge management and sharing adapted from: Alavi, M. and Leidner, D. E. [1], emphasis of wiki characteristics by author

Later on they also identified capabilities needed for knowledge management and sharing. From the table is clearly visible, that culturally-based characteristics are considered very important part of knowledge management and sharing. And exactly these (and some more) cultural aspects can be successfully observed within a wiki system.

There are a number of tools by which wiki system can achieve that. The most common is probably the „talk page" (usually an integral part of any wiki pages), which is a open platform to present various views and comments of the group. Such non-formal discussion is crucial for successful teamwork and knowledge sharing. Other aspect is inherent openness user-friendliness of the system (both discussed below).

6. Wiki system and its open, friendly and independent culture

Main reasons of wiki's fabulous success were elegantly predicted by the developer of the first wiki software Ward Cunningham [3]. He described the essence of the Wiki concept as follows:

- A wiki invites all users to edit any page or to create new pages, using only a plain-vanilla Web browser without any extra add-ons.
- Wiki promotes meaningful topic associations between different pages by making page link creation almost intuitively easy and showing whether an intended target page exists or not.
- A wiki is not a carefully crafted site for casual visitors. Instead, it seeks to involve the visitor in an ongoing process of creation and collaboration that constantly changes the Web site landscape.

Wiki system is essentially the simplest possible database for creating, browsing, and searching through information and knowledge. Probably the best proof of its success is the rapid growth of Wikipedia – world's first truly open encyclopaedia[41]. That's a lot of knowledge – and some of it tacit.

Wiki system, when managed properly is:

- Easy to use
- Open to new ideas and forms
- Independent
- Constrains free
- Intuitive
- Invites an involvement
- Interlinked
- Multimedia oriented
- Gives user a joy of use
- Enables discussions
- Fosters group
- Is "alternative" to the traditional mainstream

Those characteristics explain, why wiki systems are nowadays often used in business as an intranet and knowledge management systems. They are probably the best solution to explore both tacit (i.e. peoples experiences) and explicit (i.e. controlled policies) knowledge in one system. Wiki system can be a unique repository for different types of information and knowledge, including some aspects of tacit knowledge, provided that the system is properly managed and above mentioned cultural characteristics are present.

Wikis can be considered as an auxiliary tool for setting up/managing an IT project [6], wiki systems are also valid helpers in creating and shaping e-society [5]. Author of this paper successfully used several wiki systems as an educational tool for student group projects in the last couple of semesters. This example was in detail discussed in the article "Wiki as a knowledge management tool" [7] on last IDIMT.

[41] At the time of writing this paper, Wikipedia contents more than 10 million articles in over 60 languages. That is quite a success for just 7 years old project.

Downside of openness and restriction-free environment is a bit worse search-ability. Since wiki system by its nature does not have solid structure (wiki system is sometimes described as a “stash of interlinked hypertext pages”), it does not bound the author to follow strict logical structure (as opposed to clearly structured website or database). Any user might have written some interesting piece of data anywhere in any kind of wording and thus making the search a challenge.

7. Conclusion

Arguments mentioned in the article let us conclude that a wiki system can be effective and interesting knowledge management tool. A tool, which (under proper conditions) is able to help partially transfer even tacit knowledge. Although there are limitations and known issues, where wiki systems fail, when properly set-up and managed, the wiki system can, to some extent, facilitate exchange of tacit knowledge between its users.

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SHARING KNOWLEDGE: USING OPEN-SOURCE METHODOLOGIES IN IT PROJECTS

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Abstract

A significant part of today's IT development projects is done using Open Source programming languages, components and tools. But one must not forget that the usage of any (Open Source) "product" is not only about technology, it is also a matter of applying the knowledge embedded in the product by the original authors. Acknowledging this fact and its consequences becomes critical on the managerial level, whereat many companies are trying to take advantage of the Open Source project management methodologies. This paper exploits this topic by discussing the boundaries related to inception motives, general contents (referring to classical data-knowledge-information model) and portability of IT project management methodologies. On the basis of a specifically designed multi-criteria evaluation, general implications concerning the drawbacks of Open Source methodologies (as an example of embedded knowledge media) are declared.

1. Introduction

Applying a third-party methodology for managing IT product development projects is a risky business. Even with commercial, sophisticated products (such as IBM Rational Unified Process, Oracle Unified Method or Microsoft Solutions Framework) the odds of failure in a specific enterprise are considerable. But nowadays, just by using any Internet search engine, it is also possible to lookup a high number of Open Source methodologies that might also seem applicable. Dozens of Unified Process, SCRUM or Test-Driven Methodology variations can be found within seconds. Instantly, a dilemma is born: does it really make sense to pay for a commercial product if there are so many Open Source methodologies at hand? And isn't the possibility to apply other persons intellectual property without restrictions, i.e. to use an Open Source methodology (and maybe slightly adjust it so that it fits my specific needs perfectly), the best option after all?

Obviously, answering these questions is not that simple. There are several general drawbacks and boundaries in the Open Source area that actually prevent the Open Source commodities to dominate the IT market. Some of them – technical, legal, economical – are discussed in this year's IDIMT Session keynote paper by Michael Sonntag [11]. Most of them apply also in the area of project management methodologies, but there are probably some more, specific for the subject. To identify and explain them, the following schema is applied:

- IT project management methodologies as a broader research topic are delimited,
- inception motives for methodologies are briefly presented (psychological boundary),
- generic content and purpose of methodologies are defined with reference to the classical data-information-knowledge (DIK) model (boundary of integrity),

- the principles of transferring knowledge embedded in methodology are discussed (cognitive boundary),
- generic evaluation model for methodologies' usability is introduced on the basis of factors and boundaries identified in previous chapters,
- several widely used commercial and Open Source methodologies are assessed using the evaluation model, resulting in identification of the pros and cons of their usage,
- boundaries and drawbacks of Open Source methodologies, resulting from their common qualities, are discussed.

Note that the goal is not to "pick the best methodology", but rather to discuss them as an example of embedded knowledge media, demonstrating the pay-offs of applying a freely available third-party knowledge in an enterprise (or a scientific research).

2. IT project management "methodologies"

Methodology is defined as a "working procedure" or a "study of methods applied within a scientific discipline" [5]. But regrettably, methodology has also become one of the most common "inflation terms" that has almost lost its authentic meaning. Almost any larger enterprise or consultancy company proudly presents its own (verified, state-of-the-art, unique…) "methodologies" to convince the customers and public that it has some valuable background knowledge – for a brief list see [2]. Such "methodologies" are usually approached as any other commercial product and the term itself is used just to label some derived best practice. Analogous lack of credibility applies in the Open Source world, where a significant number of "methodologies" can be found in the Open Source knowledge bases (described for example by [10]), many of them in very poor condition and really falling short of the expected content. However, it has to be pointed out that even in this paper, the term "methodology" is used in this broader, imprecise meaning, comprising any sufficiently defined set of IT project management principles, procedures and tools. The reason for this is simple: the goal is not to decide what is a methodology and what is not a methodology, but to discuss the approach to data, information and knowledge in project management in general – and the most convenient basis for a representative research are these so-called "methodologies". It would be impossible to come to practical conclusions by taking into account only the scientifically fit methodologies – as in the field of project management, there are almost none [9].

3. Inception of a methodology – the psychological boundary

Nevertheless, seeing that innovative (and of course many useless) methodologies arise once in a while (some of the relevant are discussed in [10], an example of new methodology with inspiring paradigm shift towards value-added approach is described in [2]), there must be some inherent reasons for their emergence. Assume that - among the others - the following may be considered as their inception driver (list based on [3]):

- reluctance to utilize outside intellectual property,
- contempt for the work of others and
- questions about usability.

The last condition and the so-called "not invented here" syndrome (also noted by Chroust [3] while discussing motivations for usage of third-party components), can be rated as the most vital – it is always difficult to accept other people's work.

Let's summarize/simplify the above and designate on its basis the "psychological" boundary: the confidence in third-party products. How much is this relevant for Open Source methodologies will be discussed later in terms of the evaluation model.

4. Content of a methodology – the boundary of integrity

Whereas the divergence of views represented in methodologies is considerable and also their approach even to basic terminology differs significantly [9], it seems reasonable to define a common basis for their comparison on the fundamental principles. This can be provided for example by the means of classical data, information and knowledge (DIK) model. On its basis, the nature of any methodology can be questioned without the need to exercise over its specific terms, tools or procedures. In the first instance, let's take a theoretical look at the underlying terminology.

The following table, taken from [3], points out some well-known as well as non-traditional definitions of basic terms.

Author(s)	Data	Information	Knowledge
Wiig, 1993	-	Facts organised to describe a situation or condition	Truths, beliefs, perspectives, judgements, know-how and methodologies
Nonaka & Takeuchi, 1995	-	A flow of meaningful messages	Commitments and beliefs created from these messages
Spek & Spijkervet, 1997	Not yet interpreted symbols	Data with meaning	The ability to assign meaning
Davenport, 1997	Simple observations	Data with relevance and purpose	Valuable information from the human mind
Davenport & Prusak, 1998	A set of discrete facts	A message meant to change the receiver's perception	Experience, values, insights, and contextual information
Quigley & Debons, 1999	Text that does not answer questions to a particular problem	Text that answers the questions who, when, what, or where	Text that answers the questions why or how
Choo, Detlor, & Turnbull, 2000	Facts and messages	Data vested with meaning	Justified, true beliefs

Table 1Data, information and knowledge definitions [13]

There is no point in trying to pick the "best" definition, i.e. the one that describes the terms more precisely or in a more understandable way. All of them represent the approach of their authors and are more or less referring to their (research) topic. Nevertheless, by comparing the definitions, an interesting hint can be discovered – most of the authors use one of the terms to define the other, which leads to a hypothesis of some hierarchy or direct relation between them. For example in Choo and Davenport, this is explicitly described in the manner, described on the following picture (taken from [12]).

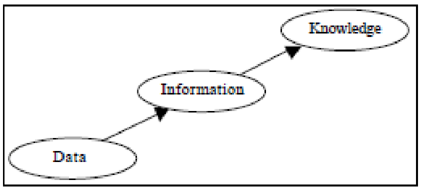

Figure 1 Linear data-information-knowledge relation [12]

In accordance with [12], such relation (sometimes a simple “knowledge pyramid” is also used - with the data being the pedestal, above them information and on the top the knowledge or even wisdom) is questionable at the very least. It may imply the conclusion that knowledge represents something more important than information; the same rationale applies to information and data. This has been contradicted by several authors from different perspectives [12], [5], [1]. What a specific person evaluates (with reference to the above listed definitions) as “information” can be considered as “data” by someone else. The decisive factor is the knowledge of the respective person as well as the situation he finds him/herself in [5]. Assuming also that the relations between the data-information-knowledge are not one-way, the particular interpretation of received data may lead not only to specific actions, but also consequently enhances the knowledge of their receptor, thus changing the outcome of any perspective, likewise situation. The relation between data, information and knowledge thus cannot be considered linear or one-way and more factors have to be taken into account. A somewhat better interpretation is illustrated in the following picture (taken from [5]), where the important drivers of experience, interactions, novelty et al. are acknowledged. Also, the importance of understanding and context necessary for getting grasp of any knowledge-based (cognitive) artifact is depicted.

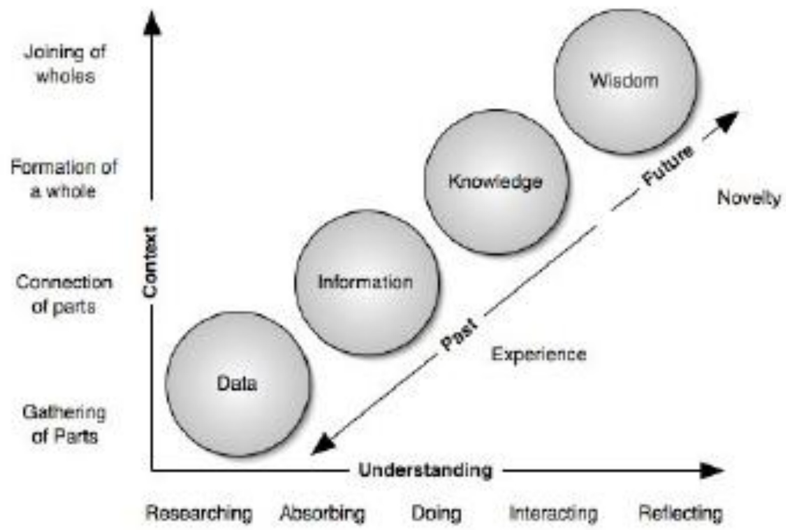

Figure 2 DIKW hierarchy (Clark, 2004), re-printed in [5]

Approaching the methodology as such artifact, or – as will be further discussed later – as an embedded knowledge medium helps to explain the boundaries of its usability. The basic idea is that any methodology should cover all parts of the data-information-knowledge(-wisdom) chain and, which is more important, cover them in a well-balanced manner. It has to describe how, by applying the appropriate (embedded) knowledge, one should work with project data and share information in order to achieve project success. The specific methods, tools, instruments, processes etc. applied can be different, but this basic purpose must be fulfilled.

Again, let's summarize/simplify the above and designate on its basis the boundary of "integrity": the completeness and balance of provided resources. How much is this relevant for Open Source methodologies will be discussed later.

5. Transferring knowledge embedded in methodology – the cognitive boundary

In order to be able to make use of any (available) methodology, one must be first able to understand it. The problem is that the knowledge embedded into any interpretable artifact, such as the project management methodology, seems to be very closely related to the specific conditions of its origin, most remarkably to the individual character of the author. This is the person who tries to express his view of the world and his specific (so called "tacit" [13]) knowledge in any convenient form (written, graphical, oral) so that they can be (in the form of an "explicit" [13] knowledge) used by other persons. It should be pointed out that this expression can be also a result of a teamwork, and especially in the Open Source area, a methodology is a typical example of the "explicit representation of the collective knowledge through a collective effort" [11]. This way or the other, the receivers of the explicit knowledge understand it in context of their own (tacit) knowledge, in relation to problem they are solving, with respect to unique situation in which they reside. The basic concept of this communication process is shown on the next picture.

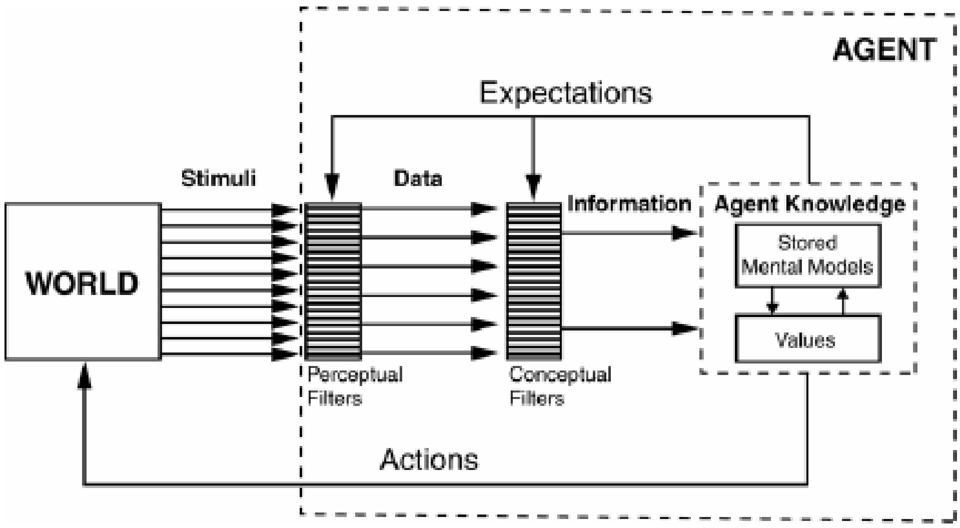

Figure 3 Agent-in-the-World [1]

In the picture, the "Agent" stands for example for a reader of a methodology. Let's consider that the other side, the "World", is represented by the author(s) of the methodology. This helps to understand the fact that the transmitted (explicit) knowledge as well as the whole transfer of data, information and knowledge is primarily a matter of mutual communication, determined by the different expectations, background knowledge, values and filters on both sides [1]. Whether the process of transmitting the knowledge will be "successful" or not depends on the ability to capture, represent and interpret the essential embedded knowledge in the methodology. Vorwerk further defines that the embedded knowledge implies such elements as (list based on [14]):

- experience,
- internalization,
- common practice, common sense and conventions,
- history, tradition, rules, laws, principles and
- contextual issues related to ethical, legislative and policy-related considerations.

By all means, these elements can be regarded as factors that designate the broader definition context of any project management methodology. On the practical, management level, they clearly influence the methodology's compatibility with enterprise core processes as well as company culture – their acceptability for the prospective methodology applicant is therefore critical.

So, at last, let's summarize/simplify the above and designate on its basis the "cognitive" boundary: the correspondence between authors' and users' mental models. How much is this relevant for Open Source methodologies will be discussed later.

6. The evaluation model

With correspondence to the previous paragraphs, several factors that influence the usability of methodologies can be picked out. In this chapter, they are transformed into specific evaluation criteria, referring to one or more identified boundaries as well as the original set by Michael Sonntag [11]. The criteria can be defined – for example – as follows:

- psychological
    - understandability (clear, uncomplicated),
    - standardization (references to standards such as UML, BPMN, UP etc.),
    - perspective (endorsement, support by authors),
- integrity
    - updateability (easy to update, open for changes),
    - comprehensiveness (integrated approach to DIK),
    - universality (usability for all types of projects),
- cognitive
    - transferability (independency on cultural and technical environment),
    - readiness (conformity with common sense and anticipated area of application) – depends on appraiser intentions,
- technical
    - operations support (backing by ICT tools, easy roll-out),
- legal/economical
    - availability (accessible and affordable).

Note that by applying a slightly different approach to the general topic, these criteria could be considered as another set of boundaries. Therefore the "mapping" of the criteria to the boundaries should not be reduced to strict 1:1 relation as the criteria are not independent and there clearly exist some overlaps – straightening this up would lead to over-simplification.

7. Assessment of the methodologies

In the following table, the above listed criteria are applied for evaluation of several widely used Open Source (eXtreme Programming, Feature Driven Development, SCRUM, Unified Process) as well as commercial (Microsoft Software Foundation for Agile Software Development, IBM Rational Unified Process) and in-house (Generic Project Process of Airbus Operations GmbH) methodologies.

	Scale 1-10 (1 lowest/worst, 10 highest/best)	understandability	standardization	perspective	updateability	comprehensiveness	universality	transferability	readiness	operations support	availability
Open source	**eXtreme Programming**	6	7	3	6	3	2	4	6	2	9
	Feature Driven Development	8	5	5	6	4	1	5	3	4	8
	SCRUM	7	6	5	8	3	7	6	7	2	9
	Unified Process	9	9	7	9	6	9	7	6	4	10
Commercial	**MSF4ASD**	5	8	9	2	10	5	7	5	10	6
	Rational Unified Process	8	8	8	4	9	6	8	5	7	5
In-house	**Generic Project Process**	5	3	2	2	8	4	2	7	7	1

Averages	understandability	standardization	perspective	updateability	comprehensiveness	universality	transferability	readiness	operations support	availability
Open source	7,5	6,8	5,0	7,3	4,0	4,8	5,5	5,5	3,0	9,0
Commercial	6,5	8,0	8,5	3,0	9,5	5,5	7,5	5,0	8,5	5,5
In-house	5,0	3,0	2,0	2,0	8,0	4,0	2,0	7,0	7,0	1,0
Overall	6,9	6,6	5,6	5,3	6,1	4,9	5,6	5,6	5,1	6,9

Standard Deviations	understandability	standardization	perspective	updateability	comprehensiveness	universality	transferability	readiness	operations support	availability
Open source	1,1	1,5	1,4	1,3	1,2	3,3	1,1	1,5	1,0	0,7

Table 2 Assessment of methodologies

Note that even on the small-scale evaluation sample, an unpleasant finding can be made: for a significant part of the criteria, the qualities of Open Source methodologies differ dramatically. Adding more specimens using [2] or [6] would further confirm this impression (but also lead to discussion about marginal subjects as the qualities of smaller Open Source methodologies vary even more). This only confirms the preposition that the evaluation must not be approached mechanically.

Nevertheless, there are still several common qualities of the Open Source methodologies that can be pointed out – let's first list the main pros:

1. Trouble-free availability. Evaluated methodologies can be found as Wiki pages, web sites, documents. They can be downloaded and studied/applied without any restrictions. As there are many clones and variants available, it is easy to find a one that is not bound by problematic licence such as GPL (see [11]). This is a far better situation than with the Open Source software or components. The fact that a methodology, as a “embedded knowledge media”, can be distributed – frankly said – as any common book is a tremendous advice, although it also has also some cons (as will be shown later).
2. Evolving on the above, the updateability of the Open Source methodologies is also very high. If it does not perfectly suit the intended purpose, it can be usually modified without restrictions.
3. At last but not at least, the understandability of Open Source methodologies is a strong advantage. Written by the people for the people, they are not plagued by PR, marketing terms and in-house terminology. Also, as they are open for other person’s updates, the support of common standards and other commonly shared resources (such as modeling tools) was or is being added to most of them. This also helps to improve the transferability to different environments as the standards are pretty widely used.

Now, let’s take a look at the main common cons:

1. Poor operations support. Commercial or in-house methodologies come pre-packed with templates, software, branch solutions. Open Source methodologies tend to suggest what should be used and how, but include only the necessary resources – usually the “know-how” and nothing else. The authors simply do not publish their internal papers or tools. It is possible to complete them with already existing stuff or to ensemble them from other Open Source resources, but then, the main advantage than any methodology should have, i.e. to instantly provide full support for project (and program) management throughout the whole project lifecycle, dies away. It takes a lot of effort to finalize all supporting documents, rules and tools to make full use of the methodologies’ potential.
2. Also with relation to the above, the comprehensiveness and overall integrity of Open Source methodologies is lower than hoped-for. The communication know-how and managerial approach stand at the pedestal, but for example the basic rules and support for handling project data (versioning, documentation etc.) must be already evolved in the company.
3. And at last but not at least, the perspective of the Open Source methodologies remains unclear. This is not about that they will become extinct – this is about that once you decide and go the Open Source way, you are on your own. If the community makes significant improvements, it is up to the applicants to promote them. And, if they have made any updates (which is the usual situation as it is one of the strong reasons for using the Open Source), they have to reconsider them again.

In other criteria applied (such as universality or readiness), the spread of results suggests that, in order to find the appropriate Open Source methodology, it is necessary to do a well-defined research and pick the one that really suit the personal needs (note: the evaluation model presented can be used for supporting this purpose). But the time spent on research in the ever changing and still expanding Open Source resources also cost something – especially in the business world, it is necessary to have this economical driver in mind.

8. Conclusion

Whether one tends to put to use any Open Source, commercial or in-house project management methodology, the impacts will be significant. As [2] notes: "Methodology can assist in the sharing of information across a virtual project enterprise. Projects have significant ... components that require management through their life cycle. Projects must comply with the correct standards and guidelines to protect the users' investment in such systems." An important fact can be pointed out with reference to this quotation – application of methodology requires investments, i.e. selecting the right methodology can save funds, whereas picking a wrong one may prove fatal. While having this simple incentive in mind, this paper presented some limits that the application of methodologies may have to overcome – psychological boundary, boundary of integrity and cognitive boundary. On the basis of evaluation of several Open Source methodologies, the following can be assumed as the specific conditions of their application: Open Source methodologies represent a suitable option for experienced practitioners with already well-defined infrastructural background and sufficient internal resources for finalization of the methodology for intended purposes. Finding the suitable assets in the Open Source world may take some time, but whereas the investment as well as result is eventually more or less comparable with the conditions of the commercial sphere, the final choice of the Open Source way should depend on the boundaries actually present in specific decision case.

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OPENS SOURCE SOFTWARE AND IBM: HISTORICAL COMMENTS

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Abstract

After some reservation and mistrust IBM also accepted the fact that Open Source Software is a feasible and often very successful business model. A then insider presents some of his personal observations.

To get a deeper understanding of the ideas, intentions and the environment lets recall the period when IBM's System /360 [1] and later /370 revolutionized the field of data processing.

Suddenly IBM offered a range of machines (a 'system family') of different performance (small to large), but all having the same interface for programs. This meant that a program could be run on any member of this family. Changing the hardware did not any more imply the need to reprogram the software. This was a tremendous success for software use. This success was creating problems, too. At the last day of the outgoing US administration in 1968 it filed an Anti-trust suit against IBM, implying that IBM was monopolizing the software market.

At this time, customers did not generally pay for software or services; software was provided at no additional charge, generally in source code form; services (systems engineering, education and training, system installation) were provided free of charge at the discretion of the IBM Branch office. Similarly, IBM services were divided into two categories 'free', provided at the discretion of IBM, and 'for fee' open also to non-IBM customers.

In 1969, IBM decided to "unbundle" software, services and education from hardware sales, this meant to price its software, services and education separately. It was an incentive for other independent companies to offer software and services on the market and this initiated the creation of a software industry (see also [2] and [5]). This decision vastly expanded the market for independent computing services companies.

Many regard this as the birth of the business software, service and education market.

Before 1999, IBM's involvement in OSS (Open Source Software) was on a case-by-case basis. A change happened in spite of many concerns in the late '90´s, taking an alternative view on OSS as an alternative business model providing different types of flexibility, opportunity, and benefits than those provided by the conventional proprietory business model. IBM was among the earliest of the major computer companies to embrace OSS as consistent with its business goals, e.g. by accepting Linux as the possibility of a unified operating system on its platforms in a way that has since been largely realized, or granting a licence for 500 patents to any OSS effort).

Since then IBM has contributed to many OSS initiatives [4, 5]

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Technological Outlook: The Future of Information Technology

BEYOND MOORE'S LAW - BEYOND CMOS - POST SILICON

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Abstract

Approaching the limits of CMOS scaling – sometimes called "the end of the reign of Moore's Law" – necessitates to consider both, the possibilities to prolong the present successful avenue and shift these limits further as well as look for promising technological alternatives.

Firstly this means perusing technologies to reduce design and manufacturing costs and continue the improvements of cost per function of integrated circuits extending the scaling economically further. Secondly the endeavour to look two, three or more generations ahead and discuss some of the emerging technological options ranging from New Materials and Devices, Nanotechnology, Molecular electronics to Spintronics, Optoelectronics, Photonics and Quantum Computing.

In spite of its speculative character will we try to gain an overview of some of the fascinating future technological options arising over the horizon.

1. Where do we stand

Discussing the future of information technology means discussing two different scenarios. Information technology industry represents enormous industrial investments therefore everything will be done to keep these investments as long as possible viable i.e. profitable.

Keeping in mind that the time span from laboratory to the marketplace can be 10 years or more in parallel intensive research efforts are devoted to technologies beyond CMOS and Post-Silicon.

Main challenges for future CMOS devices are increasing leakage currents causing high power dissipation and increasing device variability, but new materials (high-κ/metal gate, low-κ dielectrics, and strained silicon), new device structures, interfaces and tailored layouts will assist to increase performance further.

Some key areas and the scientific options to overcome the challenges are shown below:

- Lithography
- Interconnection
- New materials
- Power dissipation
- Economics

1.1. Lithography

Lithography has played and plays a key role in the success story ICs (Integrated Circuits), creating the image of the features that will be etched into a chip by imaging a negative mask, but every change means a new expensive effort.

Pattern assisted self assembly and placement may eventually replace optical and even extreme UV lithography in the next decade. [20] Mask less lithography circumvents this problem by writing directly on the chip with a beam of electrons or ions. But this method is slow and parallel multibeam is difficult. Another alternative could come from the applications of nanophotonics by plasmon and plasmon lenses.[10]

1.2. Interconnection

Interconnects are becoming essential. A microprocessor running at 3.6 GHz can execute several instructions each time its clock ticks, but the system typically takes about 400 times as long to fetch data from the main memory keeping the processor waiting [12]. Interconnectors are replacing transistors as the main determinants of chip performance. This "tyranny of interconnectors" will escalate in the future, and thus nanoelectronics that follow silicon must be interconnect-centric. Consequently, mainstream electronics will have an interconnect era - even beyond Moore's law.

1.3. New Materials

The gate stack used in current-generation, metal-oxide semiconductor field-effect transistors (MOSFET) is running out of steam because the insulating silicon dioxide in current device generations has arrived at only about five atomic layers. Thus the operating frequency of transistors can no longer be scaled more and future performance enhancements will result from materials innovation instead of pure scaling

New materials range from HfO_2 (high-κ material) as SiO_2 replacement as isolator for gates to solve the leakage problem to gates TiN, TaN metallic layers.

A great step could be replacing silicon by a material with higher carrier mobility such as Ge or III-V materials (GaAs, InAs). But GaAs may be an option for the middle of the next decade since it has about six times higher mobility, InSb (indium antimonide) has even a mobility 50 times higher, in addition one can achieve a more than 10 times improvement in power for Indium Antimonide operating at 0.5 V compared to the equivalent common devices. [6] But production yield will be affected as GaAs Wafers are typically 150 mm wide versus 300 mm in silicon.

1.4. Power dissipation

One sentence describes the challenge. If the current trend in clock frequency and number of transistors per chip would continue power consumption of a high performance microprocessor would reach 1kW/cm2 within the near future.

But not all prevailing technologies areas are reaching a maturity stage where the speed of innovation is slowing down, there may be exceptions as multi-core processors, optical data connections, 3D chips and accelerators. [1].

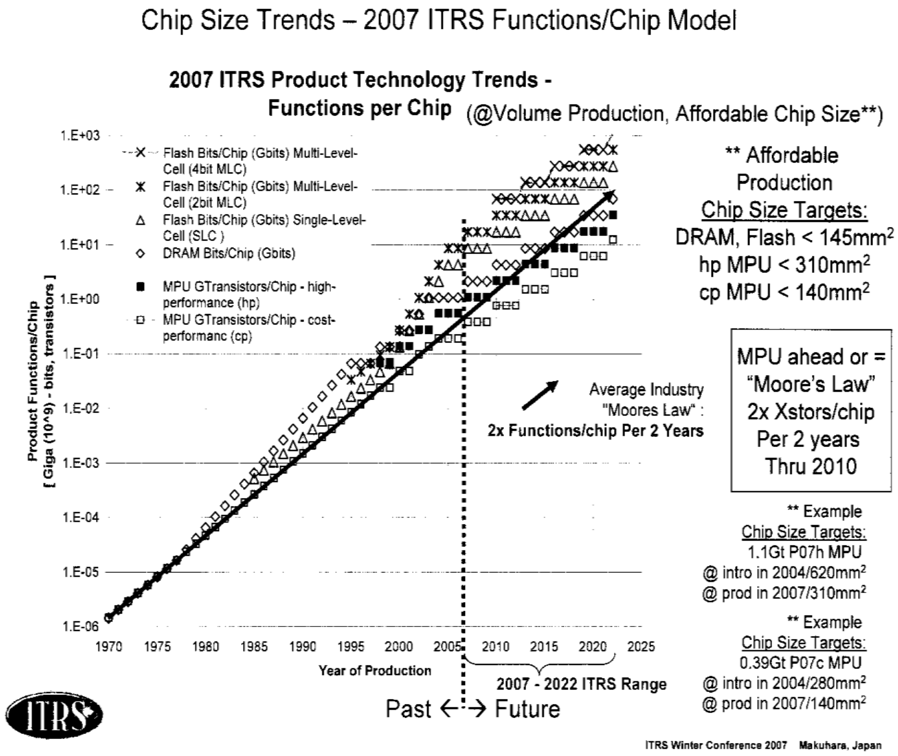


Figure 1: ITRS 2007 Product Technology Trends update 2008

The ITRS chart shows the expected trend of the available technologies for the time range up to 2025.

1.5. Some Economic Aspects

Just as in agriculture governments fuels the tendency to oversupply. Asian governments have been especially active and today more than half of the world chips are produced there.

Costs per transistor are halving with every doubling of the number per unit, but as costs of transistors come down the cost of fabs goes up. Investment costs exceed six billion $ for leading edge fabs; TSMC (Taiwan Semiconductor Mfg Co.) built two fabs for eight to 10 billion $ each.

Since established chipmakers can not longer afford to develop their own manufacturing processes or even run their own fabs so companies have teamed up to chip making technology jointly, as in the precompetitive cooperation in the 3D Integration Initiative between Amkor, Infineon, Micron, NEC, NXP,Panasonic, Qimondo, Samsung, ST Microelectronics, TI and TSMC. The past years have seen the rise of fab-less firms merely designing integrated circuits. [17].

Another phenomenon is the rise of “foundries”. These are essentially contract manufacturers; the biggest TSMC has a manufacturing capacity greater that INTEL. Decent profitability will be limited only to firms with unique intellectual property, to those who make commodity chips and to those who dispose of enough cash to achieve unprecedented scale

When industry goes to 450 mm at 22 nm or even 11 nm it is conceivable to have one fab handling all demand, the rest could be nationalistic motivated ventures or never-put-all-eggs-into-one-basket strategies or niche-operators. [3, 5]

There are corresponding developments on the consumer side; supplemental to the well-known trends comes the rise of "good enough computing", OSS far beyond Linux, or Cloud computing allowing smaller companies to outsource rather than doing all themselves. Thus SaaS and other online computing services, have become better, more widespread and report steeply growing revenues and profits and show no signs of an "economic crisis".[3]

2. Beyond Silicon - Post Moore

In the second part of we will try to peruse some of the upcoming technological opportunities as

- Molecular Electronics
- opto elEctronics
- Spintronics
- Quantum computation

2.1. Nanotechnology and Molecular Electronics

Nanotechnology is not an industry but rather an interdisciplinary enabling technology. To visualize the proportions: a nano-meter to a meter is as a soccer ball to the earth. It is more an evolution than a revolution. The use of nanotechnology is not a privilege of IT, shoe polishes, golf balls, toilet seats, paint, sun milk to mention a few, are nano-technologically enhanced products.[12]

Carbon nanotubes have been around since 1991, exciting by their unique qualities, their astonishing physical properties.

Property	Single walled Nanotubes	Comparison/Sizing
Tensile strength	45 bi Pa	Special steel alloys 2 bio Pa
Current carrying capacity	Ca. 10**6 A/cm2	Cu wires would burn
Temperature stability	Up to 2800°C in vacuum, 750°C in air	Metal wires 600 –1000°C
Cost	~500 $ /g	Au ~10 $ /g

Table 1 Nanotechnology (Source: Scientific American)

Applied to IT this could result in RAM's with 1 trillion bit/cm^2, which could read 100 times faster than silicon and conduct electricity extremely well.

A major problem is still to make nanotubes uniformly, reliable and in quantity, since structural differences can change a conductor to a semiconductor. Building molecular and Nanoscale devices is a first step, but interconnecting these devices seems to be the even greater challenge. [7, 23].

Intel hinted that Carbon and Nanotubes hold much promise for logic applications in the post CMOS era. It has already manufactured a 22-50 GHz Carbon Nanotube device with geometries from 2-5 nm; but to put millions of them on a wafer looks like a big task. [19]

2.2. Photonic computing

This is also an evolutionary development and much photonic has already arrives years ago.

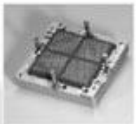
	Internet, Wide Area Network	Local Area Network	Rack-to-Rack	Card-to-Card	On-Card	On- MCM	On-Chip
							
Distance	multi-km	10 - 2000 m	30+ m	1 m	0.1 - 0.3 m	5 - 100 mm	0.1 - 10 mm
Number of lines	1	1 – 10	~100	~100-1000	~1000	~10'000	~100'000
Use of optics	Since the 80s and the early 90s	Since the late 90s	Now	2010+	2010-2015	Probably after 2015	Later, if ever

Figure 2: Optical Interconnects [8]

Photons of light have a potential for manipulating information that surpasses electronics. Photons can move faster than electrons especially in semiconductors carry many orders of magnitude more information, and in addition the photonic transistor's have the ability to switch within one cycle. The structure of light is quite different from the electron. Each photon, being quantum, provides an independent information-carrying variable for each independent photonic frequency or colour e.g. each colour in theory can carry over 200 Tbits/sec.

Optical computers would produce substantially less heat, and are not subject to the restrictions caused by capacitance, inductance, resistance, and reluctance, have no interference among the beams. Thus, an optical computer, besides being much faster than an electronic one, might also be smaller. [3]

Recent research shows promise in temporarily trapping light in crystals a necessary element in replacing electron storage for logic devices.

Optical switching, while not all-optical, has already become important in networking environments. 100 Tbit/sec data-handling is expected within a decade. Technologies range from micro-electro-mechanical systems to photonic integrated circuits and use of non-linear optical effects. A completely optical computer requires that one light beam can turn another on and off. This was first achieved with the photonic transistor, realized in 1989 at the RMRC (Rocky Mountain Research Centre). The samples developed are switching light in 1.5 femtoseconds (fs is 10^{-15} sec.) i.e. switching light with light at the full speed of light.

2.3. Molecular electronics and Organic Computing

A quarter century ago scientists of Bell Labs suggested the use of molecules for electronics. Single-molecule devices appear to be ideal candidates for future nano-electronics; they hold the potential of creating high-density devices with low power consumption in combination with high speed. But reproducible fabrication at the molecular scale presents a challenge. If molecular devices can take advantage of self-assembly processes, however, molecular devices may also feature low manufacturing costs.

Molecular memories could have a million times the storage density of today's chips. If molecular computing on its own becomes feasible, it would mark a leap beyond silicon. Engineers could pack more circuitry onto a microchip than silicon ever dreamed of, and even much more cheaply. This would translate into small devices with supercomputer capabilities on your wrist or within your shirt.

The first molecular electronic devices will probably not compete with silicon devices and they are more likely to be sensors rather than logic devices. [12]

Potential applications are in large area electronics (e.g. electronic paper, print circuitry, displays, bulletin boards and smart cards etc.). They could be fabricated on flexible substrates at low cost, as 100 millions transistors in postage stamp size, or as large flexible plastic displays driven by plastic transistors or in futuristic sounding applications like a wall or car that change color upon request. These outlooks would comprise equally futuristic manufacturing outlooks like inkjet printer or "stamping" technologies replacing the clean room fabrication or a "fab-in-a-box" or chemical factory on a chip. [11]

Another approach is the development of new conducting polymers which create transistor-like switches smaller, and theoretically up to 1000 times faster than silicon transistors.

2.4. Organic Computing

Adelman's demonstration of the solution of the "traveling salesmen problem" by organic processes created a worldwide response and interest.

Special attractiveness results from the storage capabilities e.g. DNS is 100 billion times denser than Si and potential parallelism enabling theoretically 10^{20} simultaneous processes/calculations. A tank with 0,5 kg DNS diluted in 1 m^3 of water would have more storage capacity than all computers at present in use.[10]

Disadvantages are it is slower than Si-based computing, and it is voluminous, sticky and liquid technology. Additionally chemical reactions always have and nonzero probability of going backward.

A first step in this direction may be a hybrid heterogeneous technology. As shown below, a voltage applied to the substrate increases the conductance between source and drain, demonstrating that highly ordered monolayers of conjugated polymer, can act as the channel for a FET.

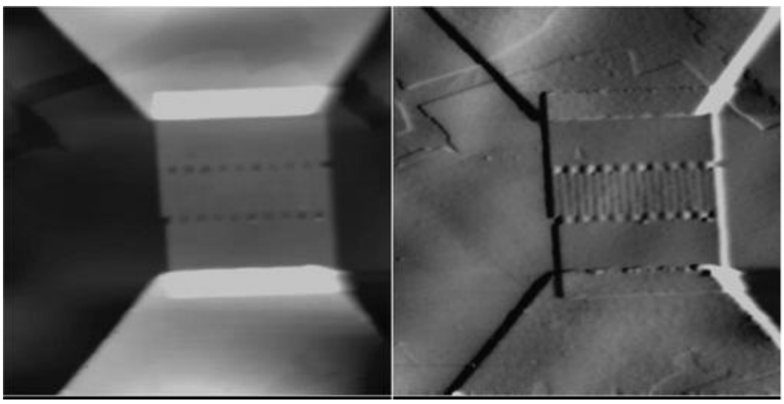


Figure 3: PDA acid multilayer on electrode pattern [IBM Almaden Research Centre]

Even with pure organic computing still being far away, a mixture of organic and anorganic layers patterned to form the channels of thin-film FETs may appear earlier. The question arises which architecture these forms of computing will require. Nature provides us with many examples of the use of physically processes for information processing as neural network models of computation, excitable media, and molecular regulatory circuit in cells, cellular DNA/RNA computing and pattern formation, and morphogenesis or computing with proteins.

Computing with proteins in information processing is still beyond our reach and rather a speculative option for the future. The complex intracellular molecular reaction networks that control the nervous system which is dynamically programmed during use by continually revising the strength of synaptic connections between neurons are not yet well understood.

Akin the genome’s output is dynamically reprogrammed during development by switching on or off whole suites of genes to adopt and maintain their unique role within the body. Living organisms have an information processing system based on complex protein signaling networks that sense a cell’s chemical state and respond appropriately. All these need intensive research to be understood [15]

2.5. Spintronics

The word “spintronics” (short for “spin electronics”) refers to the electrons quantum property called spin.

Spintronics describes a technology using of the spin state of electrons. It can provide an extension to electronics. When the intrinsic spin of an electron is measured, it is found in one of two spin states. The Pauli Principle dictates that the quantum-mechanical wave function of two paired fermions must be antisymmetric, no two electrons can occupy the same quantum state, and an entangled pair of electrons cannot have the same spin.

Spintronics´ promise is very fast switching, reduced power consumption, as well logic gates with fewer element than for their charge based counterparts. [18]

The most widely used Spintronic device is the Giant Magnetoresistive (GMR) spin-valve head for magnetic hard-disk drives with a spacer layer only 2-3 atoms thick. When their orientations are “parallel”, electrons with one type of spin pass freely while those with the opposite spin meet greater resistance. The GMR, pioneered by IBM in 1997, enabled a more than 40-fold increase in data-storage density over few years.

Promising potential of spintronics lies in embedded memories. Nonvolatile memory devices such as magneto resistive random access memory (MRAM) may revolutionize the memory market and contribute to the development of sophisticated and versatile computing and personal devices and innovations such as instantly bootable computers.

2.6. Emerging storage technologies

The expected growing need for more and more storage led to a plethora of R&D efforts; while flash-memory can offer little in the way of write speed over hard drives, alternative technologies could potentially offer access times nearly 5 orders of magnitude faster (<100 nanoseconds). Storage technologies coming in the pipeline range from Resistive RAM (RRAM), Phase Change RAM (PRAM) to array based memory to name a few. In addition there are new data storage concepts upcoming using metal oxygen compounds which change their conductivity under the external influence of magnetic fields or light up to the 10th power or resistance change memory a magnetic random access memory (MRAM) based on magnetic tunnel junctions. [15].

2.6.1. Racetrack Memory

IBM works on a next-generation non-volatile memory dubbed "RaceTrack" which is expected to replace flash memory and may be even conventional hard-disk drives. The prototype encodes bits into the magnetic domain walls along the length of a silicon nanowire. This method allows "massless motion" i.e. moving the magnetic domain walls along the silicon nanowire for the storage and retrieval of information. Such drives would be able to store data up to 1 Tbits on a 3.5 inch drive with an access time 1 million times faster than conventional disk drives. The physical principles of a racetrack memory are shown below

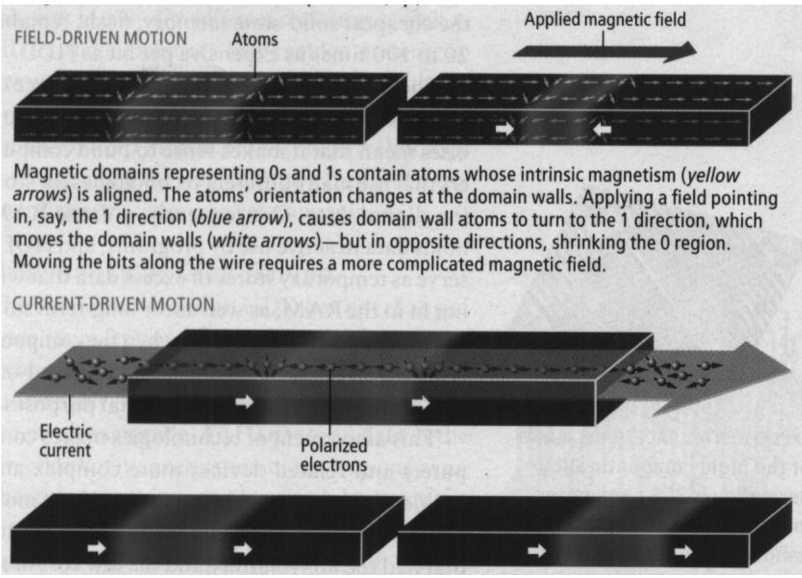


Figure 4: Racetrack memory S.S. P. Parkin SciAm 06/09

Further away is another type of spintronics: quantum spintronics, i.e. the individual manipulation of electrons to exploit the quantum properties of spin. Quantum spintronics could provide a practical way to quantum information processing.

2.7. Quantum Computing

Let shortly recall some basics and shortly explore two key phenomena of the quantum world for computing and communication.

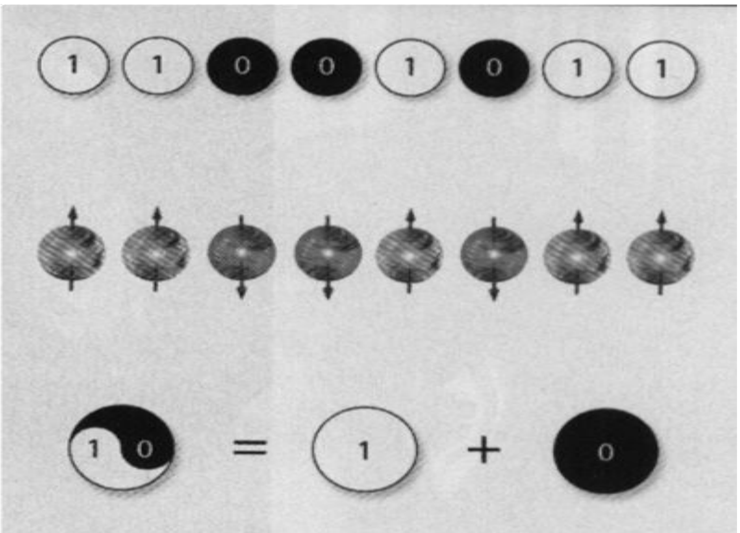


Figure 5 (Source: [18])

The first is the notion of quantum "state" as exhibited by the spins of atomic particles. Atomic particles are also spinning clockwise or counter clockwise - but until that spin is observed, the direction is unknown and is a probability of one direction versus the other. Thus a particle can be in two states at once; these particles are called qubits (quantum bits). In quantum mechanics the state of a system composed of a number of electrons and nuclei is described by a superposition of electronic configurations. Two qubits can therefore be in four states and 20 particles in a million states. Such devices could solve arithmetic problems as factoring numbers and search problems much faster than conventional computers by exploiting the properties of being in many states at once. A silicon computer uses to seek a single solution for a complex problem; a quantum computer can potentially explore all the solutions at once.

The second phenomenon is entanglement. Two particles can have linked spins even though they are at a distance. This has been demonstrated in laboratory conditions and is quoted to be a way to securely distribute cryptographic keys over distances. The quantum key distribution systems employed in quantum cryptography is an example of a few-bit system and one can already find commercial quantum cryptography systems on the market. Manipulating one particle and then reading the spin of the other linked particle is the basis of quantum information teleportation.

The advantages are counterbalanced by many unresolved problems as decoherescence, connection and signal input/output, while error correction first thought impossible seems possible but with an enormous increase in complexity.

The research challenges of quantum computing are enormous. Just to mention a few general ones: the quantum computer would not be a Turing machines, it has simultaneous read, write, and calculate capability, requiring new types of algorithms that utilize being in multiple states a.s.o.

3. Summary

We tried to pursue the present scenario of R & D and potential developments. Technological forecasting for ICs shows that the present technologies are promising progress for at least another decade, may be, even keeping the trend on track through 2020.

Nevertheless R & D for new physics replacing or complementing "charge-based physics"' that does not require the movement of an electronic charge is a fascinating option.

Nobody can forecast completely new technologies for which there are no existing paradigms. The future is to be invented not predicted.

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