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SCHRIFTENREIHE INFORMATIK
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CHROUST GERHARD ■ DOUCEK PETR ■
KLAS JAN (EDITORS)

IDIMT-2008
Managing the Unmanageable

16th Interdisciplinary Information Management Talks
September 10-12, 2008,
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Impressum

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Proceedings

Gedruckt mit Förderung des Bundesministeriums für Wissenschaft und Forschung.

This publication was partially supported
by the Czech Science Foundation
(GACR) Grant No. 201/07/0455.

Die Konferenz IDIMT-2008
fand vom 10.-12. September 2008 in Jindřichův Hradec,
Tschechische Republik statt

Herausgeber:
O.Univ.-Prof. Dr. Gerhard Chroust
Institut für Systems Engineering & Automation
Johannes Kepler Universität Linz
Altenbergerstr. 69, 4040 Linz
Tel.: +43 70 2468 8865

Herstellung:
Kern:
Johannes-Kepler-Universität Linz,
4040 Linz, Österreich/Austria

Umschlag:
TRAUNER Druck GmbH & Co KG,
4020 Linz, Köglstraße 14,
Österreich/Austria

ISBN 978-3-85499-448-0
www.trauner.at

Welcome to IDIMT 2008!

A heartily welcome to the 16th IDIMT Conference!

For various reasons we have chosen Jindřichův Hradec as the new location for IDIMT 2008, especially since the Faculty of Management of the University of Economics, Prague, is located here.

You will enjoy this lovely old town with a wonderful market place, an old castle and 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 us to stay, to stroll and to shop. 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. It now has become a well-established conference of a scientifically and geographically diverse group of scientists. The main focus of the conference are current and

future challenges and needs of a world dependent on Information and Communication Technology.

The participants discuss innovations, advantages, problems, and risks of information technology on the one side, and innovations, trends, problems, and risks in business engineering and business management on the other side. Due to the many unknowns of these fields they are not really manageable – hence the title of the conference.

This year we were able to accept some thirty papers coming from seven countries. They were arranged in 8 sessions, each session organized by a Sessions Chairperson and started, 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 from 1993 of providing a solid base for interdisciplinary exchange of thoughts by offering ample time for discussions. This is one of the outstanding features of IDIMT.

This year's session topics are:

- *Performance Management*
- *Information Management*
- *Perspective(s) of Future(s)*
- *Software Project Management and Human Factors*
- *Systems Thinking in Project Management and Business Excellence*
- *Security and Safety as a Systemic Challenge*
- *Advances in Cooperative Information Environments*
- *Privacy/Security/Trust - A clash of systems?*

We repeat the successful PhD-day concept from last year: a dozen young PhD-students will meet one day before the actual conference and will tackle a truly European challenge: discussing advantages and disadvantages of studying abroad during or immediately adjacent to one's PhD-studies.

The preparation and realization of IDIMT 2008 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,*
- *the Czech Science Foundation for partially sponsoring the conference,*
- *Raiffeisen Informatik GmbH , Vienna*
- *the University of Economics Prague and the Johannes Kepler University Linz, which as partner universities provide much of the organizational infrastructure,*
- *the Austrian Society for Informatics, Linz (ÖGI),*
- *Jan Klas as the person who kept contact to all involved parties, especially collecting the papers, reminding the authors and performing all the other necessary administrative jobs,*
- *Petr Doucek for chairing the Organizing Committee and organizing accommodation in Jindřichův Hradec,*
- *the secretaries of the involved institutes,*
- *all Session Chairpersons for establishing contacts and soliciting contributors,*
- *all keynote speakers, speakers and contributors of papers,*
- *the Trauner Verlag for acting as the publisher of our conference,*
- *all other unnamed persons contributing to the success of this conference.*

To a successful conference!

Gerhard Chroust

July 2008

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Performance Management

IT PERFORMANCE MANAGEMENT AS A PART OF THE CORPORATE PERFORMANCE MANAGEMENT SYSTEM

Ota Novotný[1]

Abstract

Key point of the business vision transformation we can find in the transition between contextual and conceptual level of company management (balancing the company targets with the business process targets and definition of relevant measures and indicators). Other key point is positioned between the conceptual and logical level of company management (task assignment and especially the creation of appropriate ICT architecture and appropriate ICT management system). In order to fulfill this transformation need the IT Performance management system (ITPMS) has to be properly established and positioned in the ICT department.

ITPMS starts with assessment of internal or external customer expectations and IT organization objectives. The resulting performance management system provides IT leadership with the means to create business metrics, understand the drivers of IT performance and deliver the tools for improving performance on a targeted, continuous basis. This performance management approach creates a framework for simultaneously measuring what customers care about and focusing measurement programs on the factors that affect IT performance.

ITPMS and CPM can be implemented as standalone initiatives, but there is a big potential of combining one with each other – especially developing the ITPMS as integrated part of CPM initiative which allows extending its reach into the area of ICT management. It also allows the ITPMS to be more focused on fulfillment the company objectives rather than the particular user requirements.

[1] Department of Information Technology, Faculty of Informatics and Statistics, University of Economics, Prague; novotnyo@vse.cz

ITPMS and CPM are discussed in the article. It also discuss possible approaches to their integration. Article concludes with the discussion about integration between CPM and ITPMS.

Key words: CPM, IT Performance, ITPMS

1. Introduction

Each company (organization) in order to fulfill its vision, strategy and relevant targets (e.g. for relevant business effectiveness) has to transform its aims from the abstract (idea) level into physical reality. Transformation process is important for several reasons. It is necessary to specify all the activities necessary for the vision fulfillment, to their qualified organization, planning and management. It serves also as a communication tool for the aim transfer between company management and employees responsible for the aim realization. This transformation of "ideas" works simultaneously among following levels of the company management:

- Contextual level – describes the vision of the company and its strategy in the wide societal context, about its business targets, efficiency parameters and company values.
- Conceptual level – defines the concept for the vision fulfilling (process models, functional models ...).
- Logical level – defines logical parts (areas) required by selected concept, their layout and their mutual relationships. This level distinguishes between two architectures – human resources architecture and information and communication technology architecture (ICT).
- Physical level – describes the real "building blocks" of systems as e.g. resources, skills, applications, databases ... integrated into above defined logical schema.

With increasing complexity of the company vision also increases the importance of its right transformation into reality. Underestimation of any of the above listed levels results in the "spaces" among the transition states, demonstrated by application of impropriate company management concepts, misbalance between motivation systems with the company aims or with the business processes and also in implementation of the irrelevant information systems (e.g. implementation of the functionally designed IS into the process managed organization). In the end we can find poor effectiveness, increased skepticism to applied management concepts, information technologies, information systems or improper investments.

2. Corporate Performance Management (CPM)

In order to solve the above issues in the current economic environment, the new management approaches were elaborated. The most promising is the Corporate Performance Management (CPM). Gartner defines its content as the processes used to manage corporate performance (such as strategy formulation, budgeting and forecasting); the methodologies that drive some of the processes (such as the balanced scorecard or value-based management); and the metrics used to measure performance against strategic and operational performance goals. However, CPM also comprises a series of analytical applications that provide the functionality to support these processes, methodologies and metrics, targeted at strategic users and corporate level decision making.

According to Gartner, CPM is like a relay race, because each element must work together in a logical and coordinated fashion. Until fairly recently, each facet of CPM typically was implemented in a stand-alone manner, with little or no linkage to other aspects of performance management. For example, it was typical for balanced scorecards (BSCs) to be implemented with no linkage to operational planning and budgeting systems. Similarly, the metrics used to control financial budgets frequently were different from those used by operational managers. Gartner's definition of CPM brings these elements together. Although there's no single or correct combination of processes, methodologies and metrics, they are starting to converge in CPM application suites, which embody the functionality of various processes and link them to many methodologies.

CPM could be understood from two perspectives – as the phenomenon of current information systems or as the approach of the contemporary management (Rayner, 2002). For our purpose we would rather concentrate on the second perspective.

The term Corporate Performance Management has been appearing in academic community in the last decade of the 20th century. In these times did not exist any common definition of this term and different authors have described it differently. Its position in the management methodology has CPM gained in the year 2001, when Gartner Inc. provides (above listed) definition which started to be widely adopted by academia and business.

One can find a number of other definitions and explanations of what is CPM and what is not. CPM is in other words the wide spectrum of tools, techniques, methods etc. which helps organizations effectively optimize their businesses efficiency. It is developed as a complex system of organizational, automated, planning, monitoring and analytic techniques, processes and systems,

which support management of an company. CPM provides holistic approach to implementation and monitoring of business strategy combining (Coveney, 2003):

- Methodologies – especially BSC, ABC, EVA and others. In the same time we can include also the methodologies for implementation of the CPM systems.
- Metrics – defined in the above methodologies.
- Processes – used by organization to implementation and monitoring of business productivity.
- Technology – information systems supporting all levels of the company management.

CPM combines different technologies and business best practices in order to ease the formulation and execution of the business strategy. CPM has been originally named as Business Performance Management (BPM), later also Enterprise Performance Management (EPM) or Operational Performance Management (OPM).

CPM could be divided to two interconnected parts according to viewpoint of its users:

- Operational CPM – covers needs of the business processes on the strategic management level (top and financial managers).
- Analytical CPM – covers reporting and analytical needs of the top management, middle management and selected operational staff. Analytical part is also used by other stakeholders, like partners, suppliers etc.

CPM is also often understood as the “next generation of the Business Intelligence”. But it is misunderstanding. CPM builds on the Business Intelligence grounds, but also adds planning, consolidation and management methodologies (e.g. Balanced Scorecard).

If we look on the CPM form the perspective of the Performance Management Systems, it is positioned on the top (strategic) management level encompassing the company as a whole (see Figure 1).

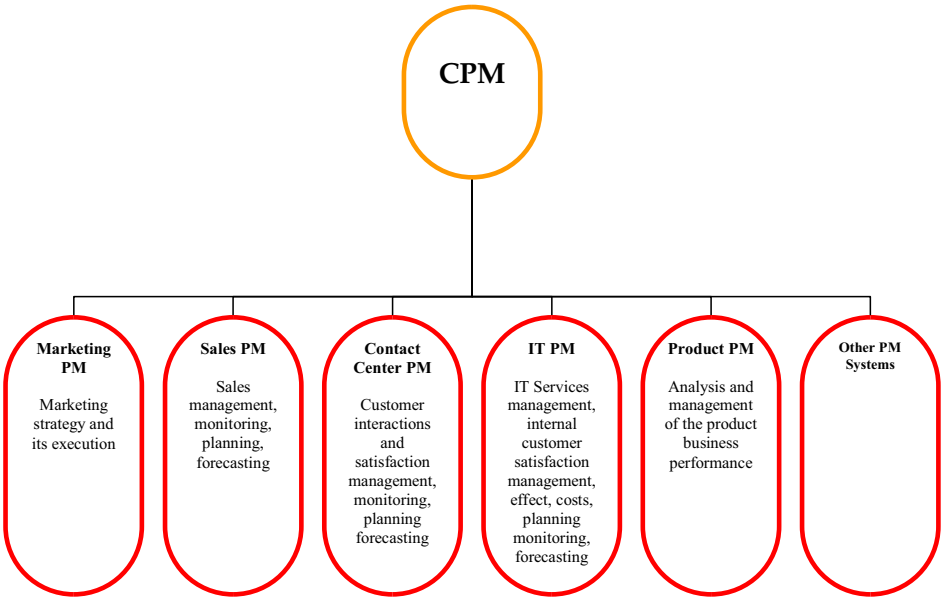

Figure 1: Position of CPM among Performance Management Systems

3. IT Performance management system (ITPMS)

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

IT Performance Management gains its momentum especially in the situation, when the IT in the company is based on the service definition and SLA – service oriented IT management. This situation brings IT Management executives to the nearly the same position as they are managing in the whole company. IT 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.

Overall concept of IT Performance Management – IT Performance Management System developed at the Department of Information Technologies VSE Praha is depicted on the Figure 2. Core of the

model is build around the IT Management Processes (10 IT process domains on three levels of the management).

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.

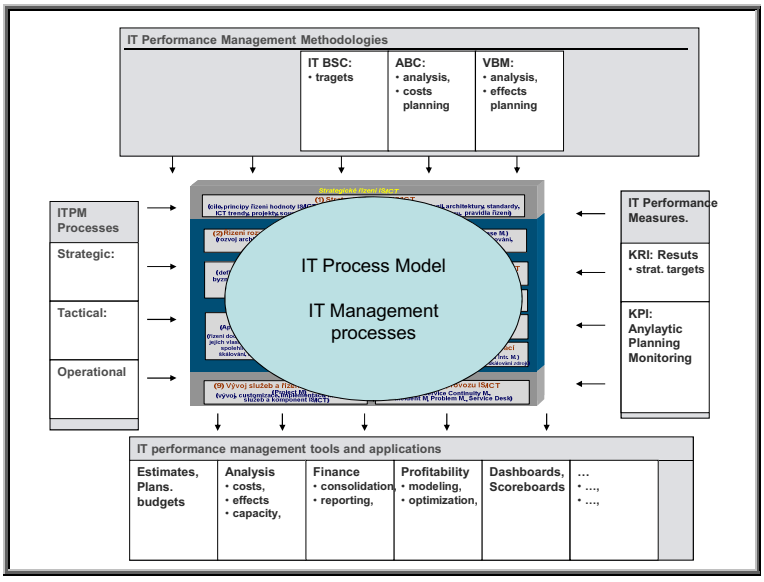

Figure 2: Basic Concept of ITPMS

It is clear, that the core IT Process Model could differ based on the selected IT management methodology, but the IT Performance System attributes are applicable for any of the IT Process Models (e.g. ITIL or CMMI)

4. Conclusions

ITPMS and CPM can be implemented as standalone initiatives, but there is a big potential of combining one with each other – especially developing the ITPMS as integrated part of CPM initiative which allows extending its reach into the area of ICT management. It also allows the ITPMS to be more focused on fulfillment the company objectives.

Above approach also limits the common problem of ITPMS - IT Centric Approach, where IT is rather concentrated on its own operational goals, then to improve the overall company efficiency and add business value to the company management.

Connecting the ITPMS with CPM (because both are built on the same principles) also saves costs connected with both systems development (either technology setup or consultancy fees). It will also allow the IT department to express the added value it brings to the business and also will allow the CIO to take part in the company business targets setting and anticipate the future requirements on IT department.

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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.

BUSINESS INFORMATICS IN A LIGHT OF COSTS, PROFITS AND GAINS

Miloš Maryška[1]

Abstract

This paper contains contemplation about measuring of economic efficiency of business informatics – especially in a light of costs, profits and gains. Each of these groups is characterized and some fundamental problems which have impact on measuring of business informatics are mentioned. The aim of this article is not to give detail information about this problem domain. The goal of this paper is to point out some actuality that should be accepted during measuring of business informatics.

In the first part of this article is stated the fundamental information with terminology that is used for evaluating of economics efficiency. It is necessary mutually merge terminology from various domain as accounting, business economics, costs accounting, finance accounting etc. In this part are noticed some problems connected with measuring of economics efficiency.

The main part of this paper is devoted to problems of measuring, including various attitudes to accomplishment. For example: problems connected with different size of companies, problems with defining gains of real investment action and especially differences among conceptions of business informatics (Strategy Business Unit, cost item, in-house division). Another disputable part of evaluations is estimation of gains created by implementation of a new investment action into business informatics. In opposite to this evaluation is detection of costs and profits very simple and exact technique (in particular made retroactively).

This article is an introduction into the problems that are solved in dissertation thesis about evaluating and measuring of business informatics and related to research projects.

Key words: Cost, profit, gain, business informatics, evaluation, measuring, economics efficiency

[1] Department of Information Technology, Faculty of informatics and statistics, University of economics in Prague; maryskam@vse.cz / milos.maryska@siemens.com

1. Introduction

Manager's requirements are based on requirements of the companies' owners to probe an economics situation of the company. This survey is made in all domain of business process that is connected with the necessity of formulation current economic situation of the company and not only for the company as a whole but very important is formulation based on survey each of company's component. We can include to this effort also effort to reach a scientific/exact description and a comparison of information systems based on multiple view.

There is not only important in-house comparison in time but also accompany different comparison (benchmarking) in scope of comparison. This effort is connected with some critical factors that are possible take into account. For example:

- differences in size of compared companies,
- differences in company parameters like number of employees, annual turnover etc.,
- dissimilarity in demandingness in branch on IT and dynamical development of companies,
- rapid changes in IT, that company implement at different speed,
- unconcealed situation in area of measuring of economics efficiency in business informatics ([3]), etc.

We can evaluate a log of facts not only in IT but also in other branches. There is possible to evaluate for example business process, SLA, services, quality of IT systems, and economics efficiency in IT. Interest in metrics and problems with measuring economics efficiency in business informatics is one of the main priorities of management in firms around the world.

At present are spent in majority of firms significant sums of money on IT department and all concerned subjects should monitor efficiency of this expenditure. For management of firm should be important a verification of all gains that business informatics give and response to question if it is better to have an internal IT department or to use an external services like outsourcing. We can illuminate the right target by measuring of economics efficiency of business informatics. Management and head workers can make better plans and make better resolution about future development based on results from evaluation. [7]

Common factor of all evaluations is dilemma how ensure the required data for measuring. The main part of data sources, that is important to identify properly, are connected with firm's accounting and financial reporting. Into this group we can place costs, profits and gains.

2. The main problems connected with evaluation - terminology

For measuring of economics efficiency of business informatics is characteristic an unstable terminology. There are not important only facts mentioned in the paper, but also need for join and interconnect terminology also from various branches that have no relationship with business informatics. We have to achieve employees to understand accepted terminology and at the same time other subjects interested on evaluation to accept terminology.

Main branch that we have to consolidate for evaluation and set up a common terminology area are the accounting, the business economics, costs accounting, financial reporting etc. Member that connect all ideas is perception of all things we have mentioned above by informatics. Very important is that we have to consolidate perception of mentioned area by informatics because we can't exclude informatics from this activity. Our perceptions have to be consolidated with other division.

In case, that we want to evaluate for example company making business only in the Czech Republic, our situation is easier. In this case we use only Czech law system – primary it is Zákon o účetnictví 563/1991 Sb. When we do business abroad, we have to accept requirements come out from international accounting standards like US GAAP, DEU, and IFRS etc.

In previous paragraph we have mentioned basic problems connected with terminology that can come up (in the context of the Czech national accounting and evaluation of business informatics) and that are:

- concept and recognition of costs,
- concept and recognition of profits,
- concept and recognition of gains,
- definition of business informatics (SBU – Strategy Business Unit, in-house division, cost item)

At the beginning every evaluation is important to determine essential terminology vocabulary that is applicable in the company and that is used by evaluators for intercommunication.

From my point of view we should harmonize between information department and evaluators are for example:

- Determine a cluster of things, which are owned by business informatics or hire by informatics.
- determine the evidence of assets that is categorised into the mentioned groups and also determine the way of depreciation, escalation of value etc. other important task is to accept this facts in finding profits/costs/gains of business informatics
- frequency and responsibility by name for above initiate activity – which ensure, that during the period of evaluation evaluators use valid data and this also ensure scene for in time evaluation.

One way how ensure above mentioned agreement is to set up in-house regulation. In this document should be define terminology, frequency of evaluation etc.

3. Relationship between Corporate Performance Management/Performance Management and Financial Management

Corporate Performance Management (CPM)/Performance Management is very frequent term in current time. This term is not easy to define as we can define three main groups/trends each of them have different point of view on CPM. We recognize these groups:

- CPM as a method of infilling business strategy
- CPM from the view of finance and financial accounting
- CPM as a management methodology

Definition of CPM is following: Corporate performance management (CPM) is the area of business intelligence involved with monitoring and managing an organization's performance, according to key performance indicators (KPIs) such as revenue, return on investment (ROI), overhead, and operational costs.

CPM is “something” that helps to organizations (both of public and private sector) to optimise effectively a business performance. CPM is a complex system of organization, automation, planning, monitoring a analytical business methodologies, procedures, processes and systems that are helpful to management.

CPM systems make a process with finished loop. This process begins by understanding of the current situation of organization – where the organization is and what the organization want to obtain. CPM offer to management the aims and džine a steps and resources that are important for attaining of aims. (Coveney, 2003)

Performance Management systems are also acceptable for monitoring of fulfilment of defined goals and give us an information about exceptions and relieves their easier revelation.

We can use CPM/PM for supporting for example following business process:

- Business planning
- Budgeting
- Forecasting
- Consolidations of financial statement, reports and analysis

We have to emphasize connection of this process with methodologies and CPM systems.

This chapter confronts CPM/PM with Financial Management and trys to find some mutual connections/relationship.

Let’s go to put one's mind to some characteristics of Financial Management, that is expressed by following definition: FM is subjective economics activity considered by acquiring of necessary amount of money a capital from various financial resources (financing), allocation of money into various form of non-monetary assets (investing) and dividing of profit (dividend policy) with the goal of maximization an market value the firm’s asset.

- Structure of financial management in a company contain for example following scope:
- Ensurance of financial resources for floatation or development of company,
- The choice of optimal financial (capital) structure with consideration to structure of asset, costs to obtaining various kind of capital etc.
- Funding and managing of short-term assets (reserves, debts and money), finding an optimal forms of shor-term funding
- Investment of money into fixed asset or into financial asset, various methods of long-term funding and evaluation of financial efficiency of investment variation,

- Financial planning of creating and using of internal and external financial resources from short and long point of view

Financial Management of modern company is not a job of one person or section (with the exception of small company) but is dispersed in the whole firm.

Financial Management is primarily implemented by top management (strategic financial question like allocation of resources, dividing of profits etc.). Into the Financial Management have to be included also other employee of the firm that are interested in managing of manufacturing, managing of investment, managing of scientific and technical progress etc. Financial Management is possible to separate into two groups:

- Finance-management group,
- Finance-control group.

The first group is usually oriented on acquisition of capital, management of money in company, relationship of the firms with the banks and other finance institutions, insurance and risks and evaluation of investment drifts and financial planning.

The second group is usually oriented on finance and cost accounting, budgeting of in-house centre, taxation of business and internal checking. There are a financial chief in greater firms, that is responsible for managing working of both of mentioned groups and he is also member of top-management.

Infer from the facts that have been mentioned above passes, that between FM and CPM/PM is mutual interlacing, but this interlacing is very complicated and especially in the scope of business informatics.

From my point of view CPM/PM use almost all principals of financial management and also financial management can make use of CPM/PM system with the goal of automated and secured basic task of financial management.

In the next part of this paper we will discuss problems connected with measuring of economic efficiency of business informatics that are deeply weeded with PM, CPM and FM.

4. Problems connected with measuring

With regard to dynamical development in economic area it is eligible to change access to evaluation of cost and cost efficiency. The same way like here is a change of development in the evaluation of the whole company, the same changes are realised in the measuring and evaluating of business informatics. The tendency of new approach to measuring is expressed in a maximal accuracy of the cost on IT (including time resolution problems etc) and this is made in a maximal decomposition.

The most significant access to measuring belong the methodology TCO (Total Cost of Ownership) that is developed by Gartner. Another significant methodologies solving our question in measuring economics efficiency are ITIL and CobIT. For these and other methodologies is very important to make evaluation for a long time and make this evaluation repeatedly under the same condition and the same model. From this evaluation we can receive data about/for prediction of future trends in our branch.

In the life-cycle of business informatics we work with costs. We have to choose one of a possible technique to account the cost. In the Czech account system we have a log of methods – classification cost by product, classification cost by species etc.

If we choose one suitable methodology to account, we have to go through the phase so-called assignment of cost on each activity of department that is recipient of IT activities/effects or assign cost to defined output.

We take into cost on business informatics these cost species (some of companies can use only subset from cost species): cost on gaining a project (cost pair with creation of a new offer etc.), cost on solving a project (cost on consultants, project managers, developers, testers, depreciation of supplier HW and SW, cost on subcontractor etc.), cost on buying and implementation of technical/SW instrument of operation and servicing (consumption of material, stock, salary of employee, depreciation on HW/SW used to solving operation problems (in case, that material is set to the problem), etc.), hidden costs and another.

In mentioned cost on IT we can found indicator of cost efficiency. This indicator is possible to divide on:

- cost on IT as the percentage on turn-over,
- ration of count of IT professional on count of all employee
- ration of internal IT professional to IT contractors and outsourcers,

- ratio of operational budget IT on one employee

The last but not at least important part is connection between above mentioned cost with measuring of economics efficiency is accounting of cost, gains and their balanced form. We have two basic accesses to measuring cost of business informatics:

- Evaluation executed after investment/at the end of the fiscal period (the results are based on exact data sources)
- Evaluation executed before a start of the investment (the results are based only on prediction of the future costs necessary for the investment – the real sum of money find out at the end of the project may be different from planned results (for example: project can be solved for longer time).

Except measuring cost, that was involved in previous text and measuring profits (that is not involved in this text, because measuring cost is similar to measuring profits), we measure also gains.

The main rule that we will use for the period of measuring business informatics gains is: "The worth of business informatics gains is assigned by owners of business process to that business informatics provide his services". [5]

Gains of business informatics for company constitute additional revenue that can be the effected from implementation and usage of new, until use new information system/application, enhancement of productivity of work that is the effect of new IT/ICT etc.

Measuring of gains represent finding out activity, how much a financial fund brings/saves the particular capital activity (executed project in aid of business informatics) in accounts of company as a whole. As an example we can use above mentioned investment.

Against measuring of cost that is possible to ensure for the mostly part accurately for example through a models or a methodology, but for this domain is situation in measuring of profits much more complicated. During measuring of profits we have to accept that we don't examine only the indicators of economic efficiency for example in account sheet, but this activity is depended on people and their judgement and especially is depended on evaluators standing outside business informatics. To this group we include especially owners of business process. They receive the changes in the business informatics by means of more effectively "their" business process. On this place we see the main terminology problems. Measuring of business informatics is not possible to realized using nomenclature of business informatics but we have to conform to a business

informatics nomenclature to nomenclature of entrepreneurial activity. We have to conform nomenclature to the owners of business process.

The first reason of complication in evaluation is objectivity and sufficient exactness of measuring of an investment in business informatics. The problem is that these activities are cumulated with other activities in business, for example:

- parallel implementation of an investment projects
- parallel investment activity in IS/IT and restructuring/optimalization of business process,
- changes in a style of management

In a context of mentioned facts, we can according to [9] distinguish consequences from an investment action:

- positive – expected –we usually review investment decision making on this results,
- positive – not expected – extra gain that could be based on knowledge of a team member from other project (they "bring forward" knowledge)
- negative – expected – for example effects from selected investment activity like reducing sum of employee, requirement on employee qualification etc.
- negative – not expected – these facts couldn't be identified, but they are very important information source that give us details for identification this problems in the future.

Above mentioned facts are remarked by one important facticity. The dynamic changes in IS/IT branch that have very short period, evaluators have complicated milieu for creating an estimation of sum of gains that is possible to receive from investment project. In generally we can say that the most responsible for estimation of sum of gains from defined investment project are key users in business (or owners of business process). Except determination of the most competent people for evaluation is needed to take into account a cardinal question of cost that we have to expend on assignment of gains and also define a gain of surveying. Among the most significant users/owner of business process are involved (in above mentioned context) for example owners of company, management on middle or top position, owners of business process that are influenced with executed changes in business informatics. Others are representatives of IT staff (IT manager, IT

project manager etc) that execute define change in business informatics or are responsible for implementation of defined change, etc.

4.1. How gains may be measured?

In the context of decision about investment we have to stipulate expected gains from investment project. There is one problem during stipulating – how find out the gain? In case of profits or cost we have a lot of exact data provided by account sheets (in case we make an ex-post evaluation), but in case measuring of gains it is not possible. Account sheets contain no information about gains. None the less our target is to express gains in money unit. But now we have one important question: "How we can say, that implementation of new IS/ICT bring us defined sum of money/gains in defined period?" Is not so easy answer this question. In practice is this make by estimates of anticipated gains. One of current targets on academic ground is a determination of steps how estimate this number to be exact as much as possible. Mentioned estimation cannot be made only by IT management, but there have to be teamwork across the company that mean teamwork among IT department and other department using services provided by IT department. Only department using services provided by IT is qualified to say whether the IT department is or isn't initiating gains and also to define gains in money.

The text mentioned above could contribute to the wrong theory that for recognition an economic efficiency and gains exist a comprehensive methodology and procedures to its recognition and this including metrics. In reality don't exist special and specific metrics for measuring economic efficiency of business informatics. Metrics that we use for evaluation of economics efficiency are generally based on standard economics metrics (for example: ROI – Return On Investment).

If we accept fact that has been wrote above we have to state that ROI cannot be determined only by IT department. In case this index is set only by IT department, it is place for doubts, because IT management hasn't enough data source to find out how many gains this investment project give to end user as a business process owners.

In a light of previous text is important to say that values of gains received from owner of business process are also only estimated. From this reason is important to check accuracy and recency calculated metrics. The company management has to set a rule how often are metrics check for recency.

It is possible to divide the procedures for finding business informatics gains on steps in following text.

Still we have not mentioned one important factor that influences all estimates – the risk. Existence of risk legitimize why fact noticed in this paper are only estimated.

4.2. Evaluating and managing of gains

If we leave away/work out all mentioned critical factor, we can make an evaluation of gains of business informatics and this evaluation pursue in defined period. Before this step we have to divide effect (gains) into four basic groups [9]:

- direct effects (gains) – as an savings of material element, more effective usage of resources, optimisation count of staff, reduction of requirement on supervisor that can be acquaint with new system ex-post and this system give them possibility to concern on systematic managing and planning and not on operative problems solving.
- indirect effects (gains) – that is hardly asset with finance, but they have important impact on another live cycle of firm – for example: enhancement in competitive advantage of our company, improvement of company's name, obtaining of strategy advantage in face of competition through capture new technology that was implemented into business informatics
- negative effects – as a risks that are connected with investment project as a risk based on lack of number of qualified staff or necessity to retrain current employee etc
- planned costs cut off project that represents costs that isn't necessary spend in case the project have been implemented
- Evaluation of cost (in time) is possible to realize using two techniques:
- „Proactive" evaluation – before implementation of investment project – in this case we based our evaluation on hypothetical condition. The most important critical factor is fact, that in this approach condition can change and an effect of this is not precise estimation of gains.
- "Retroactive" evaluation – after implementation of investment project – there is hard to define what is/isn't gains of investment project in this method.

The second access to the evaluation make after implementation of investment project get us more precise input data comprehend to estimation based on first access to the evaluation gains of new investment project business informatics.

Usually are used both access because:

- We haven't any exact data about productivity of the project in the first phase decisions about new investment project. In this phase first access provides us fundamental information about productivity and gets us basic information if our project is/isn't acceptable to implementation.
- In the second phase – usage of implemented project - get us information that are necessary for confirmation/refutation of gains (and eventually get us exact sum of gains). Also in this phase is valid that finding out gains is complicated.

Managing of gains includes in accordance with [9] and [5] following activity:

- definition of IT initiatives and definitions of business domain that are influenced by activities
- identification and structuring of gains and defined method for measuring gains
- analysis of metrics choose domain of our business
- definition of process used for formulation gain in financial terms,
- assignment of responsibility for each defined gain,
- determination of connection between success of IT initiative and improvement of defined metrics for business
- planning of realization of gains and defining of restrictive factors and risks,
- periodically measured development of metrics and interpretation and revision of results,
- changing point where we have found some limitative factor

On this text we can state that the most important and at the same time the most difficult is to define connection between success of IT initiative and improvement of defined metrics of business. For successful solving this problem we have to establish teamwork among information department and owners of business process that are defined as recipient of IT services.

5. Measuring of economics efficiency with the Return of Investment indicator

We suppose the following assignment in which we have to verify:

- whether the costs invested into IS will return to the business themselves, eventually how long does it take
- anticipated average level of costs that are necessary for preservation of an investment in comparison with average annual costs

Evaluation of economics efficiency is based on data provided by creator of the SW and users of the SW.

For fulfilment above mentioned conditions we have to define binding characteristics of firms that are potential users of evaluated IS:

- a company is VAT payer and suppose that the IS will be use for 6 years (depreciation are included in aggregate gains)
- company owns HW necessary for operation IS (HW was written-off)
- company needs 10 licences
- count of exported tours on www for 1 year – 150 kind of tours
- expected count of sold tours over www – 1500
- purchase price of investment – 110.000 Kc.

We will calculate indicator counting with one year aggregate gains. To the group of these gains we can involve: savings based on order with internet, savings based on established “electronic office”.

Calculation of ROI is based on the formula:

$$ROI(\%) = (aggregate\_gains / aggregate\_costs) \cdot 100$$

5.1. Calculation ROI on system A

Our reference travel agency uses system A, estimates saving approximately 25% (approximately 30 Kc) of salary cost per each order make by way of internet opposite to standard order and savings on operating material approximately 15.000 Kc per year. Costs savings extent 25% contain savings that company was able to identify and definitely determine. In cost savings and gains aren’t included:

- gains like new statistical source allow estimates of needs/wish our customers for future periods,
- costs savings based on savings of intermediary charge for selling our trip,
- costs savings based on reducing number of subsidiaries selling our trip,
- costs savings based on reducing costs on using subsidiaries etc.

5.2. Target values we can find out by using the following process:

- acquisition price of investment = 100.000 Kc,
- annual profits from investment for 6 years: 1500*30+15.000=60.000 Kc, where (1.500 = count of trip sold via internet, 30 = costs savings on one trip and 15.000 = cost savings on operating material per year)

Our target in this example is to receive information about duration of time period that is needed for recovery of financial funds on realised investment.

From the process of calculation we find out, that ROI = 54,55%. Recoverability of the system A is high and in the second year of using is the system full pay off.

The gains for 6 years usage of system A will be 250.000 Kc (important: we don't calculate with time-value of money).

5.3. Calculation ROI on system B

Savings of salary cost on one contract estimated by provider of system B are estimated approximately 70 Kc per each order make via internet (estimation in percentage is 25% - the same as in the first system) and costs savings of operating material are 5.000 Kc.

For comparing both systems is important get out the same average salary. Because both systems promote that they have 25% cost savings we can use, as a base for calculating sum of savings, an average salary in travel branch (see [4]). Using this process we find that costs savings on ordered trip via internet are by both systems 30 Kc per trip.

Target values we can find out by using the following process:

- acquisition price of investment = 63.800 Kc,
- annual profits from investment for 6 years: 1500*30+5.000=50.000 Kc,

From the process of calculation we find out, that ROI = 78,37%. Recoverability of the system A is high in comparison with system B and at the beginning of the second year of using is the system full pay off.

The gains for 6 years usage of system A will be 236.200 Kc (important: we don't calculate with time-value of money).

5.4. Consequences and conclusion to findings

Examples show us, that we cannot make decision based on only one metrics/criterion. In our example the investor should preferred system B in case he based his decision only on ROI. In case the firm makes decision based on the second calculation, he should preferred system A. Both of system is better in one of calculated criterion.

In our examples we can see, although time of recoverability based on ROI of system B is shorter in comparison with system A, the aggregate gains could by smaller in comparison with reference system that has longer time of recoverability based on ROI.

During measuring of economics efficiency we usually find out problems, needs etc. Our example is not exception. What problems, needs I consider as the most important? In my point of view it is:

- differences in apparat of concepts used by IT department and other parts of business
- prices of measuring
- sufficient information resources of quality that we need for measuring of economics efficiency
- If we want to make benchmarking we have to find reference business that has similar characteristics as our company. In this case we can find-out whether our state is better/worse than that of the reference company.

We have to notice to our example that in both cases could be profitability and recoverability of investment higher/smaller according to condition that we have accepted more factors connected with investment. Examples are:

- in part of increasing of cost:
- additional cost expended on learning our stuff to use new SW
- increasing of cost on administration of new e-business etc.

- in part of increasing of gains:
- improving of good name of company that can lead to higher marketability our trip.

In our example wasn't this facts included because we want to make demonstrative impact of new investment into financial situation of the company. Other facts is possible to evaluate during the live cycle of an investment (in this case is difficult exactly identify in number express) but in case we make evaluation before realization of an investment – that are only estimates that can be inaccurate. From this reason we have to emphasize that with estimations are connected risks and uncertainty. [6] This is the reason, why we cannot say that established figures are exact and sure. Dispensation is a situation in which we make evaluation retrospectively after realisation of an investment.

6. Conclusion

Measuring of economics efficiency is complicated, time consuming and information demanding discipline that pervades various branches of activities.

One of the hardest activities is harmonization of terminology among concerned IT department and concerned in other parts of company (especially business process owners, accounting specialists, company owner).

Although there were not evident complexity of finding additional information needed for realising of measuring of economic efficiency in practical illustration, this is one of the most critical factor that is connected with this theme.

The last part of this paper (practical part) shows us, that measuring of economics efficiency cannot by carry out by using only one, two or three metrics. In case we make qualify decision, we have to use metrics portfolio that cover all important area that can be influenced by the investment activity. Creation of metrics portfolio is one of the greatest risk factor we have to take into account.

Very important fact is that we cannot set up metrics portfolio (for measuring of economics efficiency of business informatics) that is identically for all company in the Czech Republic / in the world. We can recommend some of metrics that are suitable for company and recommended metrics can be divided into groups that are appropriate for business satisfying defined conditions.

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This paper was financial supported by GA CR trhought the grant project 201/07/0455 „Model vztahu mezi výkonností podnikání, účinností podnikových procesů a efektivností podnikové informatiky“ and IGA VSE „Model of measuring of economics efficiency business informatics“

IT PROJECTS: MANAGING PROCESS PERFORMANCE

Václav Oškrdal[1]

Abstract

This paper contributes to today's efforts aimed towards building up a methodology applicable in process effectiveness investigation of an enterprise, particularly in the area of IT projects management. Measurement and continuous evaluation of core processes performance, provided by the means of dedicated key performance indicators (using an automated information system), is considered to have an undeniable impact on project success. Also, in order to grant the project managers a comprehensive view of the project status, usage of key goal indicators for evaluation of goals achievement at given project milestones is suggested and advocated. As a conclusion, this paper presents the use of modified PDCA model for setting up a supportive source of management information about processes that can be used by the project managers for effective management of their projects. The importance of projects in today's enterprises and the possibility to efficiently apply process approach to their management encourage further investigation of this methodical extension to both the practical and theoretical fields of modern information management.

1. Preface

While developing new information systems, the project managers have to manage the *project processes*. Hence they have to deal with the following issues:

- defining appropriate set of managed processes with respect to the project scope,
- assigning ownership and creating responsibilities for the process owners and
- monitoring performance of each designated process.

It is clear that the overall effectiveness is enabled by well defined project processes, whereas the continuity of operations plays a vital role during the transformation of available inputs to desired

[1] University of Economics, Prague, Czech Republic; vaclav.oskrdal@vse.cz

outputs. But it is also certain that good definition of processes is just a prerequisite. The more cost intensive and complex the projects are, the greater is the importance to have current, exact and unified information about process performance, too – monitoring of processes accordingly becomes a critical success factor.

Acknowledgement of the process monitoring severity leads the project managers to a decision concerning utilization of a dedicated *information system*[2], aimed at detailed process performance measurement. This paper describes how to build up such a system for any and all relevant projects by applying the classical PDCA model. But first, core project processes are identified in order to set firm basis for further investigation, and basics of the performance management concept are presented.

2. Defining Project Processes

In this chapter, both the general approach to project processes and a preferable way to identify them (particularly in the field of custom SW development) are briefly described.

Project is "a temporary[3] endeavour undertaken to create a unique[4] product, service or result" [3]. *Process* is "a set of activities, transforming a set of inputs to a set of outputs (goods or services) in order to fulfill other peoples' or processes' needs, using specific actors and tools" [16]. A pragmatic join of these definitions (i.e. *project process*) becomes handy: when we acknowledge that an IT project is pointed towards developing a new information system, we easily uncover that the whole (development) process can be also viewed as a high-level process. Using a simple method based on the BPML standard [16], the following Tab. 1 should be acceptable as its description (on an abstracted level):

Name	Custom SW Development
Documentation	Contract, Manuals, Development Rules, …
Identity	SW Code Name
Persistent	No
Event	Sales Contact, Management Decision, …
Parameters	Schedule, Requirements, Team, …
Activity Set	Set by Methodology, ISO, …
Compensation	Contract Cancellation

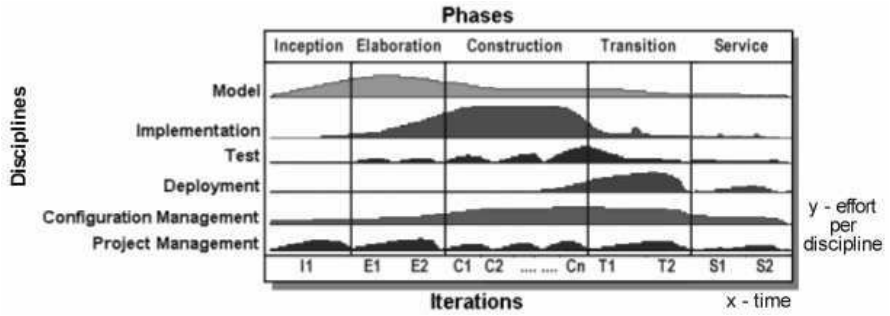
Tab. 1 IT development project top-level process attributes

[2] Inf. system = a structured set of processes, people and equipment for converting data into information [9].
[3] Temporary = has a definite beginning and a definite end.
[4] Unique = is different in some distinguishing way from all similar products or services.

The above listed attributes obviously describe only the *top-level* development process, i.e. "a process that is defined independently of other processes" [2]. It is clear that we need to go at least one level lower to get to some of the "real" project related processes that can be described, managed and monitored in sufficient detail. We need to discuss the *nested processes*[5] and activities. In order to identify the relevant lower-level (nested) processes, the following approach is promoted in this paper: *nested project processes can be easily defined by using a proper project methodology*. This is based on the assumptions that:

- top-down process decomposition is possible on any but the lowest level, therefore it is possible to de-compose any high-level process to either a coherent set of activities, or to a set of lower level processes, whereas the resulting set of lower level processes (activities) may differ depending on the approach applied,
- project methodologies describe the projects' lifecycle in a manner that is in accordance with a downright process approach – no matter whether the project processes are called "disciplines" such as in the Unified Process [12], "light processes" such as in the Feature Driven Development [11] or they are depicted using the "flow approach[6]" of the Value Centric Approach [6].

With respect to this rationale, it should be possible to take advantage of a *basic project processes model* by using most project management methodologies. For example, Pic. 1 shows the project processes of the Agile Unified Process (Agile UP) methodology. These respective project processes (called "disciplines" in the Agile UP) are listed on left axis.

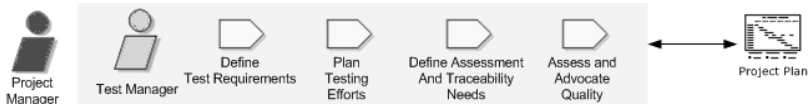


Pic. 1 AgileUP project disciplines, based on [1], simplified

[5] Nested process = a process that is defined to execute within a specific context, since its definition is part of that context's definition.[3]

[6] Frankly, this terminology is just marketing, these *are* processes. This applies for the other mentioned methodologies, too.

In order to support the thesis of project methodology usability for process identification, we need to confront the "traditional" process approach with the picked methodical framework. The following Pic. 2 depicts the Agile UP definition of the Test discipline.



Pic. 2 Test discipline [1]

A "traditional" description of a testing process could be done for example as in Tab. 2.

Name	Test
Documentation	Test Scenarios
Identity	SW Code Name Testing
Persistent	No
Event	Availability of executable product
Parameters	Schedule, Costs, Requirements, Team, Sequences, Scenarios, …
Activity Set	Set by Methodology
Compensation	Project Cancellation

Tab. 2 Test process attributes

When we see through the different terminology used, this simple example confirms that one of the "disciplines" of Agile UP can be viewed as a project process – or at least mapped to fit it – and vice versa. Could this finding be generalized? Yes, that is highly probable[7] - and even more than that with respect to initial assumptions. With respect to the basic principles of several other project methodologies (see [11], [7]), it seems that a likewise approach would be applicable to them too, or, at least, that they could be also easily "cleansed" to provide a feasible process approach to projects. Probably by using almost any appropriate methodology, the managers can be granted a good (starting) view of processes that need to be managed, monitored and perfected[8].

Let's summarize this chapter: project processes can be defined by applying a feasible project management methodology, although, to get clearer view on processes, it is necessary to review the specific terminology that applies in the methodology scope.

[7] To elaborate this hypothesis in detail is out of scope of this paper (it is planned as part of the dissertation), thus an assumption based on background research is accepted as a basis for further investigations.

[8] Discussing other impacts of using project management methodology is out of scope of this paper. For more information, see for example [9], which among others includes the following thesis regarding the importance of management methodologies: "Companies are increasingly looking to project management teams to provide solutions to many of the challenges ... Projects have significant ... components that require management through their life cycle. Projects must comply with the correct standards and guidelines..."

3. Managing Process Performance

In this chapter, the approach to performance management based on usage of KPIs/KGIs – that will be subsequently used in the area of IT projects – is presented.

In the "project management bible" – PMBOK – the basis for general performance management is defined as "an approved plan for the project work against which project execution is compared and deviations are measured for management control" [3].[9] The ways in which a general plan can be defined and the results presented are several. Plan vs. actual costs comparison, earned value concept, capacity forecasting are just few of the methods at hand [15]. But while considering the problem of evaluating processes alone, the possibilities seem to be much more limited – or more precisely (and in accordance with [13]), the principles of process monitoring methods are very likewise. As a rule, the process performance management methods utilize the following two basic sets of indicators as a basis for any common evaluation of processes (based on [13]):

- KPIs – Key Performance Indicators – used for evaluation of effectiveness, timeliness, quality or other performance aspect of the process and
- KGIs – Key Goal Indicators – used for appraisal of the level of achievement of set goal or the value added to achievement of a goal[10].

The distinction between KPIs and KGIs is not perfectly precise even in the primary literature[11]. Thus, it is not that surprising that in praxis, these terms are furthermore blurred by their extensive use for marketing reasons and (especially the KPIs) are sometimes considered almost an "inflation term". But, with respect to the fact that their application as a well described, documented and verified approach to process performance measurement [10] has been already proven, there seems to be more than a good reason for a "rehabilitation" of KPIs/KGIs and a fresh definition of their sense.

As mentioned before, the *KPIs* represent the true foundation of any performance monitoring system – they form a database of structured and controlled knowledge, providing consistent, customer oriented and permanently improved view of the monitored processes. KPIs can be defined for key processes as well as for the supporting processes. Their definitions must differ to capture the nature

[9] In particular, "the performance measurement baseline typically integrates scope, schedule, and cost parameters of a project, but may also include technical and quality parameters." [1]
[10] With slight modifications again – for example in PRINCE2 methodology, the focus would be on product completeness as a universal goal.
[11] See [11] for the original definition of KPI-KGI relation or [NO] for its usage in the area of IT services.

of monitored process in an appropriate manner, but at the same time, comply with their overall application concept. The KPI definition clearly states *what* needs to be done, while their performance goal (target value) states *how well* it needs to be done. Using the KPIs, the following can be achieved:

- unified view of the processes using clearly defined criteria,
- early warning system referring to start-end process monitoring and
- continuously growing basis for process improvement.

In order to achieve the planned benefits, at least the following questions (based on [4]) must be answered in the scope of any and all project processes (see previous chapter for their draft) to define the right set of KPIs:

- What and why should we measure?
- How many KPIs should we have?
- How often should we measure?
- Who is accountable for the KPI?
- How complex should the KPI be?
- How do we normalize the KPI?
- What should we use as a benchmark?
- How do we ensure the KPI reflect strategic drivers?

Results of this questionnaire then must be captured in formalized documents (usually called "KPI Definition Sheet"). Once the KPIs that are to be monitored are defined, their monitoring must be initiated, preferably by means of a dedicated IT tool (more on this topic later). As a result of this approach, a set of clearly defined criteria[12] is assigned to each identified project process and continuously observed – which is certainly a very good basis for management of their performance.

On the other hand, to define the *KGIs* ¨reasonably, it seems that one must pick the "lesser of evils" from various approaches, expanded on the foundation of the probably most widely referred KGI source – the COBIT definition [8]. An attempt to omit all fuzzy, vague and cut-and-try "definitions" of KGIs must be made, otherwise the probability of their misuse (or rather uselessness) is significantly high. To avoid this risk, the following paragraph elaborates only on the original

[12] Detailed method of definition of the KPIs, a full-scale description of their implementation process and their quality aspects are is out of scope of this paper, but will be further investigated.

approach and presents a clear, hands-down concept of KGI definition for the purpose of project-related processes monitoring.

As already stated in the above listed basic definition, KGI measures the level of achievement of its set goal. But what are the goals in terms of project processes? With respect to the preceding chapter, let's apply the following scheme to define a suitable set of project goals and their respective KGIs:

- the generic (top-level) project process, defined by a given methodology[13], usually divides the project lifecycle into several phases with defined milestones[14] (see Pic. 1 again for example, the phases are on the top x axis),
- in order to pass the phase milestone, specific achievements – such as pre-defined "milestone objectives" in Rational Unified Process (or the Agile UP that is used as an example here) [12][15]– must be verified by project manager and stakeholders,
- whether the milestone objectives are met or not depends on the performance of processes in the relevant project phase – thus, by assessing the impact of involved processes on specified goal(s) and monitoring their performance, it should be also possible to continuously evaluate the level of achievement of any goal.

To define the KGIs by elaboration of methodically defined top-level project process goals and their relation to the nested project processes seems to be a very natural and promising approach. The fact that the KGIs and KPIs will be closely related to one methodology applied ensures that they will be built on the same basis, approach and terminology – and also that their dependencies can be further analyzed and exploited.

Obviously, to get proper KGI definitions, it is again necessary to apply a questionnaire, characterization and implementation process analogous to the KPIs – but that is almost a standard-like procedure, already briefly described in this paper.

Let's summarize this chapter: project processes can be monitored by using a set of KPIs and KGIs, defined on the basis of applied project management methodology and its break-down of the project to specific project processes and project phases.

[13] A justification that a project management methodology should be applied to any project is not repeated in this chapter; the usage of methodology is considered as a matter of fact.
[14] A background research proves that this is valid for most methodologies based on waterfall, spiral or value-centric lifecycles.
[15] Again, the "conflict" of various terminologies plays its role here. Milestones, quality gates, checkpoints, ... – in the end, the differences are negligible. The same situation is with goals, called "objectives" etc.

Intermezzo – PPM Tools

When talking about any indicator calculation, what would we expect from it to have confidence that it can be used as a basis for decision making? At least that the indicators:

- are measured in accordance with their definition,
- are understandable, unified and integrated,
- are continuously calculated.

It is obvious that the only way to take the best of KPI/KGI utilization is their implementation in an IT supported tool. More specifically, for example the indicator presentation should also include analysis of the KPI/KGI using at least these views:

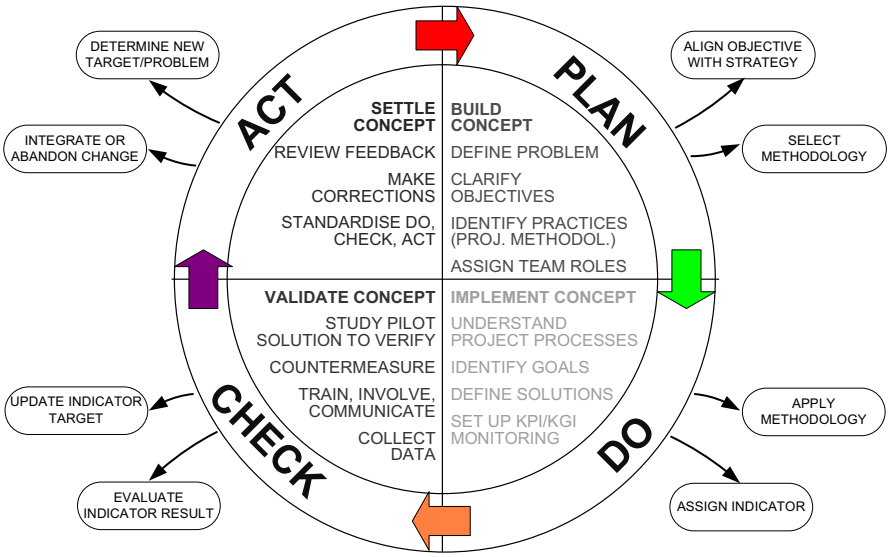
- status on defined measuring points, planned and actual value, history, trend,
- graphic representation of indicator evolvement (conforming the definition) and
- causality examination – drilldown to calculation source data.

These are the few of many requirements that could be introduced. They are listed to confirm the hypothesis that the usability of the concept is almost impossible without a usage of a dedicated IT tool. On the other hand, the fact that such tools are on the market confirms that there also exists the demand for them and the concept is not just theoretical.

4. Setting up Process Performance Management for an IT Project

In this chapter, the usage of an extended PDCA model is presented as a method for setting up process performance management for IT project(s).
The keynote of this year's IDIMT conference Information Management section by Petr Doucek confirms that traditional approaches are still used to set up a new concept in an enterprise. More specifically, he advised the usage of PDCA model and therefore this model is also referred in this paper[16]. The Pic.3 shows the PDCA model applicable for set up of IT project(s) process performance management (PPPM).

[16] PDCA cycle is a way of continuously checking progress in each step of an improvement process. [14]



Pic. 3 PDCA model for process performance management set up

The main activities of each phase can be found in the picture and therefore will not be presented again. Nevertheless, to illustrate how a "roll-out" of the project process monitoring to the organization could be done, key outcomes of each phase that would take place during the pilot project – i.e. the initial set up of PPPM – are listed.

Plan phase would be aimed towards investigating the possibilities, boundaries and objectives with respect to the core business overall strategy and definition of plan for the remaining parts of the set up process. The *Plan* deliverables would include:

- selected project methodology (for defining processes and indicators) and
- approved PPPM roll-out plan with assigned responsibilities and milestones.

Do phase would be aimed towards detailed analysis of the problem area, implementation of monitoring system and enlightening of key users. The *Do* deliverables would include:

- defined project processes and KPIs/KGIs aligned to selected methodology and
- implemented IT system providing continuous monitoring of processes.

Check phase would be aimed towards continuous support of new solution, evaluation of monitoring results and validation of I/O data. The *Check* deliverables would include:

- verification of provided process performance results and
- suggested countermeasures to improve implemented solution.

Act phase would be aimed towards correcting and standardizing the outcomes of previous phases, reviewing feedback and making corrections. The *Act* deliverables would include:

- decision about promoting or abandoning countermeasures and
- definition of new cycle goals, e.g. additional indicators, updates of SW etc.

As a result of the first PDCA cycle, a process performance management would be set up for the given IT project, including the backbone software solution. Thus, with respect do the selected project management methodology, its processes would be described and monitored using defined KPIs. The achievement of goals of all project phases (defined by the methodology, too) would be continuously monitored via the given set of KGIs. A first set of mitigation actions (rather "quick fixes") aimed at improvement of the recently created solution (in terms of the process description, indicators, software, etc.) would be applied. And, at last but not at least, a goal for next PDCA circle would be defined.

It is clear that a follow-up for another project – or project portfolio – should be done with respect to the pilot results. Of course, the background and know-how built during the pilot project (especially the IT solution) could be used, providing significant savings.

5. Conclusion

This paper briefly introduced the concept of process performance management application in the area of IT projects. It showed how a usage of a proper methodology (and software tools) for the process performance management purposes can bring new quality to project management methods and induce continuous project processes optimization. However, several issues identified in the paper – such as an extensive methodology review and evaluation – must be yet elaborated in prospective research.

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PERFORMANCE AND EFFECTS OF CORPORATE INFORMATICS

Jan Pour[1]

Abstract

The paper is aimed at the important aspects of IT business value. That means it should cover some basic principles of IT performance management and of the management IT effects. It presents the results of company surveys executed among three groups of respondents in Czech business - top managers, middle-management workers and IT managers. Respondents come from companies of various sizes – from small to big – and act on markets of various sizes (national to world-wide). The paper is divided into the following parts:

(1) discussion of some principles and approaches to IT performance management,

(2) analysis of really reached effects in companies in the view of their content, significance for company and then according to the level of their management, measuring and evaluation,

(3) analysis of effect sources, i.e. main components of the corporate informatics and their management.

Key words: Corporate Informatics, Business Effects, Performance

1. IT Performance management

IT performance management is based on the general principles of performance management applied in various levels and field of management. The basic approach as a CPM (Corporate Performance Management) has been defined by Garter. The further fields of performance management have been formulated as follows:

- Marketing Performance Management

[1] Department of Information Technology, Faculty of Informatics and Statistics, University of Economics, Prague; pour@vse.cz

- Sales Performance Management
- Contact Center Performance Management
- Employee Performance Management
- Product Performance Management
- IT Performance Management

This paper is focused on the last item. According to the PM principles such oriented solution should encompass 4 basic components:

1. Methods and methodologies applied in the performance management
2. Performance management processes,
3. Metrics
4. Applications such as dashboards, scoreboards etc.

The concept of IT performance management presented in the paper is documented on the next figure.

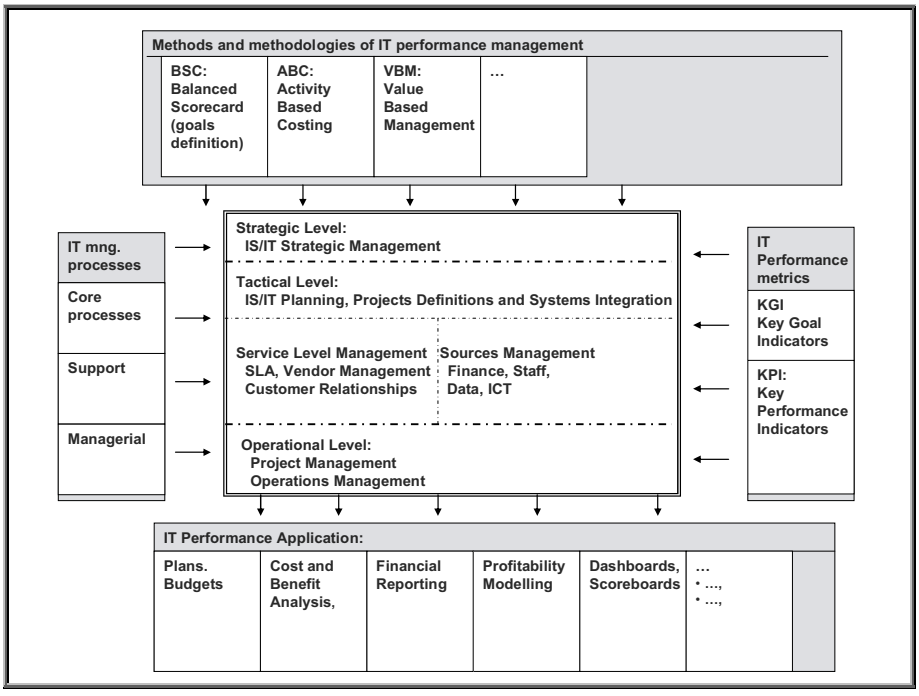

Figure 1: The Concept of IT Performance management

The concept of IT performance management includes the 4 components mentioned above. Then they must be defined in more details from the point of view of all levels and management domains described in the middle of the figure.

The metrics and applications are based on the Business Intelligence principles and technologies. So they are providing all needed views and analysis of the costs and IT effects for the company. The further parts of the paper are focused especially on some approaches to the effects management as a most significant part of IT performance management.

2. Effects of informatics and their management approach

Effects connected with an increase in process capacity of the company and the quality of its management prevails on evaluation of achieved effects in the informatics according to their **content definition** (see Tab 1).

Tab 1: Informatics Effects Distribution According To Their Content Essence (in % of respondents)

	Informatics	Middle .Man.	Top Man.	Total
Direct Benefits	33	6	6	21
Added Value	13	9	0	10
Economical Effects	19	36	12	23
Company's Position	10	33	29	20
Process Efficiency	37	33	47	38
Management Quality	46	36	71	47

Source: Own survey

Answers, which accentuate the economical effects, are in the middle. On the other side, the use of the informatics as an added value to the basic offered products and services, e.g. in support of project and design works (e.g. in construction and furniture industry), consultancy services etc. is shown as very low. Furthermore, there was no positive answer in this case of top managers.

The distinction of informatics effects is, due to its use on the market, a key based on the **significance for company**. The breakdown of respondents´ answers is illustrated in Tab 2. The prevailing part of the answers is related to the basic assurance of serviceability of a company, i.e. accountancy and financial operations, common business transactions etc. This value was the highest in all three groups of respondents, with top management group representing nearly 80 % of the answers. Similarly it is with values of increasing of total efficiency of a company (i.e. process, managerial and analytical). Significance is also given to the strengthening of the company's image both in top management group and middle management group. On the contrary, the image has an insignificant share in informatics group.

Tab 2: Distinction of Informatics Significance For Company (in % of answers)

	Informatics	Middle Man.	Top Man.	Total
Strategic Importance	40	33	18	35
Competition Advantage	27	24	35	27
Competitiveness	22	30	24	25
Company's Image	16	33	41	25
Efficiency	42	52	65	48
Serviceability	54	64	76	60

Source: Own survey

Portions of answers in the case of the strategic importance of the informatics, or importance for the competition advantage and competitiveness may appear as relatively low. However, in comparison with the situation in the past it represents a significant move; at that time the informatics only meant a basic serviceability of a company. With respect to yet more increasing number of progressive applications we can expect even further positive development in this area. A limiting factor represents the ICT qualification of managers, yet even here we can see desirable changes.

Tab 3 shows respondents´ preferences for the measurement of effects of the informatics. Direct financial indicators domain. Only a small part of the companies do not measure the effects at all. So-called soft indicators are preferred mainly by the group of informatics, whereas middle management inclines clearly toward the combination of hard, direct indicators and soft scaleable values. In any case these results imply a positive change compared to the past, when the opinion that the influence of the informatics can be measured with difficulty or not at all was prevailing in practice. This change is caused by already mentioned pressure of the competition and by companies owners on the direct determination of the effects, but also by the development of methodologies and models, which are used in this area more often.

Tab 3: Forms of Determination of Effects of Informatics (in % of answers)

	Informatics	Middle Man.	Top Man.	Total
Financial Indicators	33	27	41	32
Non-financial indic.	24	27	0	21
Soft Indicators	30	12	24	24
Combination	25	52	0	29
Nothing At All	12	15	18	14

Source: Own survey

The quality of the informatics and its actual effects are normally linked also to the way of their planning within the whole management of the corporate informatics. On managerial level, the planning is systematical and regular only in a small number of cases; the proportion of the planning of the effects together with the preparation and assignment of new projects is higher, which results

from existing methodologies. On the other side, only in a very limited number of organizations the effects are not planned at all.

Tab 4: Way of Planning of Effects of Informatics (in % of answers)

	Informatics	Middle Man.	Top Man.	Total
At project assignment	45	15	35	34
Regularly	39	33	18	34
Randomly	9	45	29	24
Not at all	6	8	18	8

Source: Own survey

The basic impacts on the success is in this case apparently the pressure for determination of the real effects already within the project solutions and also ever more intensive need on standard project methodologies, which directly demand the specification of the target effects for each proposed project.

A favorable proportion of answers can be seen in time distribution of the analyses of actually achieved effects, which are carried out continuously or in regular time intervals; analyses after project completion are significantly less frequent. The effects are not analyzed at all only in a negligible number of companies (see Tab 5).

The answers are mainly favorable (57 % of companies relate effects to individual corporate processes, 37 % don't) for the evaluation of relationships of the effects of the informatics to the individual management areas, or key corporate processes (e.g. order management, maintenance management).

Tab 5: Way of Evaluation of Effect of Corporate Informatics (in % of answers)

	Informatics	Middle Man.	Top Man.	Total
At project closure	30	12	13	23
Regularly	35	26	27	32
Continuously	18	29	20	21
Randomly	13	24	20	17
Not at all	3	9	20	6
Other	1	0	0	1

Source: Own survey

The trends relates to the insistence of the management on a clear allocation of the liability of the users not only for expensed ICT costs but also planned and actually achieved effects. The actual interest in shortening of running times of the corporate processes and increasing of their flexibility changes approaches and priorities in management and operations of ICT.

3. Sources of Effects of Informatics and their Management

Sources of effects of the informatics are divided into personal and financial (i.e. informatics costs) and then applications, services and innovation methods of the informatics.

A level of the HR set-out of the company is a decisive resource impacting the quality of the information system. Users according to management levels and specialists of ICT departments can be included into the HR. The actual users determine the final effects of the informatics at a decisive rate, for the high-quality ICT and related investments may be completely depreciated in hands of incompetent and de-motivated users. Therefore the analytic companies assume a significant increase in investments into the qualification programs for users.

According to the evaluations of the partial results of the survey and practical experience, the problem seems to be an appropriate structure of the qualification programs oriented mainly on the possibilities of the use of the implemented applications with respect to the needs of a company. The actual insufficiencies related to the incorrectly oriented qualification programs lead often to the functionality of the high-quality application software being used in practice in some cases only around 30 %.

Even with the prevailing number of big companies among the respondents (above 250 workers) prevail subjects with departments of 1 to 3 workers. There are only 34 % of big ICT departments (with more than 20 workers). This clearly illustrates strong tendencies towards outsourcing not only for system development but also for their running. The tendency towards all sorts of outsourcing and thus orientation on external specialized services is definite here. Decreasing of the number of own informatics is often also lead by the determination to decrease costs and thus reaching better price-and-performance ration of the whole system.

Tab 6: Classification of Companies According To Number of ICT Workers (in % of answers)

	Informatics	Top Man.	Total
1 – 3	28	25	27
4 – 9	17	25	19
10 – 19	12	19	14
20 – 49	8	6	7
50 – 99	8	6	7
above 100	25	0	20

Source: Own survey

In cases of ICT applications it has clearly resulted from the survey that the decisive use has standard enterprise ERP systems in the companies. By individual application modules, in

companies are operated e.g. financial modules (71 %), modules for management of sale, purchase, warehouse (65 %), HR management (71 %), production management (41 %) etc. The utilization of currently highly perspective BI application was very different according to their types. Definitively the biggest use has the standard reporting. The use of data warehouses as the core of a BI complex is on 30 %, which represents a favorable movement, but in comparison with the Western Europe (50 %) or even USA (80 %) it is still a very humble number. Similarly, the use of data-mining applications is very low.

In e-business area, applications of e-commerce dominate, i.e. applications ensuring usually the sale through business web applications to the end users (see Tab 7). It is obvious that in this case these are mainly companies of a retail nature, which impacts the utilization scope. The use of roles of e-procurement is very low, i.e. applications and tools ensuring direct communication and business links between two companies. These results are partially compensated in the actual use of e-marketplaces and systems of supplier chain management.

Tab 7: Use of E-business Applications (in % of answers)

	Informatics	Top Man.	Total
E-shop	22	12	20
E-procurement	3	6	4
E-marketplaces	7	6	7
Supplier chain management	7	12	8
Mobile commerce	0	0	0
Other applications	3	0	2

Source: Own survey

Applications complex, so-called enterprise content management (ECM) shows higher use, mainly with applications of tools of clearly infrastructure nature (e.g. document management, groupware, web content management, and workflow) – see Tab 8.

From the perspective of the company's performance is the scope of the use of workflow management important and with its integration into other application products (e.g. EPR) it can be expected its further positive progress.

Tab 8: Use of Enterprise Content Management Applications (in % of answers)

	Informatics	Top Man.	Total
Groupware	39	41	39
Document Management	43	47	44
Workflow	36	29	35
Web Content Management	33	35	33
Product Management (PLM)	7	6	7
Multimedia Management	6	12	7
Knowledge Management	13	18	14
Other	0	0	0

Source: Own survey

Finally, corporate informatics costs are around 5 % of the company turnover on average. The important role is played by the industrial orientation and other company characteristics. Still relatively high costs enforce the execution of analyses specifically for the informatics.

A frequent problem of cost analyses in the informatics is however the availability of required detailed source data from the analytical accountancy. Perhaps the most interesting observed fact is that 51 % of the companies allocate the informatics costs to individual departments, with companies where the costs are paid from budgets of specialized departments (21 %) and companies where they are paid from the ICT department budget (30 %). This is a relatively high percentage, mainly with making provision for the problems, which are brought with such allocation exactly in the informatics (e.g. re-calculation of infrastructure costs and costs of some services, questions of the license policy of the suppliers and other). Positive movements in this area can be credited to the increasing interest of the managers

4. Conclusion

The quality of business informatics has gradually become one of the key resources of the competitiveness of companies and organizations. It is influenced by many factors, mainly the level of rendered informatics services, and the quality of application within business information systems and also the degree of the quality of business informatics management.

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This paper was elaborated with the support of the research grant GAČR GA201/07/0455 „Model vztahu mezi výkonností podnikání, účinností podnikových procesů a efektivností podnikové informatiky“, research grant GAČR 402/05/2210 and MŠMT 1M0524 (výzkumná centra).

INNOVATION MANAGEMENT FRAMEWORK "INNO IT"

Eva Šimková, Josef Basl[1]

Abstract

The main topic of this paper is IT innovation management which is very up to date theme. IT innovation should be managed jointly with the IT Governance to support effectiveness of IT and competitiveness of the whole company.

This paper introduces new process approach to IT innovation management the "INNO IT Framework". The framework is intended as guidance tool for managers and IT practitioners who manage innovation throughout its entire life cycle within an IT department. The INNO IT Framework provides a set of well structured processes that help practitioners to govern the innovation. The benefits of the framework may be realized by companies of any size or sector using extensive IT support to achieve their business goals.

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

1. Role of innovation in IT

To discover the importance of IT innovation management an analysis has been made. Notions about the importance of innovation management can be found e.g. in European Commission working group programs (European Commission, 2006), at a company level (3M, PricewaterhouseCoopers) and in a research agencies (Gartner).

A PricewaterhouseCoopers study on innovation identifies key sources of innovation (Rozwell, 2002):

[1] University of Economics, Prague, Czech Republic; {simkovae | basl}@vse.cz

- 46 % originate from customers, suppliers or market intelligence
- 29 % originate from employees
- 11 % originate from specialists
- 9 % originate from R&D
- 5 % originate from competitors

This study identifies that 49% of innovation originates from within the company. This represents internal innovation opportunities that need to be managed and integrated with the global enterprise strategy. That substantiates the motivation to integrate the IT innovation management framework with the IT Governance. External innovation impulses are represented by 46% of market innovation (customer, suppliers) and 5% of competitors' innovation. In order not to lose a market share, company should be flexible in reaction to these external innovation impulses. To do so, a managed process for innovation should exist.

Despite this obvious need for innovation management a Gartner research discloses, that not all companies are ready: "Innovation represents a strong impulse for enterprise growth strategy. However, according to a 3M innovation survey, fewer than 40 percent of companies have formal procedures in place to manage innovation." (Rozwell, 2002).

As another Gartner study predicts innovation management will be crucial to retain competitive: "Organizations that consciously integrate change management best practices into their evolving innovation management strategies will realize a 40 percent improvement in innovation shelf life and cycle times over their traditional competitors (0.7 probability)." (Young, 2001).

The analysis has discovered that innovation is the corner stone for the sustainable development and competitive edge. For this reason, the author assumes an innovation management model, or framework, should be of a significant value.

2. Coverage of innovation management within existing approaches

An analysis aimed at identifying available innovation management frameworks has been performed.

2.1. Czech Republic

U-SME Innovation - Design of a model for joint university-enterprise innovation, (University of West Bohemia, Pilsen 2001), Leonardo da Vinci project. (University of West Bohemia, 2001)

This project is focused on identifying an innovation potential within SMEs and then to educate these companies how to work with innovation. The specifics are in anticipated cooperation between the university and the company.

The project is focused on searching and developing innovation opportunities. It has two main parts:

- Company assessment – it uses a Map of the company innovation potential - Questionnaire for the company assessment and the methodology of its evaluation
- Training delivery

The project focuses on manager techniques and soft skills in innovation management.

The U-SME Innovation model is a good step forward in managing innovation; however it does not cover the role of IT in innovation support, or the complete IT innovation lifecycle within the company. It provides a set of advices or questions that should help companies realize the importance of innovation, however it is not a process framework that could be adopted by a company as a part of its IT Governance.

Business information systems innovation methodology (Metodika inovace podnikových informačních systémů) – Ing. Radim Bohuslav, University of West Bohemia, Pilsen 2006 – PhD thesis. (Bohuslav, 2006)

The thesis is focused on business information system innovation for which it suggests a new methodology. This methodology covers IS functionality, SW decision support, data, IT management, IT processes, IT personnel and information and communication technology. A seven degree innovation scale is defined for each of these areas. The methodology further suggests mathematical models for dependence between innovation degrees and way how to decrease cost of innovation. The designed methodology uses approach similar to CMMI (Capability Maturity Model Integrated) to describe the degree of innovation at each level. For the purpose of innovation management in IT this methodology is too high-level.

2.2. Worldwide

TRIZ is a romanized acronym for Russian “Теория решения изобретательских задач” (Teoriya Resheniya Izobretatelskikh Zadatch) meaning "The theory of solving inventor's problems" or "The theory of inventor's problem solving". It has been developed by a Soviet engineer and researcher Genrich Altshuller and his colleagues starting in 1946. Today, TRIZ is a methodology, tool set,

knowledge base, and model-based technology for generating innovative ideas and solutions for problem solving.

TRIZ provides tools and methods for use in problem formulation, system analysis, failure analysis, and patterns of system evolution (both 'as-is' and 'could be'). TRIZ, in contrast to techniques such as brainstorming (which is based on random idea generation), aims to create an algorithmic approach to the invention of new systems, and the refinement of old systems.

Some TRIZ is in the public domain. Some TRIZ resides in knowledge bases held by commercial consulting organizations. A complete and open TRIZ development process is not yet evident.

Gartner Innovation Value Chain covers high level structure of the main building blocks for the innovation in the company. It integrates them into a closed system.

These process areas are:

- Strategic Management
- Human Capital Management
- Knowledge Management
- Innovation Management
- Innovation Capital (IC) Lifecycle Management

The innovation value chain helps to:

- Clarify organizational context
- Identify, acquire and maintain knowledge resources,
- Explicit information, knowledge and competencies
- Assemble and focus resource teams on explicit innovation goals
- Manage innovations as assets
- Repeat, factoring asset portfolio into strategic management decisions

This model provides very high level view on what should be done, however it gives no guidance about how this should be done.

2.3. IT Service Management and IT Governance frameworks

Nowadays, number of frameworks exists to assist in managing the organization as a whole, or in part e.g. IT department. Let’s name some of the internationally recognized ones: CobiT, eTOM, ITIL, M_o_R and others. Those frameworks are more or less focused on some area with overlaps to others.

An analysis of IT Service Management and IT Governance frameworks has been performed. List of frameworks that have been analysed:

- Information Management (IT Service Management): BiSL, ISPL, ITIL, eTOM, ASL.
- IT Governance Frameworks: AS 8015, CobiT, M_o_R.

These models focus on how to govern the business to IT relationship and how to run the IT services effectively and efficiently aligned with the business needs.

Generally, IT Governance and IT Service Management approaches are aimed at operational or strategic management of the IT or company. It focuses on activities performed on daily basis, as well as on those interconnected with the company strategy further reflected in IT strategy. Nevertheless, these approaches lack any connection to innovation management, which is a key driver of the competitiveness. Innovation management may be viewed as part of the company strategy; however existing approaches are not specific in covering this issue.

2.4. Summary

Analyzed models provide little or no information as how to deal with an innovation cycle in IT. A partial coverage has been identified within the Leonardo da Vinci project, Methodology for innovation of business information system – PhD thesis, TRIZ and Gartner Innovation Value Chain. However the level of detail or the scope is not sufficient to cover the whole innovation management process.

This is the motivation for creating the INNO IT framework as the authors of this paper lack proper coverage on this issue within the approaches available.

3. INNO IT Framework

3.1. The objective of INNO IT Framework

To fill this missing area the IT Innovation Management process framework “INNO IT Framework” has been developed covering whole IT innovation lifecycle. The objective of the INNO IT Framework is to help companies successfully adapt to external innovation, thus retaining their competitive edge, and to develop the innovation impulses internally to gain an overall competitive advantage. Integration with existing processes in IT is crucial therefore the INNO IT Framework has been designed to fit into existing IT Service Management and IT Governance approaches such

as ITIL (ITIL, 2004) or CobiT (ISACA). INNO IT follows the high level structure of process description similar to the CobiT framework because INNO IT focuses on the strategy process level for which a high level process description is suitable.

INNO IT framework mission:

To define an IT innovation process framework for adoption by enterprises and day-to-day use by business managers and IT professionals.

3.2. Framework Structure

The INNO IT Framework defines a set of domains and further detailed processes with defined goals and measurable objectives.

The INNO IT Framework defines following 4 domains and 10 processes:

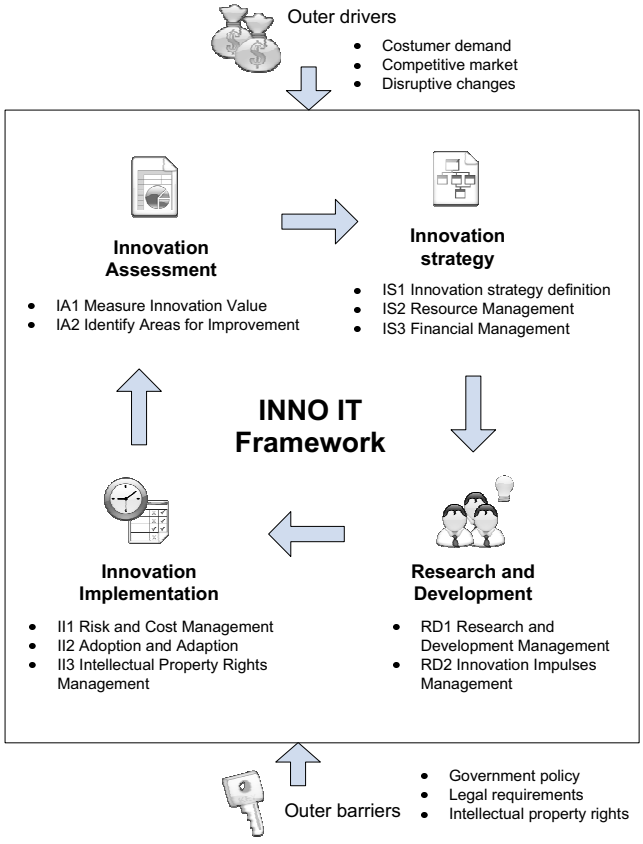


Fig. 1: INNO IT Framework domains and processes

For each process the information in the structure below is defined:

- Process Description
- Activities
- Deliverables
- Competencies

Further an approach to implement the framework into a real life is designed, including:

- Innovation Scorecard Assessment
- Innovation Maturity Model
- Key deliverables checklists

The INNO IT Framework is designed as a “plug-in” framework into an IT Governance model. Thus the INNO IT Framework may be integrated with existing processes in the company. The design of the processes is aimed at readiness for use and minimum of the office work.

3.3. Stakeholders

An innovation process framework needs to serve a variety of internal and external stakeholders, each of whom has specific needs and goals.

3.3.1. Management

Goal: Innovation as a profit-making investment
Value from the INNO IT Framework:

- Information for investment decision
- Risk management
- Portfolio management – what services and products to provide
- How to distinguish the company from its competitors
- Long term market positioning

3.3.2. Employees

Goal: Interesting work
Value from the INNO IT Framework

- A defined approach to deal with innovation ideas

- Innovation oriented company culture
- Knowledge management and sharing
- Personal growth and competencies development
- A systematic way how to develop and innovation from an idea to a real life product or service

3.3.3. External Customer

Goal: New products or services on the market

- Value from the INNO IT Framework
- New impulses for the market
- Innovation driven supply
- Innovation as a tool for costs reduction and quality improvement
- New market segments opened

4. Examples

This chapter shows excerpt from the INNO IT Framework – domain, process description, maturity model and deliverable checklist.

4.1. Domain IS Innovation Strategy – domain example

This domain aligns IT strategic planning and innovation management. Business requirements on IT reflected in the IT strategy should incorporate an approach to both business and IT driven innovation.

4.1.1. Process domain checklist

This domain typically addresses the following management questions:

- Does the IT strategy encompass the innovation aspect?
- Are the right people with right skills available?
- Are physical assets to support the innovation available?
- Is there funding policy and budget for innovation?

This domain encompasses the following process areas:

- IS1 Innovation strategy definition

- IS2 Resource Management
- IS3 Financial management

IT strategy definition is necessary to manage and direct the IT innovation approach and its priorities. The IT innovation strategy should bring optimal value realized from the research and development and future market launch.

4.2. IS1 Innovation Strategy Definition – process example

4.2.1. Process description

IT Innovation Strategy should be defined and aligned together with the overall corporate strategy for innovation and development. The Innovation Strategy Definition process ensures that resources are used in line with the business strategy and priorities. The goal of the innovation strategy is to define how would IT react on innovation from the business site to support it and how the IT would manage and govern the innovation from within and populate it up to the business. The Innovation Strategy improves the key stakeholders' understanding of opportunities and limitations of IT innovation, to assess the risk, potential and investment required.

Metrics

To measure correct operation of this process, following metrics may be used e.g.

- Percent of IT innovation objectives in the IT innovation plan that support the strategic business plan.
- Percent of IT innovation objectives in the IT innovation plan that represent an IT driven innovation with a real value to the business.

4.2.2. Activities

Define Innovation Strategy

Align the business innovation strategy and governance of requirements on IT innovations whilst being transparent about opportunities, benefits, costs and risks. Bring together business and IT management to discuss areas of strategic development a future perspective trends.

The Innovation Strategy should be defined for 3-5 years horizon as a vision, for 1 year as a strategy with set goals, milestones and metrics. Fulfilment of the Innovation strategy should be done at least quarterly.

When defining the Innovation strategy, a research focused on market, competitors, new patents in a given area, new scientific discoveries and other sources of either market or abrupt innovation impulses must be performed.

For each key area (service, product or process approach) following set of steps should be performed:

- Set business priority and severity
- Identify risks and its mitigation
- For areas with high priority and/or severity, prepare a business case
- Based on business case and risk analysis, decide how to react on this area and incorporate this in the Innovation Strategy.

Set business-IT interfaces for innovation

The interface should allow involving IT into business or market driven innovation along with the IT suggesting use of new processes or tools as a matter of IT driven innovation. This interface must be flexible enough to be able to react upon a market or technology abrupt changes quickly.

Set and foster innovation culture

Develop strategies to deliver the IT innovation value across the whole organization in a transparent and effective manner with special regard to company business needs and preferences and significant market signals. Provide an evaluation and prioritization scheme for the innovation ideas. Do not punish for bad success of once approved and funded innovation idea. Set all employees into an "innovation positive" mode. To do so, a motivation and benefit system should be set up.

4.2.3. Deliverables

Innovation Strategy

The innovation strategy should reflect business and IT priorities with respect to IT opportunities and limitations and assess the investment level required. The innovation strategy should be understood and agreed upon by both management and IT and should be further decomposed into action plans with established objectives, tasks and measures.

Business-IT innovation interface – Prioritization committee

The interface may be physically represented by a process or even better by a committee consisting of business and IT representatives. This committee should be sitting at least once in a month.

Innovation reward system

This system should grant a reward for an innovation incentive leading to a real innovation service, product or process. To ensure the broad acceptance of such a system easy and fair rules for benefits must be defined.

4.2.4. Competencies

Skills needed to accomplish activities within this process:

- Management skills
  - Vision making
  - Strategy development
  - Business impact analysis
  - Negotiation
  - Facilitation
- Marketing skills
  - Market monitoring
- Human resources skills
  - People management
  - Innovation reward system setting
  - Culture changes management

4.3. Innovation Process Maturity Model

The process of Innovation Management is:

0 Non - existent when

Innovation Strategy and processes to manage innovation is not defined. The enterprise has not recognized yet the importance of aligning innovation strategy with business and IT strategy to sustain the future development.

1 Initial / Ad Hoc when

The company understands the importance of addressing innovation strategy together with business and IT strategy; however the innovation strategy does still not exist and processes are realized on an as-needed basis rather than systematically. A defined way to identify, promote, prioritize and manage innovation ideas and impulses does not exist.

2 Repeatable but intuitive when

Innovation strategy is created and discussed with IT and business on as-needed basis. Innovation is managed casually project-by-project with no company-wide and business to IT aligned strategy. Some of the Innovation processes exist but are fragmental and undocumented. The innovation is purely reactive to outer stimuli. Innovation risks and opportunities are identified randomly in an intuitive way.

3 Defined when

Innovation strategy definition procedure standardizes tasks that should be performed, roles responsible and interaction with business and IT strategic plans. Since the procedure only documents existing practices, there are no procedures and measures to examine the process. Innovation strategy is discussed with business and IT on a regular basis. A consistent process to identify, promote, prioritize and manage innovation ideas, impulses and risks does exist.

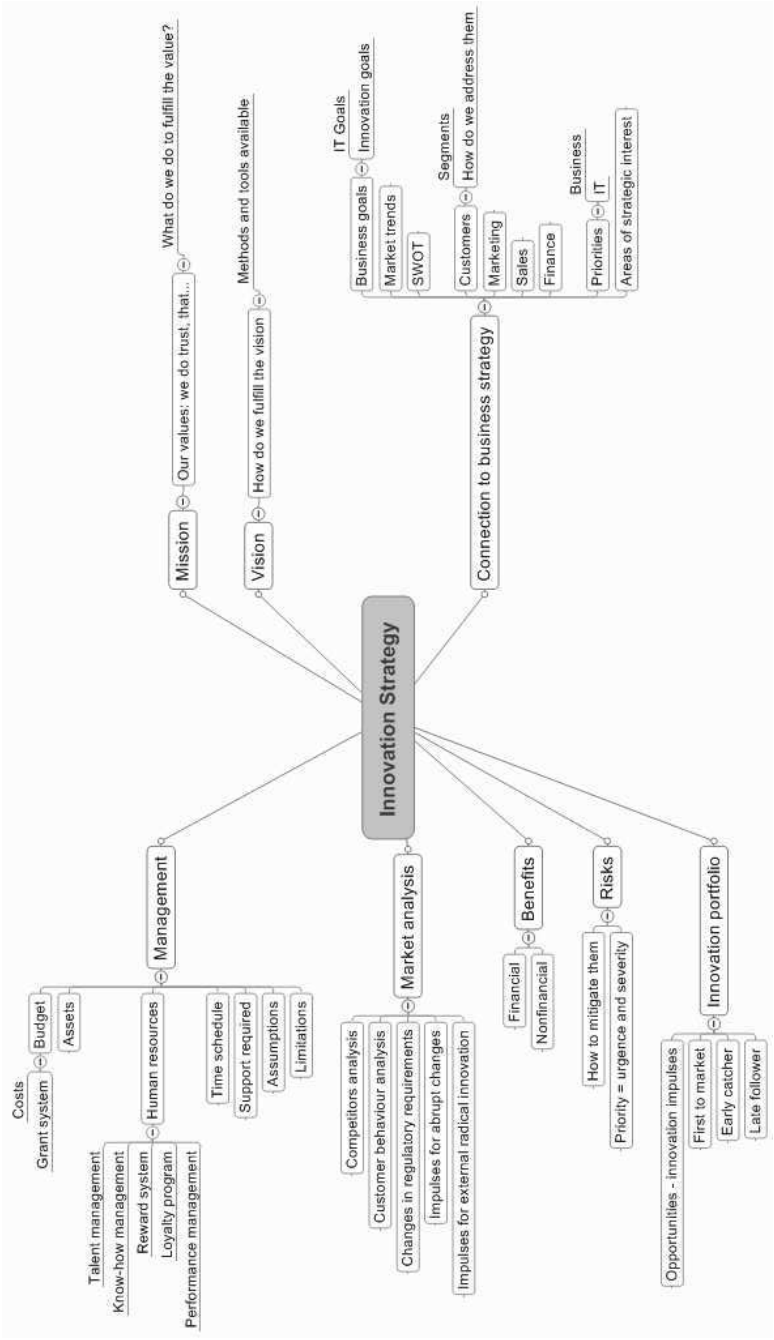
4 Managed and Measurable when

Management has defined measures to regularly evaluate adhesion to the defined Innovation strategy and process. Based on the results of the monitoring management can adopt a decision for future time period and ensure continuous improvement and refinement of the innovation strategy. A sophisticated IT support is not implemented for this function.

5 Optimized when

The Innovation strategy as well as innovation processes are well defined, documented and continuously discussed with business and IT to identify how it adheres to company-wide strategy and where possible areas for improvement could be identified. Innovation impulses are systematically evaluated for risks and business benefits. The strategy reflects the innovation not only from the reactive perspective, but also seeks for proactive innovation impulses through market trend analysis adding a competitive edge to the company.

4.4. Innovation Strategy – Deliverable Checklist



5. Conclusion

The importance of innovation is broadly understood and it proves that the speed and efficiency of the dissemination of innovation through the economy is critical to productivity and economic growth. To realize value from breakthrough ideas with realizable business value, enterprises must focus their effort to address critical issues and develop innovation representing a critical business edge.

Since the innovation has its specifics and the innovation management process is not satisfactory covered within existing approaches, the INNO IT Framework has been developed as an initial effort to help the innovation management at the corporate level. The INNO IT Framework is the main contribution of the author.

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Information Management

APPLIED INFORMATION MANAGEMENT – MANAGEMENT REFERENCE MODEL – SECURITY METRICS

Petr Doucek[1]

Motto: ***Information management is the conscious process by which information is gathered and used to assist in decision making at all levels of organization. (Hinton, 2006)***

Abstract

Information management as a discipline of science applies system approach and managerial techniques, methods and tools in the area of IS/ICT (Information Systems and Information and Communication Technology) and integrates them all in one unique coherent system – Management of Information in an organization. This system of management is complex and could be investigated from several different points of view and different aspects of it could be underlined. More and more, increasing IS/ICT influence practically on all human activities started rapidly higher our society dependence on information systems and its availability, reliability, confidentiality – security of ICT. This contribution offers basic steps how to plan and to improve an effective information security management system (ISMS). General basis for this system are ISO/IEC international standards and practical experience in real project security projects in Czech and international corporations. The most effective ISMS system improvement is in two hierarchical levels – the first level is represented by general PDCA approach to problem solving and the second level is proposal, improvement and maintenance of information security system indicators - metrics.

[1] University of Economics, Prague, Faculty of Informatics and Statistics, Department of System Analysis, W. Churchill Sq. 4, 130 67 Prague 3, Czech Republic, E-mail:DOUCEK@VSE.CZ
This contribution is prepared with support of the Czech Science Foundation GACR – research project 201/07/0455 „Causality model between corporate performance, process efficiency and ICT effectiveness“ and the research project 201/06/0175 „Informatics management model modification“.

1. About Information Management

In last period are accented different approaches to information management in business praxis as well as in theoretical discussions on universities and research and development organizations. Different concepts could be found in several publications (Oesterle, 1993), (Taylor, 1996), (Earl, 1989), (Best, 1996), (Martin, 1995), (Galiers, 2003), but they have one common general feature – are mainly based on process management approach (Drucker, 1992), (Řepa, 2007) and most of them are sharply connected to business process reengineering (El Sawy, 2001), (Davenport, 1993).

Actual interpretation of the term "information management" underlines the importance of managerial work. Experts in all different types of science have almost the same opinion - managerial work is the key activity for each organization. Primarily, it should be based on processes management, therefore the transition from a functional to a process approach in an enterprise must be completed first by managers (Kern, 2001). A process approach to managerial work is significantly supported by information processes which support managerial work in order to supply required information to managers (Oesterle, 1993). The time scale is also important. The above listed requirements are fulfilled by data logistics. A definition of data logistics is: "to deliver right and relevant data to the right person/place at the right time" (Doucek, 2005). Effectiveness of information management application in practice is deeply related to data logistics quality (Oesterle, 1993), (Best, 1996).

Information processes are understood by experts as supporting process. They are not included in core-business processes of organizations that are not IS/ICT services suppliers. Nevertheless, their significance for an organization is fundamental (Galiers, 2003). By performing them, information services are provided. Information manager have to manage IS/ICT as a complex of (Leibold, 2002), (Earl, 1989):

- sources – data, employees, finance,
- processes – identification, description and optimization (Ministr, 2003),
- organization structures – competencies, responsibilities, style of management (Scott Morton, 1993),
- knowledge management – management of the knowledge life cycle – collect data, production, distribution and remove of knowledge (Porat, 1978),
- strategic visions for further IS/ICT development in an organization in co-ordination with strategic goals of the core business (Scott Morton, 1993).

Information management therefore penetrates into IS/ICT management, and it could also become a tool for the measurement of IS/ICT benefits and effects. The comparison of costs invested in the IS/ICT and final benefits gained from its improvement form the base of the economic dimension of information management – investment effectiveness measurement (IT Governance Institute, Cobit 4.0, 2006).

Information management competencies (Oesterle, 1993), (Galiers, 2003) in different areas are shown in Figure. 1. They could be distinguished three following levels of management:

- strategic,
- tactical,
- operational.

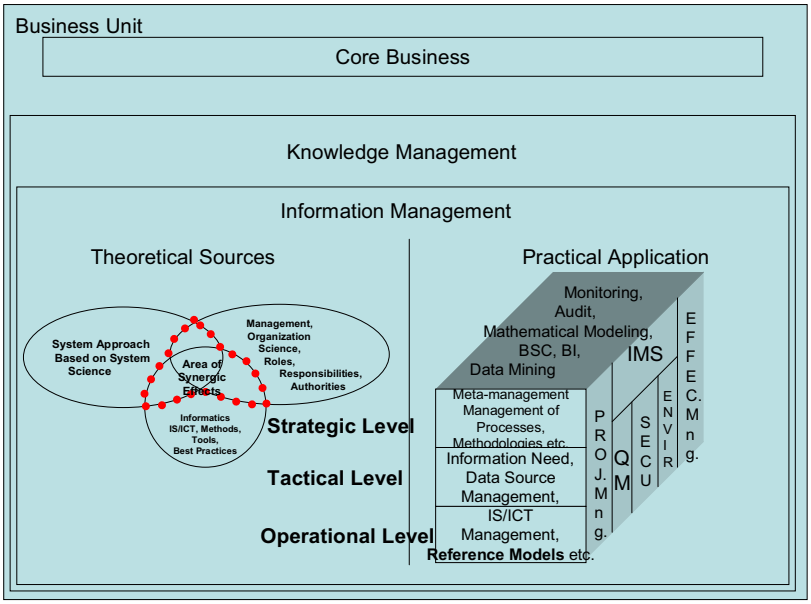

Figure 1 Area of potential synergic effects in information management

The first category of information management could be described as a tool for the **managing of top managers** – meta management on a **strategic level**. The main service and mission of information management on this level is to manage, plan, forecast, and teach top management to use related managerial tools. These tools such as, for example, mathematical models, business intelligence elements and applications, decision support systems, are regularly incorporated into decision making process (Kern, 2005). They also evolve into the new methodologies describing the use of data, information and knowledge.

The second category, we could say "classical **tactical category",** is the area of **planning and information need management** with special accent on managerial information needs fulfillment. The planning process of information needs coverage is deeply related to other aspects of managerial work such as organizational structures definition and authorities and responsibilities assignment for each employee in an organization. Information management is slowly becoming an irreplaceable part of organization science. The most important role of information management at this level is to interconnect the management of the organization to the IS/ICT management on the basis of a process and service approach.

The **operation management** category of information management is focused on data collection from real operations of the IS/ICT in an organization with the final goal of preparing data for effectiveness measurement and the IS/ICT effectiveness evaluation. It is characterized by significant interconnection with informatics management. In practice, it is represented mainly by IS/ICT reference models (Novotný, 2005), process descriptions (Ministr at all, 2003), competencies and responsibilities descriptions.

The IS/ICT reference model describes main corporate IS/ICT processes and relation between corporate IS/ICT elements and components and represents the basic guideline for manager in each level of IS/ICT management.

Management of IS/ICT in an enterprise is becoming increasingly important 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 models principles (formalized structure and predefined content) in the area of IS/ICT management would help to address the above listed needs. If we accept the IS/ICT management to conform 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.

There are two major sources of knowledge on which the IS/ICT management reference model could be elaborated:

- IS/ICT management methodologies,
- IS/ICT management tool.

Their roles in the reference model elaboration could be explained as:

IS/ICT Management Methodologies

IS/ICT management processes and some of the best practices are already described in several IS/ICT management methodologies, e.g. ITIL (The Stationery Office, Service Support, 2000), COBIT (IT Governance Institute, Cobit 4.0, 2006) or ISO/IEC 20000 (ISO/IEC 20000, 2005) – service oriented IS/ICT management. For especially parts of IS/ICT management are in practice used other special methodologies – international standards. For information security is the family of norms 27 000, for quality management the family of 9000, for environmental management ISO/IEC 14 000 family, for risk management family ISO/IEC 31000, for privacy ISO/IEC 29000 etc. The main problem of these „best practices" is that they are described in a form of plain text without any concrete recommendations for improvement of them in real conditions. Implementation of such a methodology in a real environment still needs a lot of implementation effort for it to be effectively used as a structured management system (IT Governance Institute, IT Governance Global Status Report, 2006).

An IS/ICT management reference model should contain the above listed best practices (mapping to relevant IS/ICT methodologies should be provided), but these have to be expressed and managed as formalized procedures, forms, relationship tables and other structured content, which could be instantly used while implementing the IS/ICT management. This suggestion is based on the empirical experience gained while implementing the IS/ICT management principles in real projects.

IS/ICT Management Tools

IS/ICT management tools (Pink Elephant, 2006), formerly also called meta-models, are used mainly for tracking information about IS/ICT assets structure (e.g. SW and HW location and configuration) and about events occurring in IS/ICT (e.g. incidents, problems). They contain predefined, partially customizable structures for each asset and event. Their disadvantage is that they come without reference content, so it is necessary to fill all the structures with data from scratch. They also usually do not track information about all the IS/ICT objects required for the IS/ICT management (e.g. documents or procedures, processes).

An IS/ICT management reference model should contain these structures for all the IS/ICT assets, but it should also include their predefined content (where it is appropriate).

Combination of the above listed sources into the IS/ICT management reference model can provide an IS/ICT manager with a powerful tool for supporting his or her tactical and strategic tasks. As examples (based on our empirical experience), we can list:

- cost of application upgrade (impact analysis) – application upgrade (e.g. new version of the SAP R/3 software package) usually comes with higher desktop hardware requirements (e.g. larger screen, more memory). With data stored in the IS/ICT management system, one can easily identify all the desktops where the SAP client software is installed, and their configuration. Then, it is easy to calculate the real cost of upgrading including the replacement of relevant desktops,
- Service Level Agreement (SLA) chargeback calculation – SLA are usually calculated in a "per user" or "per computer" mode. With the real data in the model structure it is easy to calculate how many users are using the specific service or on how many computers it is installed. Such data are then used for precise internal or external billing of IS/ICT services provided to an enterprise organizational units,
- process catalogue – a predefined (reference) process catalogue is usually used as a basis for IS/ICT management implementation. In this case, it is not necessary to build everything (model all the processes) from scratch, but only update those processes which will be managed differently to common practice,
- document examples – document examples are used in the same way – if there is a need for any IS/ICT management document, its structure and outline could be found in the reference model and it could be instantly used.

Research and Development Work – New Item in IS/ICT Reference Model

In international co-operation between two faculties (Faculty of Finance, Technical University of Košice and Faculty of Informatics and Statistics, University of Economics, Prague) the research team investigated existing IS/ICT KIT reference model (Figure 2) and based on it the team formulated (and many others):

- general conclusions concerning relations between core business management and IS/ICT management,
- recommendations how to build up an effective and efficient information security management system.

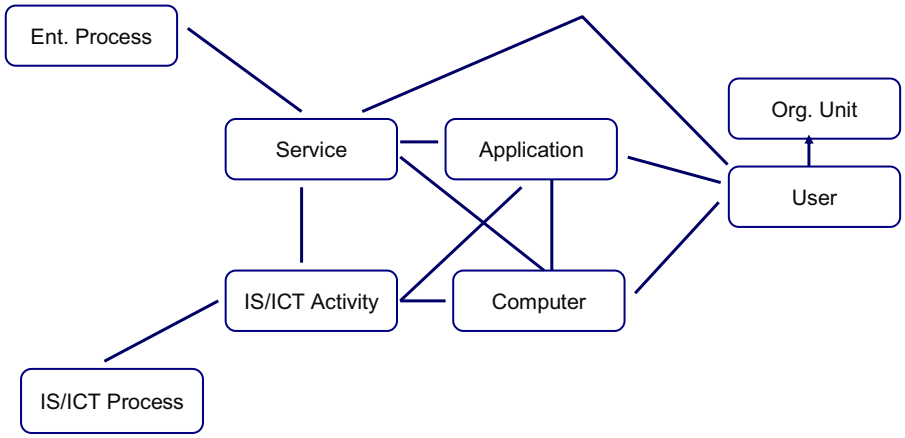

Figure 2: KIT Reference Model – key relationships tracked among model components (Novotny, 2008)

General conclusions concerning relations between core business management and IS/ICT management are topics of the session "IT Performance Management" with the keynote speech "IT Performance Management as a Part of the Corporate Performance Management System"

The small part of corporate effectiveness and efficiency measurement in the area of IS/ICT security is presented on following pages.

2. Why to Have an Information Security Management System – Czech Experience

The state of art of the Czech economy in the domain of the information security is shown on following figures and is based on statistical survey realized by company Ernst & Young, journal DSM – data security management and National Security Authority (NBÚ). This survey has been started for the first time in 1999 and it is performed every two years and this is the fifth to be performed.

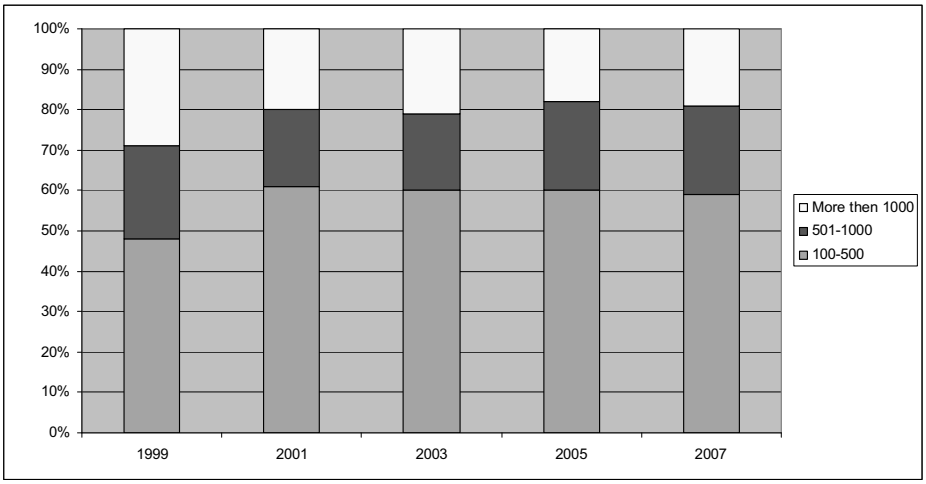

Chart 1 Distribution of Respondents by Number of Employees
(PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

This survey is typical for medium and large enterprises, state and public sector, where is more employees than 100. This feature is typical for today's information security management systems improvement into praxis. It is normally that information security is systematically operate and managed in large enterprises, rarely in medium. For state and public administration institutions is almost obligatory to execute some level of information security. On the other hand small and micro subjects exploit only the "light" version of security principles – main reason – to complicate and to cost intensive.

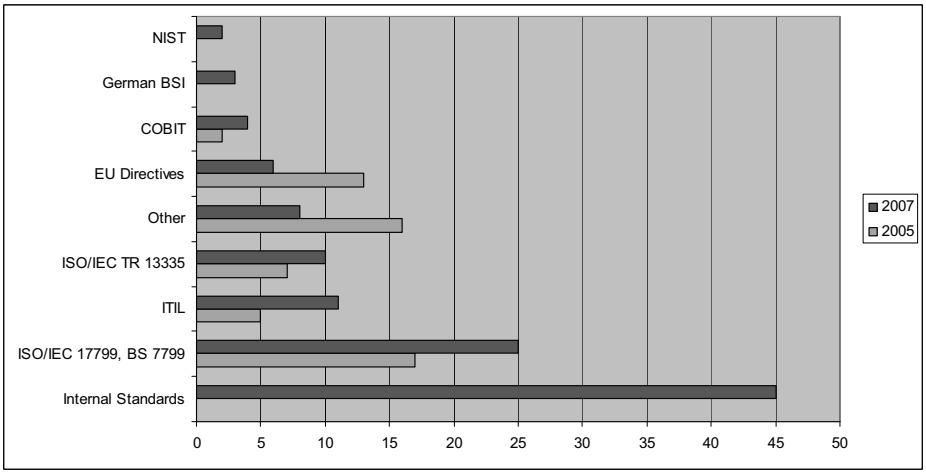

Chart 2 IT Standards Applied For IS/ICT Security
(PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

The survey respondents clearly prefer internally developed standards. The question is about the compliance of these internal standards with other all over the world accepted standards and methodologies and the rate of this compliance. The application of the ISO/IEC 17799/BS7799 standards (or more precisely said the family of norms ISO/IEC 27000) is permanently growing (in 2005 - 17%). It is interesting that 41% of respondents using more than one standard. The internal standards are most often associated with the ITIL and ISO/IEC 17799/BS7799 standards.

Remark to Chart 2

The name „German BSI" used in Figure 3 represents the German authority for security in information technology - Bundesamt für Schicherheit in der Informationstechnik and does not have any relations to BSI – British Standards Institute.

The standard ISO/IEC TR 13335 has been replaced by ISO/IEC 27005 in 2007.

The standard ISO/IEC 17779 has been replaced by standards ISO/IEC 27001 and ISO/IEC 27002, BS 7799-3 will be replaced by ISO/IEC 27003.

Important aspect of all information security management systems are incidents – reasons, and incident management (More detail description is in Part 4 - Security Incident Management and SIMS). There are presented on Chart 3 the most occurred security incidents in the last year 2007.

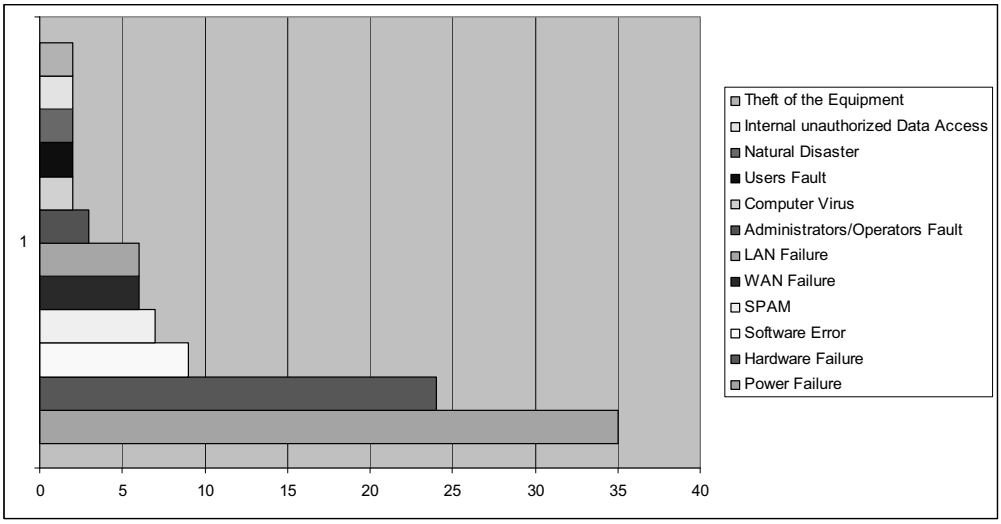

Chart 3 Security Incidents and the Most Serious Impact
(PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

Another dimension of security incident is their impact on enterprises. Average direct financial impacts are shown in Table 1. Small problem is that here are presented only direct impacts and another costs is not so easy to identify in practice. Second dimension are labor and knowledge costs and its evidence.

Security Incident	Average Financial Impacts in EURO
WAN Failure	48000
Power Failure	40000
Software Error	10400
Theft of the Equipment	9000
Hardware Failure	8000
SPAM	6400
LAN Failure	3200

Table 1 Average Direct Financial Impacts on the Most Serious Security Incidents (PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

Trend in information security improvement in Czech enterprises is presented on Chart 4 and could be evaluated as slow growing. In the period of eight years it arises 18%. For the first time in the history o this survey, the number of companies having a formally defined security exceeded 50%. Approaches to this area are very mixed and an extraordinary flexibility is recommended. Nevertheless, it is very complicated to take any security measures without the existence of a general standard such as security policy.

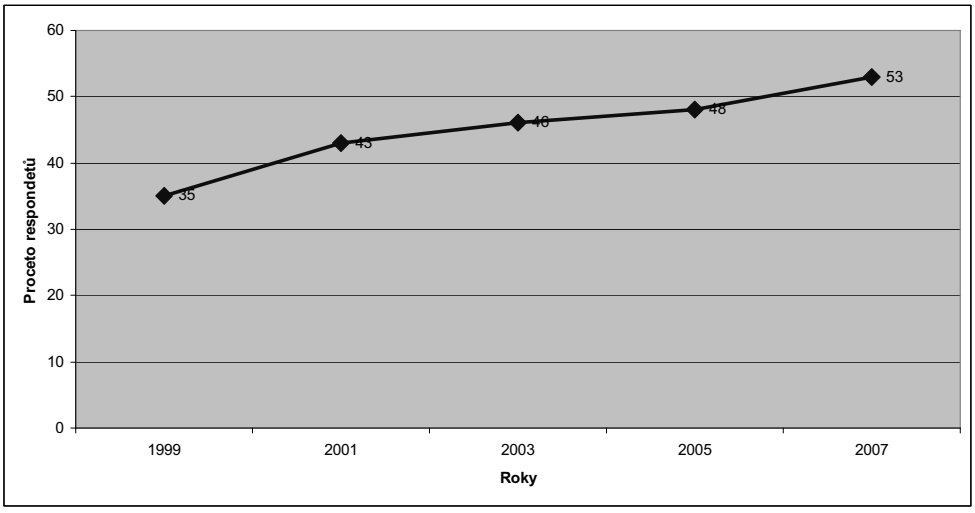

Chart 4 Security Policy – Existence (PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

The indicator of information security is not only the existence of the security policy, but also the scope of the policy. Almost 60% of survey respondents now prefer a medium scope security policy.

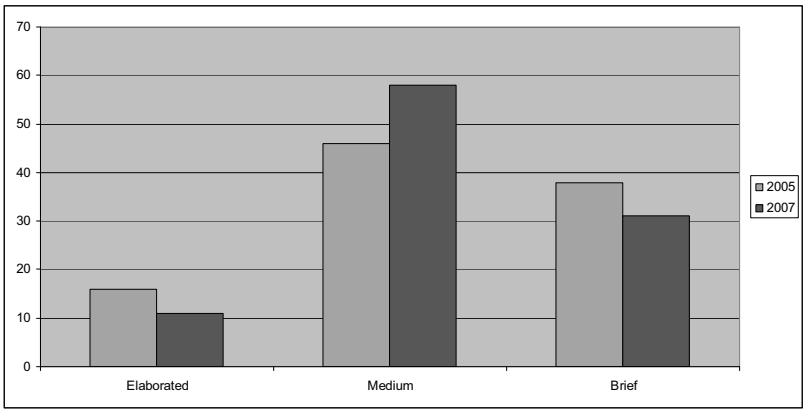

Chart 5 Security Policy Scope
(PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

Remark to Chart 5	
Elaborated	dozens of pages, detailed description of all areas,
Medium	approximately up to 20 pages, quite detailed description of requirements and security organization,
Brief	approximately up to 3 pages, rather declarative nature

Very discussed problem in information security management is the list of the most frequent barriers for IT security improvement. The most important of them in the Czech Republic are shown on Chart 6.

The only principal change consists of decreasing the number of opinions that faster information security implementation in the Czech Republic requires a specific Czech security standard. The respondents opinions on other areas are more or less stable – low security awareness and demand for financing trouble more than 50% of companies over the long term (1999 - 2007).

The state o art is gone and it comes to question. "How to build up an effective and efficient ISMS?" Some recommendations and remarks are shown in the next part of the contribution.

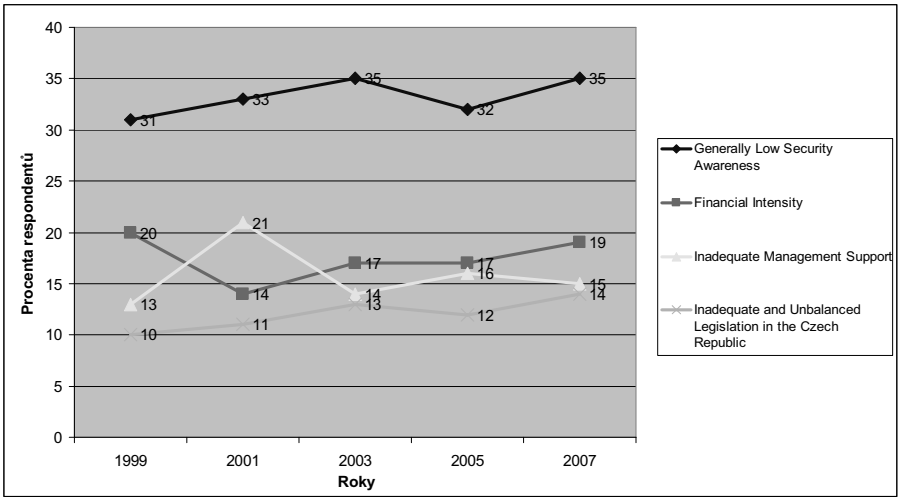

Chart 6 Greatest Obstacles To Faster Information Security Implementation in the Czech Republic (PSIB ČR '07, Ernst & Young, DSM – data security management, NBÚ, 2008)

3. Security Management System - How to Build up an Effective and Efficient Information Security Management System

There are a lot of best practices dealing with security and ISMS all over the ICT world. But these best practices have a character of recommendations and their observance can not be exacted by some legal method in generally. It does mean that for normal entrepreneurial organization and its informatics management, there are no special rules or directives in the domain of the information security. This fact has it's for and against. Managers are not limited with a lot of directives, norms ordinations, but on the other hand they have to face the problem how to stay well informed in the mass of the international standards and recommendations. In present days, according to the "2005 information security research" the enterprise practice uses conception of the standard family ISO/IEC 27000. This standard has been used, according to the mentioned research, by 17% of inquired Czech enterprises (respectively its IT managers). The main advantage of this standard is that it is primarily determined for the information system management (unlike COBIT methodology) and contains also the strategic dimension of the management (unlike ITIL methodology). Its other advantage is, that the processes described can be replenished by appropriate implementation of both other methodologies (COBIT and ITIL) can supplemented by exactly specified processes of the security management. Such described processes or its groups can be

integrated into both methodologies and therefore increase its efficiency for the enterprise informatics management as whole.

The main source for building up of the ISMS general concept is the Deming's PDCA model (Deming, 1982). This model represents best practice in management used in the second half of the last century for revitalization of Japanese economy and its main idea is the cycle of permanent perfection of the focused problem. The PDCA frame model for the whole ISMS is shown on following Figure 3. This model also represents the first - highest level of the ISMS effectiveness assurance.

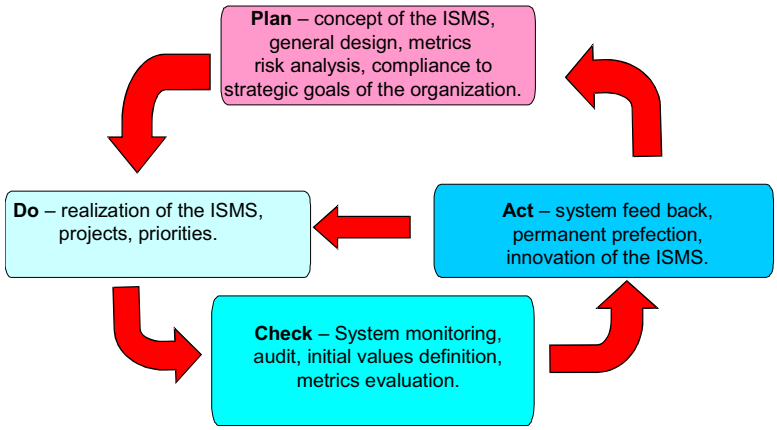

Figure 3 Deming's PDCA Model for General ISMS

Effectiveness of the ISMS is one of attributes of the approach shown on the Figure 2. The first main problem in the ISMS effectiveness measurement and evaluation can be indicated in the initial phase of the whole PDCA concept - in **PLAN phase** in Risk Analysis. Risk analysis is the essential activity, which determinates the quality of the design of the ISMS and its effectiveness as well. The information strategy (business strategy) of the organization, its limits in legal area (legal requirements on local or international acts – as Sarbanes - Oxley Act, US Patriot Act etc.) and stake holder's requirements on business or ICT parameters are the most important sources for initial information security risk analysis. The importance of the correctness, well prepared and designed risk analysis is shown in the Table 2.

Phase of the PDCA	Relative Costs
Plan – concept building	1,0
Do – implementation	6,5
Check – testing	15,0
Act – Maintenance	100,0

Table 2 Relative Costs to Correct Security System Defects by Phase (Jaquith, 2007)

Risk analysis products different outputs with diverse impacts on the corporate ISMS:

- identification and corporate assets assessment,
- identification of threats, vulnerabilities, and impacts on corporate assets,
- assessment of corporate security projects within organization (aim is to protect corporate assets)
- priority definition for security projects and for countermeasures realization,
- effectiveness evaluation for each define project and countermeasure (general schema of the effectiveness evaluation commonly used for these proposes is shown on Figure 4).

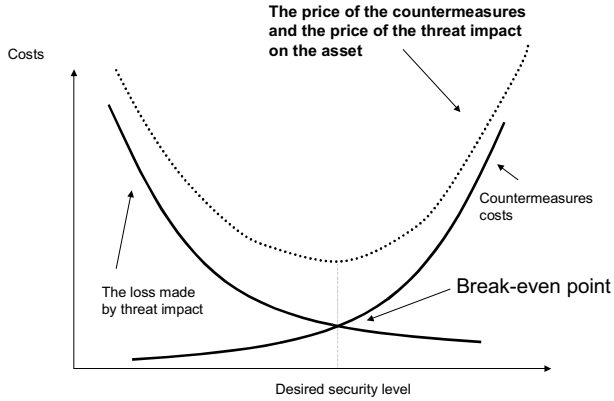

Figure 4 Effectiveness Evaluations For Projects And Countermeasures

Another chapter in ISMS design, realization and operation is the way how to evaluate partial components of it and how to define particular indicators (metrics). "There are two fundamental types of metrics that must be considered before commencing with IT portfolio management:

- value delivery,
- process improvement.

Value delivery consists of cost reduction, increase in revenue, increase in productivity, reduction of cycle time, and reduction in downside risk.

Process improvement refers to improvements in the portfolio management process.

While the metrics are similar and in many ways interrelated, process metrics focus on effectiveness. Is the process improving? Is the process providing perceived value? Is the process expanding in scope? More and more, leaders are looking into the metrics microscope to eliminate non-value-added activity." (Maizlitch, B., Handler, 2005).

Another dimension of this problem is concrete indicator establishment including the starting value definition and monitoring process assignment. There could be found a lot of best practices and recommendations when and how to use different security indicators for different types of information systems. Using of concrete indicator depends on actual conditions in corporation and of course on ability to monitor and to collect necessary data for indicator evaluation. Very large scale of proposed indicators can be found for example in ISO/IEC 27004, NIST 800-55, NIST 800-80 and ISO/IEC 18028 (Novotný, Doucek, 2006). More important matter than to declaim a list of security metrics is to have a common vision for general use of it in different corporations. One indicator or set of indicators could be relevant in specific conditions of an organization but use of it or a set of them in another corporation could be completely unsuccessful.

Every indicator takes time to compute and is defined also by frequency of computing (Jaquith, 2007), (Novotný, Rydziová, 2006). Several different situations in a corporation need different approach to indicator computing and frequency of this activity. "For most security processes, such as those for operations and crisis management, "often" is better then "sometimes". Metrics with short sampling interval help companies analyze their security effectiveness on a day-to-day and week-to-week basis rather than through a yearly rearview mirror. It stands to reason that if a metric needs to be computed frequently, the metrics source data should be cheap to gather in terms of time or money" (Jaquith, 2007).

A schema of strategic concept for information security indicators use with importance of ever indicator and proposed frequency of computing is shown on Figure 4.

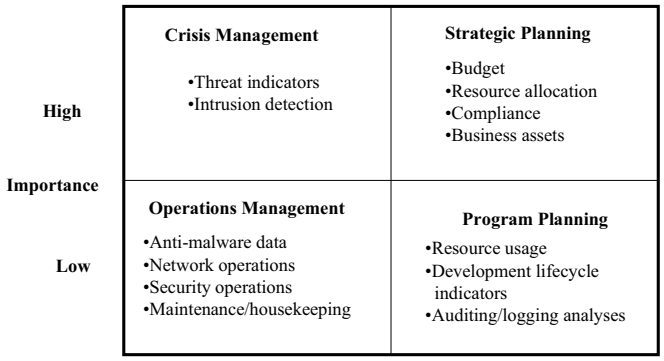

Figure 5 Schema of Indicators (Jaquith, 2007)

4. Security Incident Management And Security Incident Management System

Other dimension of operating ISMS is ability to indicate security incidents, to make relevant decisions in the relation to detected incident evaluate them and after evaluation of incidents to start the phase ACT in ISMS – to change the SIMS in the small loop and to update the ISMS in the large loop of innovation.

Main feature of the Security Incident Management System (SIMS) is the fact, that all aspects of it planning, improvement, operating and perfection are managed according to the PDCA concept (Figure 1). Improvement of this system is not only improvement of new processes and new dimensions of managerial work, but also establishment of new organization structures in corporations. One of it is the structure primary focused on solving IS/ICT security incidents – about ISIRT (Information Security Incident Response Team). An ISIRT is a pre-selected team of appropriately skilled and trusted members of the organization, which will handle information security incidents during their lifecycle. At times this team may be supplemented by external experts, for example from a recognized computer incident response team or Computer Emergency Response Team (CERT). Let us dive into the security incidents management processes and joined problems. General other aspects of organization structures improvement into practical conditions during the period of information society are discussed and shown in (Kern, 2005).

Phase PLAN - Plan And Prepare the SIMS

Effective information security incident management requires appropriate planning and preparation. Thus, for responses to information security incidents to be effective, the following actions are necessary:

- develop and document an information security incident management policy and gain visible commitment to that policy from all key stakeholders, particularly senior management, develop and comprehensively document an information security incident management scheme to support the information security incident management policy. Forms, procedures and support tools, for the detection, reporting, assessment and response to information security incidents, and details of the incident severity scale (An incident severity scale to be used to grade incidents should be established. This scale could be such as major and minor, with in any event, the decision based on the actual or projected adverse impacts on the organization's business operations.
- should be encompassed within scheme documentation. (It should be noted that in some organizations, the scheme may be referred to as an information security incident response plan.),
- update information security and risk management policies at all levels, i.e. corporate-wide and for each system, service and network, with references to the information security incident management scheme,
- establish an appropriate information security incident management organizational structure e.g. Information Security Incident Response Team, with defined roles and responsibilities allocated to personnel who are available to enable an adequate response to all known types of information security incident. Within most organizations the ISIRT will be a virtual team, with senior management representation leading the team supported by groups of individuals specialized in particular topics, for example, in the handling of malicious code attacks, who will be called upon depending on the type of incident concerned,
- make all organizational personnel aware through briefings and/or other mechanisms, of the existence of the information security incident management scheme, its benefits and how to report an information security event. Appropriate training should be provided to those personnel responsible for managing the information security incident management scheme, decision makers involved in determining whether information security events are incidents, and those individuals involved in the investigation of incidents,

- thoroughly test the information security incident management scheme.

There is prepared and designed a Security Incidents Management Systems for concrete organization. After this phase of the IS/ICT SIMS life cycle is time to put the designed system into work.

Phase CHECK - Use And Operating SIMS

For normally users is very important to distinguish between information security event and information security incident. This distinguishing process could be included into the IS/ICT management reference model (Novotný, 2007). An information security event is an identified occurrence of a system, service or network state indicating a possible breach of information security policy or failure of safeguards, or a previously unknown situation that may be security relevant. An information security incident is indicated by a single or a series of unwanted or unexpected information security events that have a significant probability of compromising business operations and threatening information security. The following processes are necessary to make use of an information security incident management scheme:

- detecting and reporting the occurrence of information security events (by human or automatic means),
- collecting information associated with information security events, and assessing that information to determine what events are to be categorized as information security incidents,
- making responses to information security incidents:
    - immediately, in real-time or in near real-time,
    - where information security incidents are under control, conducting activities that may be required in slower time (for example, in facilitating full recovery from a disaster),
    - if incidents not under control, instigating crisis activities (for example, calling the fire brigade/department or activating a business continuity plan),
    - communicating the existence of information security incidents and any relevant details thereof to internal and external people and/or organizations. (This could include escalating for further assessments and/or decisions as required.),
- forensic analysis,
- properly logging all activities and decisions for further analysis,
- closing incidents on resolution.

General description of the SIMS life cycle is described on the following Figure 6.

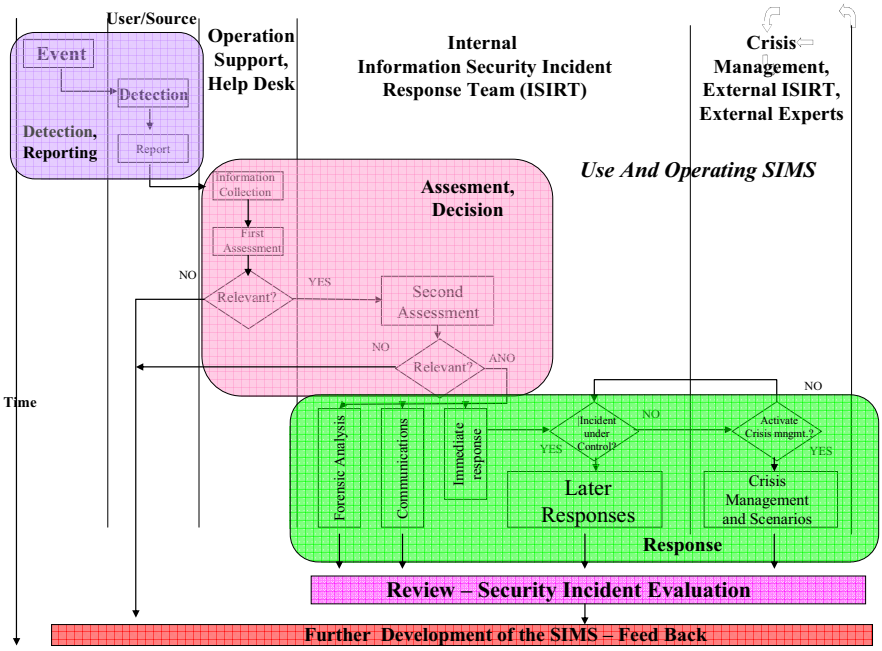

Figure 6 IS/ICT SIMS Life Cycle

Detection, Reporting

Detection phase is a key moment for successful solving of security incidents in a firm. The normal user – not an expert in IS/ICT security problematic -comes to contact with security event and her/his non substitutable role is to distinguish between security event and/or security incident. Is the event an incident or not? With this basic question are confronted millions of IS/ICT users each day. That is why is important to perform a continuous system of permanent training and security education in a firm. If employees will not be able to detect incidents, could be on one hand neglected important incidents and the other extreme is to solve all security events as incidents. The effectiveness work of ISIRT (Information Security Incidents Response Team) will be very marginal in this case. Further very important fact of future process of incident response is to perform evidence of facts about disappeared incident. Detection of an incident must immediately start standard (regularly managed) process of data collection about this incident. It normally that some of

this data collected in the first phase of indication in security incident management life cycle determines successfully response on it.

Assessment, Decision

The next phase of the incident management life cycle is the Assessment and Decision phase. The first reaction to incident is usually realized by Help desk employees or by employees supporting operating of information system. These employees get the first announce of incident and realize the initial process of identification. The main roles of supporting services are to:

- get maximum information from users about detected incident,
- make primary identification and assessment,
- perform evidence of all data about incident,
- give initial information to ISIRT,
- pass all collected data to ISIRT.

Whatever the next step is determined to be, the ISIRT member should update the information security incident report as much as is possible, add it to the information security event/incident database and notify the ISIRT manager and others as necessary. The update may cover further information on:

- what the information security incident is,
- how it was caused and by what or whom,
- what it affects or could affect,
- the impact or potential impact of the information security incident on the business of the organization,
- changes to the indication as to whether the information security incident is deemed significant or not (using the organization's pre-determined severity scale),
- how it has been dealt with so far.

If an information security incident has by any chance been resolved, the report should include details of the safeguards that have been taken and any other lessons learned (e.g. further safeguards to be adopted to prevent re-occurrence or similar occurrences), and be added to the information security event/incident database and notified to the ISIRT manager and others as required.

Response

Basic information about security incident are sent to ISIRT – to professionals in IS/ICT security. Their role is at first to put incident under control and at the end to solve it. They realize final classification of the incident – either to confirm the first classification or to re-evaluate it.

Next step in ISIRT work is to collect all required information for successful solving the indicated incident. It does mean to assess further data form users, computer network (audit records, records of access management, parameters and mechanism for required information security level etc.) and immediately and quick to analyze it. Sometimes the help of external security experts is needed. When is the incident under control the proposal of solving it is putting into work.

Different situation must be managed in the case, when the ISIRT did not put the incident under control. Then the crisis management scenarios are activated and the crisis is proclaimed in the organization. The role of crisis management is realized by Business Continuity Planning and Disaster Recovery Planning functions and scenarios.

The further important goal of this phase is to assure the documentation process of the whole incident from the phase of identification to the final solving and to prepare foundations for realizing the feedback into the security management documentation and processes. ISIRT prepares the final report for top management of the organization.

Review – Security Incident Evaluation

After information security incidents have been resolved/closed, the following review activities are necessary following the resolution and closure of incidents:

- conducting further forensic analysis, as required,
- identifying the lessons learnt from information security incidents,
- identifying improvements to information security, as a result of the lessons learnt, whether from one information security incident or many,
- identifying improvements to the information security incident management scheme as whole, as a result of lessons learnt from quality assurance review of the approach (for example, from review of the effectiveness of the processes, procedures, the reporting forms and/or the organizational structure).

Reviewing of security incidents, their sources and causes is the first qualitative new step in IS/ICT security incidents evaluation. There could be analyzed information about incidents and got first new knowledge and experience in this phase of the IS/ICT SIMS life cycle.

Phase ACT - Further Development of the SIMS

It is emphasized that the information security incident management processes are iterative, with regular improvements made to a number of information security elements over time. These improvements will be proposed on the basis of reviews of the data on information security incidents and the responses to them, as well as trends over time. This will include:

- revising the organization's existing information security risk analysis and management review results,
- making improvements to the information security incident management scheme and its documentation,
- initiating improvements to security, that may encompass the implementation of new and/or updated information security safeguards.

This phase represents real improvement of the in security incident management processes gained knowledge and experience into practice in a firm. Real processes and countermeasures are implemented according to former security incidents evaluation and their reviewing in this phase.

5. Conclusions

Effectiveness of the ISMS is an organic part of the whole ISMS life cycle. General schema for its modeling is based on actual conditions in an organization. Indicators are emerging field of interest for the majority of ICT professional. Another approach to them should practice managers especially those of them that are responsible for finance and investments effectiveness and efficiency. For them is the topic to develop a coherent system of indicators not only in information security or in information system and information technology management, but also the corporate system of indicators for general effectiveness investigation (Svatá, 2007). General effectiveness investigation is representing by effectiveness of core business processes as well as of supporting processes. Informatics and ICT management is one of the most important supporting processes in an organization. IS/ICT security indicators are tolls in only small area of management but its correct

definition, use, evaluation and feedback in its management protect corporations assets in IS/ICT (Antlová, 2008).

ISO/IEC norms of the family 27000 became widespread standard for implementation and control (audit) of the corporation information security management system. There are huge changes in the standards and norms for the corporation information system management in these days. These changes are expressed by transition from organization standards ISO/IEC (former was not the approach to corporate security management based on PDCA model) to new uniform series ISO/IEC 27000 (based on PDCA model). This series is characterized by uniform conception (i.e. usage of the Deming approach to information security project life cycle) and there is also rising the effort for harmonization of already published documents, by the form of its revision with new fundamental changes for this domain.

General concept of the ISO/IEC 27000 family is shown of the Figure 7.

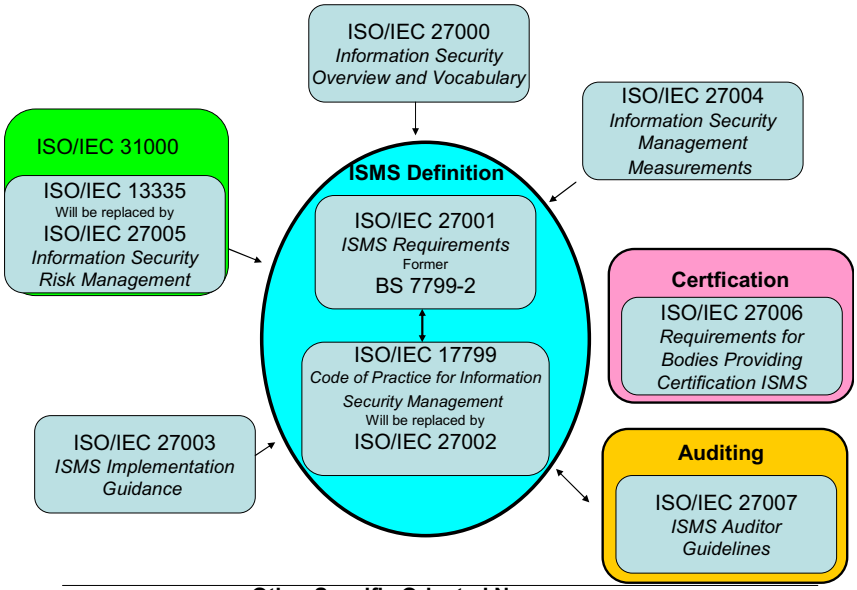

Figure 7 General Frame – ISO/IEC 27 000 International Standards

Further standards and norms from this family - mostly under construction – are presented in following:

- **ISO/IEC 27 011** - Information technology - Security techniques - Information security management guidelines for telecommunications,

- **ISO/IEC 27 031** - Information technology - Security techniques - Specification for ICT Readiness for Business Continuity (draft, title not yet approved),
- **ISO/IEC 27 032** - Information technology - Security techniques - Guidelines for cyber-security,
- **ISO/IEC 27 033** - Information technology - Security techniques - IT network security,
- **ISO/IEC 27 034** - Information technology - Security techniques - Application security,
- **ISO/IEC 27 799** - Security Management in Health using ISO/IEC 27002.

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INTEGRATION MODEL FOR INFORMATION MANAGEMENT

Vlasta Svatá[1]

Abstract

The main aim of the paper is to discuss the term information management (IM). This discussion is useful in current situation where there is a big pressure towards the transparency and better quality of both the business and IT processes and their compliance with many different standards. The paper introduces several different definitions of IM and attempts to summarize their common features. In order to simplify the complexity of IM the models are developed. The paper summarizes the most important of them and provides their brief analysis. On the base of this analysis the new model IMIM (Integration Model of Information Management) is introduced.

1. Introduction

Being involved as a teacher in the study line of Information Management (IM) for several years I can declare, that the term "information management" does not have the fixed definition till now. This conclusion is valid for both the Czech Republic and the rest of the world.

People using this term usually try to stress the fact, that IM has another – more general and more business oriented - content than the similar terms like IT or IS management. But trying to specify the differences in more detailed way we are facing great problems.

According my opinion there exist at least three reasons of this situation:

- there is no common understanding of the term management,
- there is no common understanding of the term information,
- the evolution in the relation and mutual integration between IT processes and business processes is very dynamic.

[1]University of Economics, Prague, Czech Republic; svata@vse.cz

On the other hand, there exist pressures on the IT management professionals (and other experts like IS auditors, process owners, security managers etc.) to improve their ability to assess and assure the IS/IT services in order to be compliant with many different external and internal standards and to declare the value delivery through IT/IS. The origin of those pressures is in the problems with the integrity and relevance of the financial information offered by the business management outside the organizations. The real declaration of such problems were widely discussed after the Enron bankruptcy, accompanied by the WorldCom debacle and other corporate scandals. They has caused a sea change in the attention given corporate governance and in how directors are viewed by the public, shareholders, employees, and the courts. These high-profile corporate governance failures have led to new laws and regulations designed to force improvement in organizational governance, security, controls and transparency. This scandals opened wide discussion about the reliability and accuracy of information (mainly financial) and resulted in introduction of many different standards and supporting tools aiming to improve the quality of business information (SOX, BASEL, COSO, COBIT, ITIL, ISO etc.). New legislation has been a shake-up in the pre-existing roles and responsibilities of directors as well as the structure and function of boards.

This situation where there is no common understanding of information management on one side and the pressure towards the transparency and better quality of business processes on the other side is a good base for the discussions about the content and models of information management.

1.1. Different Meanings of Information Management

The content and meaning of information management changes in course of time range and according to the different authors or firms.

Throughout the 1970s this was largely limited to files, file maintenance, etc. and such as it was compatible with the term data life cycle management.

Data life cycle management (DLM) is a policy-based approach to managing the flow of an information system's data throughout its life cycle: from creation and initial storage to the time when it becomes obsolete and is deleted. DLM products automate the processes involved, typically organizing data into separate tiers according to specified policies, and automating data migration from one tier to another based on those criteria.

With the proliferation of information technology starting in the late 1970s, the job of information management took on a new light, and also began to include the field of information life cycle management (ILM). ILM is a comprehensive approach to managing the flow of an information

system's data and associated metadata from creation and initial storage to the time when it becomes obsolete and is deleted. Unlike earlier approaches to data storage management, ILM involves all aspects of dealing with data, starting with user practices, rather than just automating storage procedures, as for example, hierarchical storage management (HSM) does. ILM is often considered a more complex subset of data life cycle management.

Both DLM and ILM has become increasingly important as businesses face compliance issues in the wake of legislation, such as HIPAA and the Sarbanes-Oxley Act, that regulates how organizations must deal with particular types of data. Data management experts stress that information life cycle management should be an organization-wide enterprise, involving procedures and practices as well as applications.

While the concepts of DLM and ILM are still alive and needed, currently there is a need to broaden the content of these terms and to stress the fact that just provision of data/information through the optimal (most productive and economical) use of resources (efficiency**)** is not sufficient. There is a need to deal with data/information being relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner (effectiveness).

Next are the examples of different definitions from different sources:

- *Information management* is the collection and management of information from one or more sources and the distribution of that information to one or more audiences. This sometimes involves those who have a stake in, or a right to that information. Management means the organization of and control over the structure, processing and delivery of information (Wiki).

- *Information management* has meant deploying new technology solutions, such as content or document management systems, data warehousing or portal applications (Robertson James, 10 principles of effective information management, Month 2005).

- *Information management* is the regime that oversees the investment in new information systems and the operation of existing systems. Information management requires the deployment of a diverse range of management skills in order to successfully deliver the benefits of information systems investments (Andy Bytheway, Exploing Information Management,University of Western Cape)

- *Information management* is both a strategy, driven by customer needs, and an infrastructure, shaped by technology, for handling and distributing information. Information management crosses disciplinary and administrative boundaries

  (USGS, http://www.usgs.gov/themes/info.html, April, 08)
- *Information management* is the management of organizational processes and systems that acquire, create, organize, distribute, and use information. We adopt a process view of information management. In this view, IM is a continuous cycle of six closely related activities:
  - identification of information needs;
  - acquisition and creation of information;
  - analysis and interpretation of information;
  - organization and storage of information;
  - information access and dissemination;
  - information use.

  (FAQs, http://choo.fis.utoronto.ca/Imfaq/, April,08)
- *Information Management* describes the measures required for the effective collection, storage, access, use and disposal of information to support agency business processes. ... (www.records.nsw.gov.au/recordkeeping/glossary_of_recordkeeping_terms_g-o_4300.asp, April,08)

Trying to define the term information management we shoud take in account another important concept which deals with the same problems – IT Governance. The fall of Enron was a direct result of failed corporate governance and consequently has led to a complete reevaluation of corporate governance practice, IT governance practice included.

- *IT Governance* in simple terms can be said to be a method for CIOs to manage IT strategy and execution by enabling a consolidated view of key governance functions such as project, demand, resource, risk and performance management.

On the base of these definitions we can summarize:
Information management is the effective information lifecycle management which has next important characteristics:

- the base for ILM are business processes,
- bridges the gap between business customers needs and IT infrastructure,

- ILC covers not only the procedure of collecting data and processing, presenting and communicating information, but it addresses next important stages : identification of information needs, interpretation of information, information access and dissemination and the use of information,
- focuses on the business benefits delivery of information systems investments,
- IT related risk management is an important part of management activities,
- information is only one type of IT resources (others are applications, people, infrastructure); there is a need to deal with all of them,
- includes performance measurement which means tracking project delivery and monitoring IT services by means of measures based on classic accountancy,
- needs deploying new information technology (complex software integrates support of many different fields of ICT management: project management, compliance management, risk management, systems administration, performance management etc.).

2. Information Management Models

There exist many different attempts to simplify the complex reality of IM by the help of models.

2.1. Allen Lee's model

The Figure 1 shows *information technology* at the left and *business strategy* at the right, thereby reflecting the arrangement of ideas in Allen Lee's model. It attempts to bridge the gap between the two using three specific, additional areas, that are of concern to both parties: the *information system* that makes information technology useful and workable, the *business process* that is improved by the introduction of new information systems, and the *business benefits* that evidence that business process.

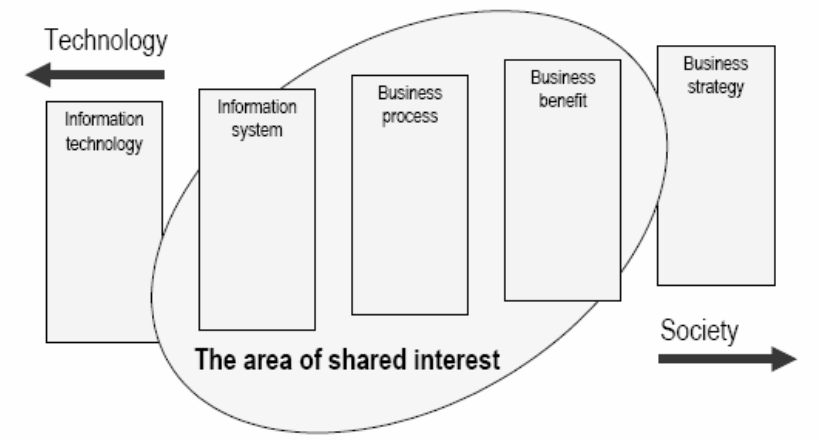

Figure 1 : Allen Lee´s Model

2.2. IMBOK – Information Body of Knowledge (2004)

Those, who are knowledgeable about the international project management methodology called PMBOK (Project Management Body of Knowledge) can anticipate the main idea of this model. Model is based on two different views over the problem: one encompasses the knowledge areas and the second the processes important for the selected object (either project management or information management).

IMBOK model takes in account next knowledge areas and processes (see Figure 2):

- Knowledge areas:
  - Information technology,
  - Information system
  - Business processes
  - Business benefit
  - Business strategy
- Processes are:
  - Projects
  - Business change
  - Business operations
  - Performance management

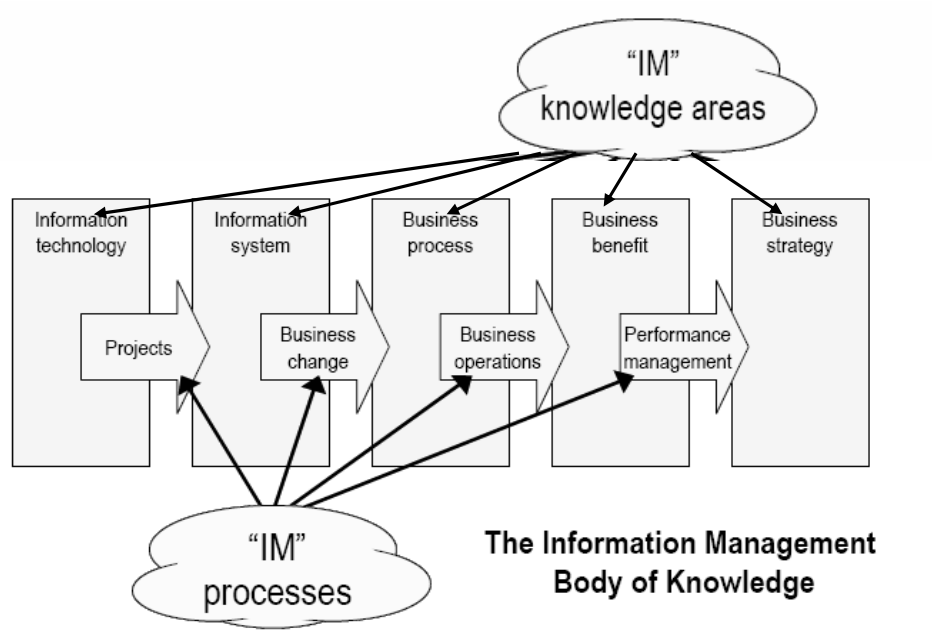

Figure 2:Processes and knowledge areas of IMBOK
(IMBOK Collected and edited by Andy Bytheway Cape Technikon,2004)

2.3. John Zachman Model (1987)

One long-standing framework was published by Zachman some years ago. In his original paper (which has been widely referenced and which embodies ideas that he is still developing) he argued for six levels of systems thinking, loosely along these lines:

- The objectives and scope of the business
- Models of the business
- Models of the information systems that serve the business
- Models of the technologies that serve the information systems
- Techniques and tools for the representation of information systems
- The component elements of the actual functioning system

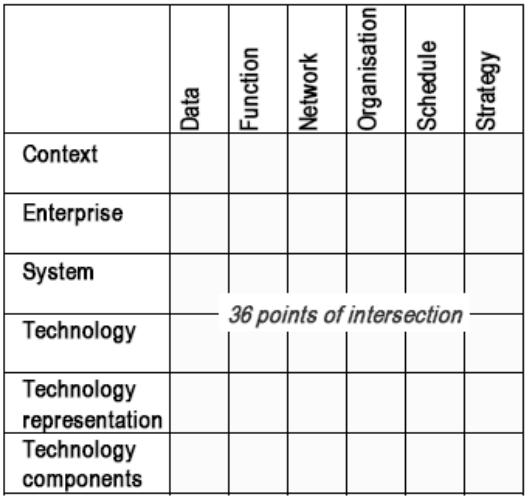

Figure 3: Zachman model, 1978

These six levels of systems thinking are each represented by Zachman as rows in a matrix with six other areas of concern represented as the columns –Function, Data, Network, Organisation, Schedule and Strategy (see Figure 3). Thereby he presents us with 36 points of intersection – too many to work through quickly and quite demanding on the abilities of one person. Again, we are reminded of the complexities that we are struggling to deal with in managing IT.

2.4. Jacob's ladder (1990)

This framework for thinking about the information management is based on different management issues in dealing with IT and the business. The author John Browne termed the framework "Jacob's ladder".

It has four main components:

- The *business processes* that deliver business outcomes: this is the level at which we should measure business performance.
- The *information* that those business processes need in order to function: consider that every decision at every point in every business process needs information if it is to be an informed decision.
- The *applications* (applications of information technology – we often choose to call them "information systems") that store, process, move and deliver information to the places where

it is needed: if there is an application that is delivering information that is not used, then it should be closed down.

- The *infrastructure* that is the foundation for the information systems to run upon: this is what we can easily measure – server availability is a classic example – money might been another. We can easily work out what the information technology infrastructure actually costs, but do we know the cost of developing applications and garnering information?

At each side of the figure are the indicators of value and expertise. Value *creation* is about seeing the strategic potential for improved use of information in the business; value *realisation* was a question of ensuring world-class delivery of IT services.

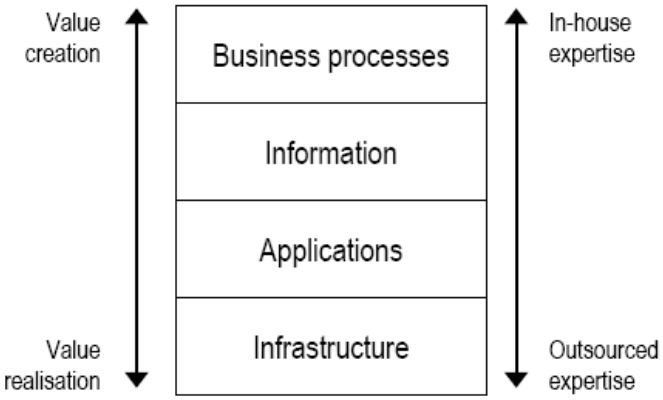

Figure 4: "Jacob's ladder" framework

2.5. Cranfield Model

Other research has addressed similar ideas and embodied them into a simpler form, but with the intention of establishing a framework for managing the requisite information management competencies.

An interesting feature of this work (from the Cranfield School of Management) is that it highlights three areas of management concern – IS/IT strategy, IS/IT supply, and IS/IT exploitation (see the figure) – and then points out that it is the areas *between* these three that are most challenging (as indicated by the arrows in the figure). Broadly speaking, these common areas include strategy implementation, systems delivery, and the delivery of strategic benefits – all notoriously difficult even in the most progressive organisations. The Cranfield work proposes six "macro competencies" based on this model, and substantiates the proposal with a very detailed review of the literature that

vindicates it – this must be one of the most definitive lists of references concerning information management that is available.

Figure 5: Cranfield Model (Bytheway A J,1995)

2.6. Rosický&Vodáček Model

In 1997 my colleagues introduced in their book "Information Management" another "three bubble model" of IM. This model stresses the fact, that roots of IM are three types of disciplines: system, management and IT.

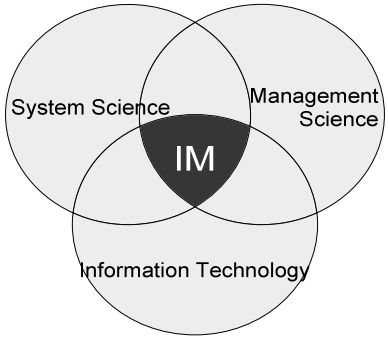

Figure 5: Rosický&Vodáček Model (Vodáček, Rosický, 1997)

2.7. IT Governance model

IT governance addresses two key areas that are considered as the outcomes of IT Governance.

IT's value delivery to the business: IT should enable organisations to grow by delivering the expected business value through the successful completion of critical projects on-time and within-budget.

Mitigation of IT risks: Embedding accountability into the enterprise. Enterprises should identify their appetite for risk management in IT investments especially with respect to the security, reliability and compliance and have clear-cut strategies to manage risk.

Factors that drive outcomes are:

Strategic Alignment: Enterprises need to ensure that that all investments in IT are selective and strategically aligned to long term business goals

Resource Management: Managing resources (people, applications, technology, facilities or data) is one of the key elements behind maximising the business value of IT addressing needs of recruitment, retention, education, training and development of IT staff.

Performance Measurement: Performance measurement is a cumulative measure of available resources, processes and outcomes of IT Governance and measures its effectiveness in delivering four key objectives—the cost effective use of IT, the effective use of IT for asset utilisation, the effective use of IT for growth and for business flexibility.

Figure 7: IT Governance model

3. Differences in the models

Trying to compare the above mentioned models we are facing two main problems:

1. problem of different level of detail (Zachman and IMBOK are more complex than the rest)
2. problem of different approach:
    a. Zachman model is based on six levels of system thinking which represents horizontal scale and six components of IT management – vertical scale

b. Cranfield model: three areas of IT management concern (the business aspect is only partly covered in the area of information exploitation)

c. Jacob's ladder: pragmatic approach based on four layers and their indicators of value

d. IMBOK: based on knowledge areas and processes covering both the business and IT issues

e. Vodáček, Rosický: very generic approach trying to integrate different disciplines, good base for developing educational programs.

In the next table there are listed the main characteristics of information management (taken from the chapter Different meaning of IM) and these characteristics are related to different models (X means that the relation exits while space means there is no relation).

Characteristics of IM	*IMBOK*	*Zachman*	*Cranfield model*	*Jacob's ladder*	*Vodáček ,Rosický*	*ITG*
Business process oriented	X			X	X	X
Bridges the gap between business and IT infrastructure	X	X		X	X	X
Performance measurement						X
Business value indicators	X			X		X
Mitigation of IT risk						X
Resource management						X
Summary	3	1	0	3	2	6

Figure 1: IM models comparison

According this simple table we can see, that IT Governance framework seems to be the most relevant ones towards the content of Information management.

4. Integrated Model of Information Management (IMIM)

All previous models of information management are static models. They do not take in account the aspect of time and improvement of information management maturity. This reason was an opening impulse for developing a new model addressing the current trends in information management and exploiting the best practices in this field of management.

These reasons gave rise to the idea of Integrate Model of Information Management. The model is based on next three principles:

1. Business processes are fundamental for any IT activities

2. IT Governance framework is the best practice well accepted by the both the business and IT professionals with a huge background in standards, methodologies, etc.
3. Information management is not static; it must viewed as dynamic discipline which is within each organization at different level of maturity. As such it could be useful to apply the principles embedded in CMM.

IMIM has three integrated dimensions which can be introduced as IMIM cube:

- Horizontal dimension represents value chains (business processes), but on the contrary of other horizontal business process models (the IT is not viewed as supporting process of core business processes),
- Vertical dimension represents IT Governance domains (vertical process domains); they are common for all the business processes and provide linkage between business and IT by focusing on It value delivery, risks management, performance measurement, resource management and alignment of strategic alignment.

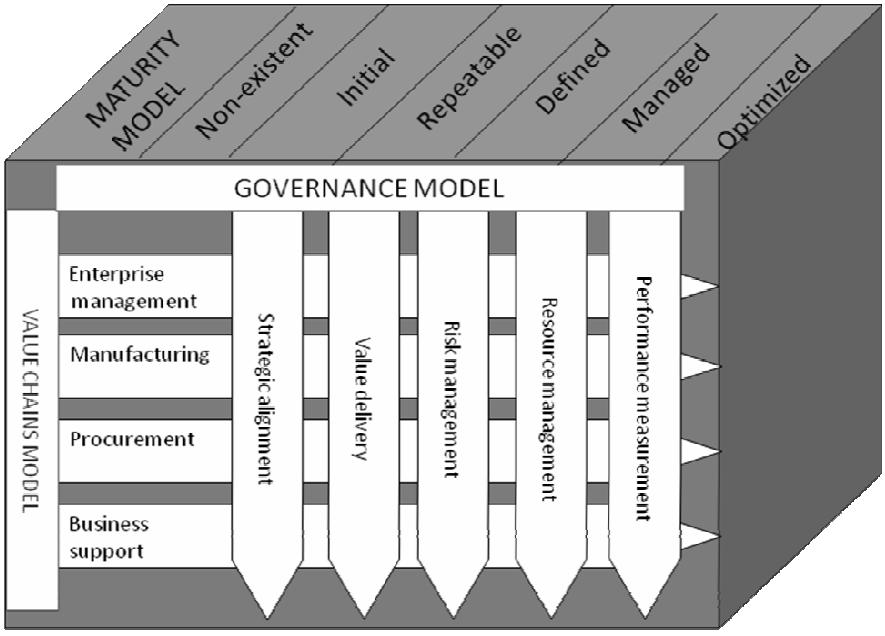

Figure 9: IMIM Cube

- The third dimension incorporates the dynamic aspect of information management. It is based on Capability Maturity Model; the CMM was originally intended as a tool for objectively

assessing the ability of government contractors' processes to perform a contracted software project. Though it comes from the area of software development, it can be (and has been and still is being) applied as a generally applicable model to assist in understanding the process capability maturity of organizations in diverse areas.

5. Conclusion

This model is just initial step towards more detailed analysis. The output of this analysis should be

- standard process maps which can differ according to vertical industries,
- the description of each process will include the recommendations about how to provide
    - strategic alignment between the process and IT,
    - process value delivery based on IT,
    - IT risk management issues,
    - IT resource management within the specific business process,
    - IT performace measurement within the specific business process.
- an inherent part of each process will be the Capability Maturity Model which will on the base of 5 IT Governance areas define the 5 maturity levels (level 0 means that business process has no relation/support of IT).

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KNOWLEDGE MANAGEMENT: A FUTURE APPLICATION OF SOCIAL NETWORKS?

Na Xing, Markus Helfert[1]

Abstract:

Knowledge management has been on the agenda for both research and practitioners. Recently social network analysis is gaining more prominence in the knowledge management community. The purpose of this research is to examine the social aspect of knowledge management (KM) in an organization, and the relationship between social network (SN) and knowledge management. We review the literature of knowledge management and social networks, and explore a new dimension of knowledge management systems. We focus on communication and collaboration between uses of social networks and the future development of knowledge management in an organization. Our result indicate that there exists a general lack of user input (communication and / or collaboration) in traditional knowledge manage approaches. Addressing the drawbacks of current approaches, we conclude that social networks are a way to support knowledge management and collaboration in organizations.

Key words: Social network, Social Network Analysis, Knowledge Management

1. Introduction

Over the last decade researchers and practitioners alike analyzed and proposed various approaches to manage knowledge and information within enterprises. One important reason is that organizations are hoping that knowledge management (KM) processes will allow the creation of knowledge to take place for increasing innovation in the organization [4]. Innovation could be in terms of new products or services, or business process, or better customer services. For example, JD Edwards applied knowledge management for internal sales support first, taking the lesson learned

[1] Dublin City University, Dublin, Ireland; {nxing | Markus.Helfert}@dcu.ie

and successes into a second stage, and extending “the knowledge garden” to its business partners and integrators [8].

Recently research on social network (SN) became prominent among researcher and practitioners. Social network helps employee to capture and share ideas across the organization, and provides an efficient review process to evaluate the ideas. The average internet user now spends three hours a week on social-networking sites, according to research organization YouGov[15]. That sums up to six days a year, and makes social networking more popular than online banking, shopping or music downloads. There is a rising concern about employees spending too much time on Facebook or Youtube. Some employers have banned Facebook to their employees due to concerns about productivity and security. Thus, is the social network site simply a productivity threat or can companies learn to live with Facebook?

Companies have already experienced the level of communication increases on social network platforms. There are some benefits of using social-networking applications as a search and recruitment tool. Like in LinkedIn, where potential employers could check people out, see what their career past is like, who they associated with, even what their contact outside the office.

Social network analysis is the mapping and measuring of relationships and flows between people, groups, organizations, animals, computers and other information/knowledge processing entities [10]. The nodes represent different entities in the network, while the links show the relationship between the nodes. The structure of the social network site is composed of groups or substructure among the sub-groups. Applied to knowledge management, analyzing the social network can identify patterns of interaction in an enterprise, including its properties, such as the average number of links between people in an organization, the number and qualities of subgroups, information bottlenecks and knowledge brokers [1]. In today’s extremely competitive world, the most valuable asset of the company is the knowledge, and social network let you to find people with the knowledge you need, and use those skills better in collaboration with other people in your organization.

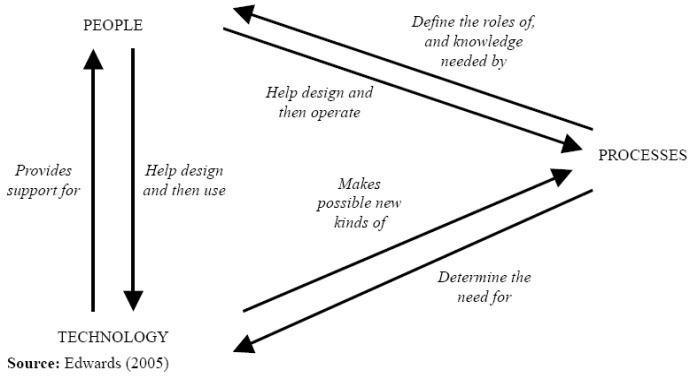
This is what knowledge management is designed for? But the reality is that not many people use the knowledge management tool to find the solution. They would rather using social networks for knowledge sharing and collaboration. So the question rising here is: Is it possible to use social network sites to support knowledge management and collaboration in an organization? Can companies benefit more from using these social network sites? How can they achieve that?

To answer these questions, we review prior research on social network sites, and how the existing social networks can be enhanced though supporting awareness information, thus supporting knowledge management. In section 2, we describe KM and SN. And also, different representations of the social network model are illustrated. In section 3, we will explain the methodology and approach for our research. Finally, we have discussion and conclusions and agenda for future works.

2. Literature Review

2.1. Knowledge Management

Knowledge management is the name of a concept in which an enterprise consciously and comprehensively gathers, organizes, shares, and analyzes its knowledge in terms of resources, documents, and people skills [9]. The term "knowledge management" was recognized in the 1980s and became popular in the 1990s. Nowadays, many large organizations have resources dedicated to knowledge management and some sort of knowledge management framework in place.



Source: Edwards (2005)

Figure 1. People, Process and Technology in a KM system [6]

According to Edwards [6], the three major components of KM are People, Process and Technology. The interactions between the three components are shown in Figure 1.

The biggest challenge in KM is to ensure people participation in knowledge sharing, collaboration and re-use to achieve business goals. This requires organizational culture changing from "knowledge hoarding" (keep hidden or private) to "knowledge sharing" (share among team members) and creating an atmosphere of trust. This is achieved through a combination of motivation / recognition and rewards, re-alignment of performance appraisal systems, and other

measurement systems [13]. An important factor is to recognize and credit people's expertise in their field and to leverage their expertise/specialties for business success.

The process component includes standard processes for knowledge contribution, content management, knowledge retrieval, project implementation based on knowledge reuse, methodology and document formats and so on. All processes must be kept as clear and simple as possible and well understood by employees across the entire organization. KM technologies provide great support to the KM system. The most popular form is the Knowledge Portal on the Corporate Intranet and extranet. Common technologies used on the Knowledge Portal include standard Microsoft technologies or Lotus Notes databases.

2.2. Social Networks

Recently, there is an increasing interest in social networks and a huge or rapidly growth of user population in successful social networks. The most popular social networks grow their membership through viral marketing – the natural human behavior that causes people to tell other about products or services that are particularly good or bad [14]. Table 1 lists some currently most popular social network websites.

The most common feature of social network sites is a profile. A typical profile includes identifying information (such as a photo), and contact information (such as email address). Nowadays, many people use social network sites to maintain existing relationships and develop new ones. Members described an increase in their social productivity and reported the use of social networking sites to re-establish connections with lost friends and to view friends through their profile [5].

Name	URL	Focus	Registered Users*
Facebook	Facebook.com	Upload photos, post video, get news, tag friends	70,000,000
MySpace	Myspace.com	Video, movies, IM, news, blogs, chat	110,000,000
LinkedIn	linkedin.com	Business	22,000,000
Windows Live Spaces	spaces.live.com	Blogging	120,000,000
Bebo	Bebo.com	Similar to Facebook, generally popular in the US, UK and Ireland	40,000,000
Fotolog	Fotolog.com	Photo Blogging	15,000,000

**The Number of registered users is taken from http://en.wikipedia.org/wiki/List_of_social_networking_websites*

Table1: Social Network Websites

The profile is crucial in the use of social network sites. Some social network sites require a lot of personal information; this causes a big public concern about the privacy issue. Recently, Facebook introduced features to address privacy and control over access to the information. Facebook users can change the privacy level through their account setting and only let certain groups/networks of

people to have access to their profiles. There are two main representations of the social network model: Graph and Matrix:

2.2.1. Graphic Representation of Social Network Model

There are different types of graphs: bar chart, pie chart, line chart and so on. While network analysis uses (primarily) one kind of graphic display that consists of nodes to represent the actor/entity and lines to represent the relations. When sociologists borrowed this way of graphing things from the mathematicians, they re-named their graphics "sociograms" [7].

There are a few variations on the theme of sociograms, but they all share the common feature of using a labeled circle for each actor/entity in the population that we describing, and the line part between pairs of actors to represent the relation between the two. Let's look at one example, assuming that we have a group of four people (Bob, Alan, Carol and David). We want to represent the friendship between them. We asked each member of the group (privately and confidentially) who they regarded as "Close friends" from a list of remaining members in the group. Each of the four people could choose none to all three of the others as "close friends". In our case, Bob chose Carol and David, but not Alan; Carol only chose David; David chose Bob and Alan and Carol; and Alan chose only David. We would represent all the information in the following graph.

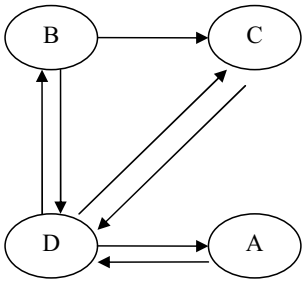


Figure 2: Graphic Representation of Social Relations

2.2.2. Matrix Representation of Social Network Model

The graph is a very useful way to present information about the social network. However, when there are so many actors and different kinds of relations, they can be so difficult to view patterns. Thus, we can use matrices to represent social networks. A matrix is an arrangement of items, which are represented in rows and columns within a table. The simplest way of representing the relation is binary. That is, if a relation exists, a one is entered in that cell; if there is no relation, a zero is entered. The matrix is called an "adjacency matrix" because it represents who is next to, or adjacent

to whom in the social space mapping the relations that we measured. Let's look the previous example – the direct graph of relationship between Bob, Carol, David and Alan in Figure 1. Now all the same information can be represented in a matrix. See in table 2.

	Bob	Carol	David	Alan
Bob	-	1	1	0
Carol	0	-	1	0
David	1	1	-	1
Alan	0	0	1	-

Table 2: Matrix Representation of Social Relations

2.3. Usages of Social Network Sites and Case study

Social Network sites offer a great way to share information among people in the easiest way possible. We categorized them into three categories:

- Communication – Keep in touch with people and other tools. E.g. MySpace, Facebook, LinkedIn.
- Distribution – Make easy to share information from anywhere. E.g. Flickr (Photo sharing), TeacherTube (Instructional Teacher Video sharing).
- Organization – Keep all your information handy and accessible with these tools. E.g. Dell.icio.us (social bookmaking).

A typical case study is provided for instance in j4b (it is a UK web-based service that provides small and medium size business across Europe with information about grants and other funding opportunities). The company decided to use a public social network platform as a cheaper and faster alternative to build their own service. They invited users to join a social network run on Viadeo, and 700 signed up within two days. Many of their clients are small or medium sized businesses, and thus they were interested to have a forum for information sharing and advice between themselves. Using the social network helps customers but also provides j4b with valuable insights into their customers' needs [15]. For example, some clients discussed challenges around applying for funding for agricultural projects in Northern Ireland, an area that the site hasn't covered previously.

2.4. Knowledge Management and Social Networks

Social networks whether supported by relationships established through computer environments or not, serve as a base for communities of practice. Communities of practice [2], in turn, serve as a base for knowledge management [3].

We can look at KM into two different directions – codification and collaboration. Codification is the idea of taxonomy, such as system defined taxonomy, user defined taxonomy. The problem is there seems too much taxonomy in nowadays. On the other hand, collaboration is gaining momentum with the evolution of Web 2.0 technologies. Collaboration can be more beneficial than simply going through documentation. Collaboration has always been a centre position of sharing thoughts in the human society. Social network can help and support knowledge sharing by focusing on various core applications of knowledge management, for example:

- identify experts in the field and their expertise and knowledge;
- research into the transfer and sustainable conservation of tacit knowledge [12]
- discovery of opportunities to improve communication processes and efficiency [12]

It's becoming clear that the core of information flow exists in social networks. Most people learn through their social connections, both formal (at work) and informal (family and friends) [11]. People are influenced by their connection in the network. By applying social network analysis to knowledge management, we can influence people (actor in the network), their relationships and network structure to improve knowledge sharing between individuals, groups, and organizational departments/units or the whole organization.

3. Discussion and Research Approach

The goal of this research is to find a new way to apply social network to knowledge management in organizations. The research model is shown in Figure 3.

The model represents three stages involved in this research and various methodologies associated with each study. The case study we used is the current library system in Dublin City University. The first was a qualitative study based on semi-structured interviews with 3 librarians in Dublin City University. From the interview and the feedback, we can observe that they were aware social networks. They were familiar with most popular social networks such as Bebo, Facebook and MySpace. They also suggested that social networks could be a suitable way to improve library services and manage knowledge. However, while regarding to knowledge management, they were not aware on how social networks could be used in detail to search information. Based on this initial feedback, we are currently carrying out a second study in which we survey members of social networks such as Bebo, Facebook and LinkedIn. For this we are using an online survey. In conjunction with this survey, we are also preparing a computer lab experiment, in which we apply a

simple social network approach to knowledge management. There will be 50 undergraduate students to attend the experiment. They will be given numbers of tasks on social network sites. The typical task could be “profile design”, and “maintain a new relationship on Facebook”.

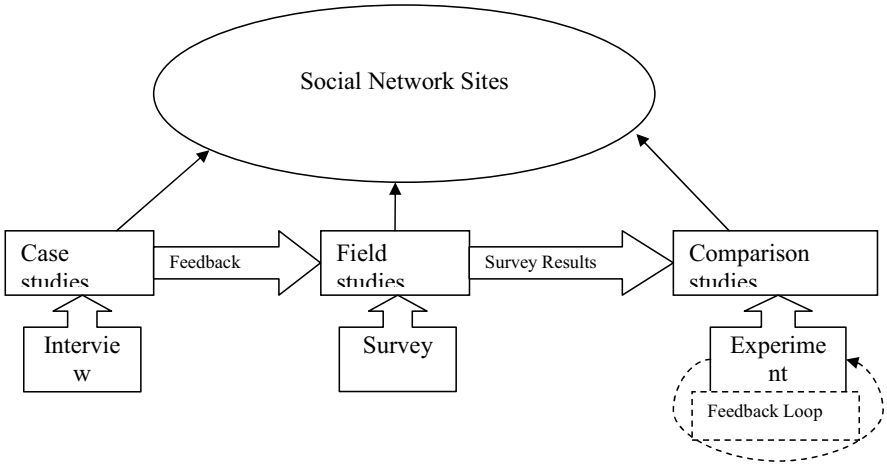


Figure 3: The Research Model for Social Network and Knowledge Management

4. Discussion and Conclusion

Traditionally, people turn to other people to find new contacts, because it is the simple, fast and easy way to do it. With the aid of information technology based environments, it is not only the end contact that is important for knowledge dissemination and collaboration, but also the contacts in between actors. Social networks in organization might support a natural way of searching for information.

The work described in this article provides a brief overview of social network sites, the relationship between social networks and knowledge management. We have discussed some options of social network for knowledge management. Based on the proposed combination of social networks and knowledge management, we plan in our future research to detail this concept and validate a simplified scenario via a laboratory based scenario. Our current collaboration with experts in the library at Dublin City University will be extended. We expect valuable feedback for using our approach in practice. However, people need to be more aware about the situation and understand the

long-term implications of social networking tools. We hope that the work we discussed would help to build a foundation of future investigation of these and other important issues about social network sites.

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ERP SYSTEMS SELECTION CRITERIA: A COMPARATIVE STUDY OF SLOVAK AND SLOVENIAN SMES

František Sudzina[1], Andreja Pucihar[2], Gregor Lenart[2]

Abstract

Enterprise resource planning (ERP) system selection process is an important step in ERP adoption, since inadequately selected ERP may affect companies' market share and implementation time, effort, and cost. The selection process is not very well understood, as there are very few empirical studies of it. The research conducted in Slovakia and Slovenia focused on selected criteria, which influence the enterprise resource planning system selection process in small and medium enterprises (SMEs). Examined were criteria, which are both system- and vendor-specific. The article estimates the importance and differences of factors in relation to a country, company size, turnover growth, information strategy, and representation of the IT department on the board level.

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 information to reduce costs and to improve management of business processes [1]. Authors of [10] 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.

ERP systems used to be a domain of large companies, but there is an increasing number of SMEs adopting them as well. There are some reasons for this trend, including a saturation of the market, as most large organizations have already implemented an ERP system, increasing possibilities and

[1] Copenhagen Business School, Denmark
[2] University of Maribor, Slovenia

need for the integration of systems between organizations and the availability of relatively inexpensive hardware [6]. An interesting research question arises: What ERP system selection criteria should be included in the decision making?

ERP systems received a lot of attention in recent years; there are many ERP systems research instances and quite a lot of reviews, e.g. [4], [9] and [3]. However, the latter does not mention the ERP system selection issue at all – although evaluation of information systems investments as such is rather old. Researchers, such as [5] and [7], began working on evaluation of information systems in 1960s. But also according to [8] very little had been written about ERP system selection criteria even in academic journals. This was the motivation for our research.

2. Data and Methodology

The questionnaire research was conducted in May and June 2007. Questionnaire forms accompanied by cover letters were mailed to randomly selected companies in Slovakia and Slovenia. Lists of addresses and information about the number of employees were retrieved from respective Statistical Bureaus. In each country, 600 questionnaires were sent to small companies and 300 to medium companies. The number of questionnaires mailed to small companies was double the number of medium companies because small companies constitute the highest proportion of companies and based on our personal experience, they are less likely to respond. In total, there were 110 responses (61 from Slovakia, and 49 from Slovenia).

The questionnaire survey is based on criteria identified in [2]. Y2K readiness and EURO currency conversion were left out because they are not relevant anymore. Criteria used in the research are: reduced cycle times, enhanced decision making, improved service levels/quality, incorporation of business best practices, business process improvement, integrated and better quality of information, e-business enablement, increased organizational flexibility, increased customer satisfaction, improved innovation capabilities, enabler for desired business processes, organizational fit of system, software costs (licenses, maintenance, etc.), functionality of the system, system flexibility, systems reliability, advanced technology, operating system independency, system interoperability, internationality of software, system usability, vendor reputation, vendor support, market position of vendor, availability of an industry focused solution, short implementation time, enabling technology for CRM, SCM, etc., connectivity (intra/extranet, mobile comp., ...). The importance of these dependent variables is measured on Likert scale 1-5, where 1 is of very little importance and 5 is of very high importance.

Independent variables are country, company size, turnover growth, representation of the IT department on the board level (CIO) and information strategy. The research was conducted in Slovakia and Slovenia. Analyzed are small and medium companies, where companies from 10 to 49 employees are considered to be small enterprises and companies from 50 to 249 employees are considered to be medium enterprises. Turnover growth over the years 2004-2006 is divided into five categories: reduction in turnover, stable turnover, turnover growth of 0-5%, turnover growth of 5-10%, and turnover growth of more than 10%. Information strategy stands for formal information strategy, and representation of the IT department on the board level means that there is a CIO or a like director for IT.

All analyses (tables 1-14) are analysis of variance (ANOVA). A multivariate approach is used and results are commented on confidence level $\alpha = 0,05$. Significant relationships in the tables are marked by an asterisk (*). The Tukey-Kramer multiple-comparison test is used to identify significant differences between instances of an independent variable. Standardized Cronbach's alpha is used to measure consistency of chosen selection criteria. It is suggested that it should be at least 0,7.

3. Empirical Results

This section offers statistical tests of relationships between ERP selection criteria and independent variables. The first 13 subsections analyze the following individual criteria: reduced cycle times, incorporation of business best practices, business process improvement, integrated and better quality of information, e-business enablement, system flexibility, advanced technology, system interoperability, system usability, vendor support, market position of vendor, availability of an industry-focused solution, enabling technology for CRM, SCM, etc. The last subsection analyzes the relationship between all the criteria. There was no significant relationship found between enhanced decision making, improved service levels/quality, increased organizational flexibility, increased customer satisfaction, improved innovation capabilities, enabler for desired business processes, organizational fit of system, software costs, functionality of the system, systems reliability, operating system independency, internationality of software, vendor reputation, short implementation time, connectivity, and independent variables, so these criteria are not present in the following subsections.

3.1. Reduced cycle times

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of reduced cycle times is presented in Table 1.

Table 1: Reduced cycle times

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	9,029022	9,029022	11,69	0,000974*
Company size	1	3,852307	3,852307	4,99	0,028220*
Growth	4	8,998839	2,249710	2,91	0,026185*
CIO	1	0,748736	0,748736	0,97	0,327760
Information strategy	1	0,387838	0,387838	0,50	0,480617
S	84	64,90678	0,772700		
Total (Adjusted)	92	87,95699			
Total	93				

The importance of reduced cycle times depends on the country (it is 3,23 on average in Slovakia and 3,88 in Slovenia), company size (3,77 on average in small and 3,34 in medium companies), and turnover growth (there is a difference between companies with reduction in turnover (2,75) and companies with growth of 5% and more (3,92 for 5%-10% growth and 3,88 for 10%+ growth)).

3.2. Incorporation of business best practices

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of incorporation of business best practices is presented in Table 2.

Table 2: Incorporation of business best practices

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,455090	0,455090	0,65	0,420720
Company size	1	0,439723	0,439723	0,63	0,428643
Growth	4	4,410525	1,102631	1,59	0,185714
CIO	1	0,017752	0,017752	0,03	0,873408
Information strategy	1	3,137959	3,137959	4,52	0,036626*
S	81	56,28276	0,694849		
Total (Adjusted)	89	64,1			
Total	90				

The importance of incorporation of business best practices depends on information strategy (it is 4,12 on average in companies with information strategy and 3,70 in companies without information strategy).

3.3. Business process improvement

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of business process improvement is presented in Table 3.

Table 3: Business process improvement

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,327082	0,327082	0,56	0,456017
Company size	1	0,015500	0,015500	0,03	0,870887
Growth	4	1,876963	0,469241	0,80	0,525649
CIO	1	0,947048	0,947048	1,62	0,206086
Information strategy	1	2,564150	2,564150	4,40	0,039043*
S	83	48,40089	0,583143		
Total (Adjusted)	91	53,25			
Total	92				

The importance of business process improvement depends on information strategy (it is 4,45 on average in companies with information strategy and 4,08 in companies without information strategy).

3.4. Integrated and better quality of information

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of integrated and better quality of information is presented in Table 4.

Table 4: Integrated and better quality of information

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	1,210149	1,210149	1,90	0,171744
Company size	1	0,002190	0,002190	0,00	0,953385
Growth	4	7,983189	1,995797	3,13	0,018663*
CIO	1	0,072090	0,072090	0,11	0,737420
Information strategy	1	0,212241	0,212241	0,33	0,565354
S	86	54,79854	0,637192		
Total (Adjusted)	94	63,53684			
Total	95				

The importance of integrated and better quality of information depends on turnover growth (there is a difference between companies with growth of 0-5% (3,95) and companies with growth of 10% and more (4,73)).

3.5. E-business enablement

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of e-business enablement is presented in Table 5.

Table 5: E-business enablement

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	39,24377	39,24377	40,59	0,000000*
Company size	1	0,228351	0,228351	0,24	0,628261
Growth	4	3,187652	0,796913	0,82	0,513426
CIO	1	0,787138	0,787138	0,81	0,369516
Information strategy	1	0,199575	0,199575	0,21	0,650777
S	83	80,24929	0,966859		
Total (Adjusted)	91	126,5543			
Total	92				

The importance of e-business enablement depends on the country (it is 3,08 on average in Slovakia and 4,45 in Slovenia).

3.6. System flexibility

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of system flexibility is presented in Table 6.

Table 6: System flexibility

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,102943	0,102943	0,19	0,663682
Company size	1	0,173136	0,173136	0,32	0,572956
Growth	4	3,390241	0,847560	1,57	0,190496
CIO	1	0,344332	0,344332	0,64	0,427075
Information strategy	1	3,134955	3,134955	5,80	0,018245*
S	83	44,86554	0,540549		
Total (Adjusted)	91	52,55435			
Total	92				

The importance of system flexibility depends on information strategy (it is 4,50 on average in companies with information strategy and 4,09 in companies without information strategy).

3.7. Advanced technology

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of advanced technology is presented in Table 7.

Table 7: Advanced technology

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,055819	0,055819	0,10	0,749386
Company size	1	2,216926	2,216926	4,08	0,046652*
Growth	4	2,405247	0,601312	1,11	0,359033
CIO	1	0,521222	0,521222	0,96	0,330240
Information strategy	1	0,479804	0,479804	0,88	0,350118
S	82	44,55272	0,543326		
Total (Adjusted)	90	50,72527			
Total	91				

The importance of advanced technology depends on company size (it is 4,10 on average in small and 3,77 in medium companies).

3.8. System interoperability

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of system interoperability is presented in Table 8.

Table 8: System interoperability

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	11,717350	11,717350	19,07	0,000038*
Company size	1	0,022426	0,022426	0,04	0,848983
Growth	4	3,254410	0,813603	1,32	0,268387
CIO	1	0,611390	0,611390	1,00	0,321587
Information strategy	1	1,221729	1,221729	1,99	0,162477
S	78	47,92391	0,614409		
Total (Adjusted)	86	63,95402			
Total	87				

The importance of system interoperability depends on the country (it is 3,22 on average in Slovakia and 3,99 in Slovenia).

3.9. System usability

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of system usability is presented in Table 9.

Table 9: System usability

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,262696	0,262696	0,42	0,519418
Company size	1	0,230460	0,230460	0,37	0,546164
Growth	4	1,985934	0,496483	0,79	0,534181
CIO	1	1,627981	1,627981	2,60	0,111138
Information strategy	1	3,814723	3,814723	6,08	0,015805*
S	80	50,18757	0,627345		
Total (Adjusted)	88	57,97753			
Total	89				

The importance of system usability depends on information strategy (it is 4,58 on average in companies with information strategy and 4,11 in companies without information strategy).

3.10. Vendor support

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of vendor support is presented in Table 10.

Table 10: Vendor support

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,536445	0,536445	0,69	0,408580
Company size	1	0,414320	0,414320	0,53	0,467462
Growth	4	2,017594	0,504398	0,65	0,629274
CIO	1	1,180969	1,180969	1,52	0,221323
Information strategy	1	4,214826	4,214826	5,42	0,022403*
S	80	62,18150	0,777269		
Total (Adjusted)	88	69,97753			
Total	89				

The importance of vendor support depends on information strategy (it is 4,55 on average in companies with information strategy and 4,06 in companies without information strategy).

3.11. Market position of vendor

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of market position of the vendor is presented in Table 11.

Table 11: Market position of vendor

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	5,637192	5,637192	5,89	0,017474*
Company size	1	0,461574	0,461574	0,48	0,489314
Growth	4	3,794333	0,948583	0,99	0,417112
CIO	1	1,445402	1,445402	1,51	0,222629
Information strategy	1	2,715079	2,715079	2,84	0,095984
S	79	75,56821	0,956560		
Total (Adjusted)	87	87,89773			
Total	88				

The importance of market position of the vendor depends on the country (it is 3,03 on average in Slovakia and 3,56 in Slovenia).

3.12. Availability of an industry-focused solution

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of availability of an industry-focused solution is presented in Table 12.

Table 12: Availability of an industry focused solution

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	0,603140	0,603140	0,94	0,336403
Company size	1	0,177795	0,177795	0,28	0,600988
Growth	4	3,119191	0,779798	1,21	0,313398
CIO	1	2,716925	2,716925	4,21	0,043354*
Information strategy	1	0,203510	0,203510	0,32	0,575850
S	81	52,24138	0,644955		
Total (Adjusted)	89	59,28889			
Total	90				

The importance of availability of an industry-focused solution depends on representation of the IT department on the board level (it is 3,64 on average in companies with CIOs and 4,00 in companies without CIOs).

3.13. Enabling technology for CRM, SCM, etc.

The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), and information strategy on the importance of enabling technology for CRM, SCM, etc. is presented in Table 13.

Table 13: Enabling technology for CRM, SCM, etc.

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	6,08563	6,08563	5,85	0,017891*
Company size	1	5,24739	5,24739	5,05	0,027516*
Growth	4	5,80307	1,45077	1,40	0,243468
CIO	1	1,31748	1,31748	1,27	0,263810
Information strategy	1	4,36072	4,36072	4,19	0,043954*
S	78	81,11736	1,03997		
Total (Adjusted)	86	100,9195			
Total	87				

The importance of enabling technology for CRM, SCM, etc. depends on the country (it is 3,11 on average in Slovakia and 3,66 in Slovenia), company size (it is 3,64 on average in small and 3,13 in medium companies), and information strategy (it is 3,64 on average in companies with information strategy and 3,14 in companies without information strategy).

3.14. Intercriteria comparison

Although there is a high correlation between selection criteria (standardized Cronbach's alpha = 0,902 724), there are significant differences between the selection criteria. The analysis of the impact of country, company size, turnover growth, representation of the IT department on the board level (CIO), information strategy, and criterion on criteria evaluation is presented in Table 14.

Table 14: Intercriteria comparison

Source Term	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio	P-value
Country	1	20,90492	20,90492	26,90	0,000000*
Company size	1	0,05316	0,05316	0,07	0,793713
Growth	4	17,92208	4,48052	5,76	0,000129*
CIO	1	8,63452	8,63452	11,11	0,000871*
Information strategy	1	27,87283	27,87283	35,86	0,000000*
Criterion	27	370,00890	13,70403	17,63	0,000000*
S	2516	1955,497	0,77722		
Total (Adjusted)	2551	2385,827			
Total	2552				

The importance of selection criteria depends on country (it is 3,85 on average in Slovakia and 4,04 in Slovenia), turnover growth (there is a significant difference between companies with turnover growth of 5-10% on one hand and all three groups of companies with lower turnover (i.e. reduction

in turnover, stable turnover, turnover growth of 0-5%) on the other hand; and between companies with turnover growth of 0-5% on one hand and companies with turnover growth of more than 10% on the other hand; it is 3,84 on average in companies with reduction in turnover, 3,91 in companies with stable turnover, 3,86 in companies with turnover growth of 0-5%, 4,08 in companies with turnover growth of 5-10%, and 4,01 in companies with turnover growth of more than 10%), representation of the IT department on the board level (it is 3,88 on average in companies with CIOs and 4,00 in companies without CIOs), information strategy (it is 4,06 on average in companies with information strategy and 3,83 in companies without information strategy), and criterion, which is presented in Table 15 in detail.

Table 15: Comparison of selection criteria

Criterion	Average
Internationality of software	3,16
Market position of vendor	3,29
Enabling technology for CRM, SCM, etc.	3,40
Vendor reputation	3,45
Operating system independency	3,50
Improved innovation capabilities	3,57
System interoperability	3,65
E-business enablement	3,67
Reduced cycle times	3,69
Incorporation of business best practices	3,77
Enabler for desired business processes	3,82
Short implementation time	3,87
Connectivity (intra/extranet, mobile comp., ...)	3,88
Availability of an industry focused solution	3,92

Criterion	Average
Advanced technology	3,95
Increased organizational flexibility	4,01
Enhanced decision making	4,09
Software costs (licenses, maintenance, etc.)	4,09
Increased customer satisfaction	4,19
Business process improvement	4,26
Vendor support	4,29
System usability	4,29
System flexibility	4,34
Improved service levels/quality	4,35
Organizational fit of system	4,38
Functionality of the system	4,41
Integrated and better quality of information	4,46
Systems reliability	4,61

In Table 15, there are significant differences between criteria, where averages differ by at least 0,49. It should not be concluded that the criteria in Table 15 with lower rating are not important. Even they score above average, since only criteria believed to be relatively important were chosen.

4. Conclusion

The top 10 ERP selection criteria for Slovak and Slovenian SMEs are:

1. systems reliability,
2. increased customer satisfaction,
3. business process improvement,
4. vendor support,
5. system usability,

6. system flexibility,
7. improved service levels/quality,
8. organizational fit of system,
9. functionality of the system,
10. integrated and better quality of information.

There is no significant difference between systems reliability and the remaining nine criteria. Price (software costs), which might be intuitively expected to rank high because of economic reasons, is the 11th most important one. So, there is a significant difference between system reliability and price. All other criteria, which are significantly different from price, are of lower importance.

A surprising finding is that availability of an industry-focused solution is less important for companies with representation of the IT department on the board level. A probable reason is that SMEs, which are highly IT-focused, can utilize general-purpose ERP systems for their purposes.

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Perspective(s) of Future(s)

TECHNOLOGICAL FORECAST IN PERSPECTIVE(S)

Christian W. Loesch[1]

Abstract

The desire for understanding the present and divining the future has always been inherent in human nature to cope with the future and its risks. But we have to keep in mind that all forecasts (FC) are opinions on the future, more or less profound, responsible or futile. K. Popper argues that it is for strictly logic reasons impossible predict the future course of history and C. v. Clausewitz writes that the volume of relevant factors to be considered surpasses human capabilities. FC are becoming even more complex evolving from static structural thinking models to dynamic process thinking, self-organization, order through fluctuation and dissipative structures..

The increasing leverage of mankind on its future and the development of science have instigated the development to enrich non-scientific approaches by scientific methods. Technology FC as e.g. the Delphi method, brainstorming, regression analysis, scenario planning or technology road mapping can be defined as the methodology and practice of predicting the future state of technology.

We will examine examples from business and the factors impacting the implementation. The increasing risk of FC based decisions in industries resulted in high quality technology FC. Reviewing some of it findings, technologies which may forge the future as Nanotechnology, Fabricators, Spintronics, Quantum computing, Medico-electronics or Photonics will complement our session.

1. Introduction

” God does not throw dices”
A. Einstein

1.1. Philosophy and FC

The search for causality accompanied human thinking probably because without causality a disquieting feeling of helplessness can arise and it seems to be a better feeling to be responsible having thus the illusion or possibility of influence.

[1] Vienna, Austria; cwl001@attglobal.net

The principle of causality is already appearing at Democritus, at the Stoics and Epicure; the scientific causal concept has been introduced by G. Galilee and J. Kepler.

I. Kant regarded the principle of causality as apriori condition to the possibility of experience. The question of causality and determinism has been discussed since centuries and is actually discussed on the background of the free will by neurophysiology.

The paradigm of determinism can be understood as the success story of science since P. S. Laplace,

But the development and achievements of modern physics changed the prevailing paradigm.

K. Popper understands himself as representative of the physical indeterminism, and argues that it is for purely logic reasons impossible to predict the future course of history because it is strongly influenced by the growth of human knowledge. Since we cannot predict the future growth of our scientific knowledge, it means that no society can scientifically predict its own future states of knowledge. Therefore, we cannot predict the future [14]

1.2. From Philosophy to Physics

The belief in a well-understood statically clear picture of the world in science has been shattered at the end of the 19th century. The 20th century brought several breakthroughs in physics revolutioning the 19th century understanding of the world. It is connected with names as Heisenberg, Schrödinger, Boltzmann, Plank or subjects as Quantum physics and uncertainty relation; also the concept of Entropy creating a direction of time is incompatible with the consequences of Laplace, even before it was even more extended by the introduction of self-organization, dissipative structures, bifurcation or order through fluctuation as heralded by I. Prigogine [12, 19] and others.

2. Technological Forecasting (TFC)

TFC can be defined as the methodology and practice of predicting the future state of technology and extend of its use.

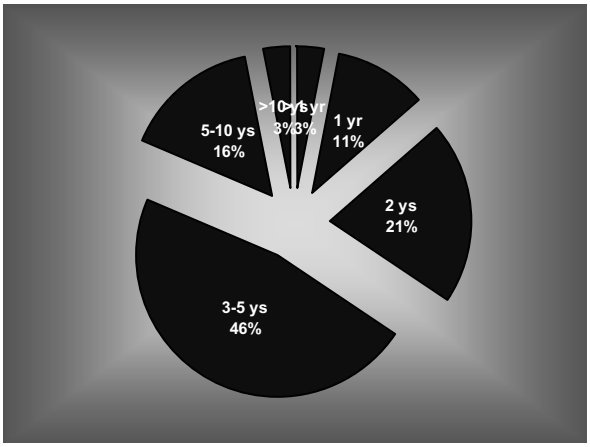
Early TFC as developed in the 40´s through the 60´s and effectively captured in monographs by Jantsch, Ayres, Martino etc, has not flourished. The concept of TFC had its core in the application of mathematical tools of modest sophistication and the analysis of historic trends in order to forecast future developments. By the end of 60´s interest dropped, society was stable and the economy booming. But nevertheless technological forecasting emerged as a recognized

management discipline around 1960. With the increase of risk associated with wrong decisions forecasting has become increasingly important. In order to effectively prepare business strategies in the technologically fast-paced world it has become imperative for companies and policymakers to apply more sophisticated models and techniques. The development of the Delphi Method by the Rand Corporation (Ted Gordon and his associates) looked like a potential shortcut. Normative FC became popular in WWII and the post-war period of the Cold War and space age (man on the moon). In the civil sector the PERT charts became a forecast.

It took not long to the rise an increasing interest in the future and consequently in TFC. Governments and many organizations moved into forecasting as Japan in the 1970, the OECD, UN, Fraunhofer Institute.

Times have never been better for forecasting. Today there are myriads of forecasting techniques on the market, ranging from simple extrapolations to Delphi techniques TRIZ, corporate models and OR applications. An additional trend in FC over the last decennium has been the shift from acute attention to technical astuteness to a growing consideration of how to deliver the message, a shift from correctness and analytic elegance to emphasis on the communication of results. [5]

A recent study of the Economist Intelligence Unit [6] shows the present use of FC status in industry:



PICTURE 1: Study Risk 2018 "How far into the future does your company plan"

It smacks of hubris to say that one can predict the future, but much benefit can be gained from considering what the coming years might hold. To check the quality of forecasts the highly reputed

journal Scientific American compared the forecasts of an article in October 1920 aiming 75 years into the future in 1936 as follows:

38 %	already verified
30 %	nearly certain to be verified
8 %	proven wrong
3 %	probably be proven wrong
22 %	uncertain

Steinmetz (Chief scientists of GE Corp) made 25 predictions relating to housekeeping in 1915 by 1936 their status was as the following:

28 %	fulfilled
48 %	destined to be fulfilled
24 %	doubtful
0 %	proven wrong

2.1. Limits to technological FC

No matter all the industrial companies are in the business of forecasting the future: what a customer will buy, how a product can be made more attractive, how competitive it will stay or how new laws will affect profit margins. The company that forecast the future is the company that is going to lead the market. In addition to the arguments stated above, we cannot forecast completely new technologies for which there are no existing paradigms.

2.2. The Human Factor

Nevertheless having good forecasts does not mean you can implement them without problems. There are potential sociological and psychological barriers of technology transfer both in interfacing the user as well by the prevailing organization culture, some of these will address below. [6]

Internal psychological barriers have to be overcome; we are prisoners of our basic images of reality. The influence and bias of personal or vested interests on forecast results both intentional and unintentional should not be underestimated. Ethnical, gender and other factors can be of importance but can be integrated into the planning process. We will discuss in the context of the ITRS and IBM

where examples the integration of personal interest and responsibility is a crucial factor to make these forecasts successful.

The “Stock option model” approach is another approach mobilizing the hidden knowledge and attitudes of employees to contribute to corporate forecasting.

Famous predictions show that the human factor is not always very helpful, (in spite of assuming that the present population is the result of f selection of the better forecasters throughout millennia).

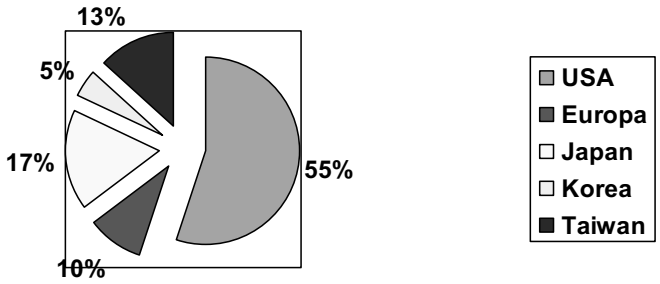
- “640k are enough” Bill Gates, Microsoft,
- “Five Computer will be enough”, Watson, IBM
- TV (Darryl F Zanuck, 20th Century Fox) “TV wont be able to hold on to any market”,
- Motion Pictures – “books will be obsolete” Thomas A. Edison,
- Telephone (US Pres .R. Hayes)”an amazing invention but who would ever want one?”
- William Orton (Pres. of Western Union) rejects telephone patents for 100 00 $ “what use can this company make of an electrical toy”,
- McKinsey (1981) less than 1 mio mobile phones in US by 2001 (YTD > 130 mio users)
- “Two years from now spam will be resolved“Bill Gates 2004.

3. From Theory to Business

Due to the high if not existential risk of decisions in industry forecasting has reached special importance and quality, especially in fast developing industries as IT, aerospace aso.

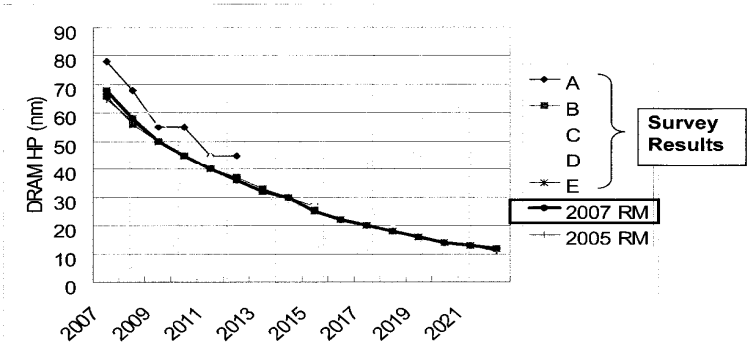
3.1. ITRS

The International Technology Roadmap for Semiconductors, known throughout the world as ITRS, is the fifteen-year assessment of the semiconductor industry’s future technology requirements. It constitutes worldwide organizations with participants reflecting the structure of the IT world in its composition as shown below:



Picture 2: ITRS representation [10]

The picture below shows a comparison between the forecast of a key feature of IC technology DRAM (half pitch) by ITRS and the achievements of three leading companies, proving the quality of the forecasts. [10]

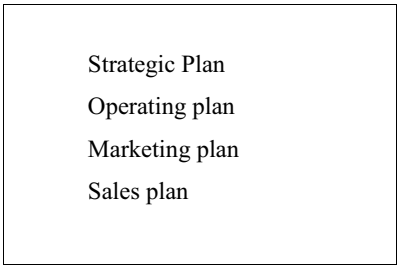


Picture 3: Scaling of DRAM (half pitch) [10]

The quality of the planning process is enhanced by the knowledge of the participants that the forecast can become a practical commitment to achieve it in competition with other companies participating and thus a self fulfilling prophecy.

3.2. IBM Planning & FC System

The IBM planning system is an example of a combination of rational data based research, business cases and human assessments. It consists of several strings of inputs consolidated into a plan in a bottom-up and top-down process. A key feature is the regular review and updating process leading to a revolving planning system. The inputs of different plans are interacting with the strategic plan which has a revolving two years operating plan at its front-end.



Since the quality of the plan and its achievement is a personal responsibility and implies consequences reaching from personal targets to budget, manpower, income and career, forecasting is regarded as an important personal responsibility and not just a theoretical exercise.

There are few major trends developing over years which can not be identified by systematic research.

Nevertheless new revolutionary technologies sometimes appear from nowhere others are heralded by such long fanfares that it seems they will never arrive. The problem is both the detection and the selection; let us look at some of these forecasts especially relevant o ICT.

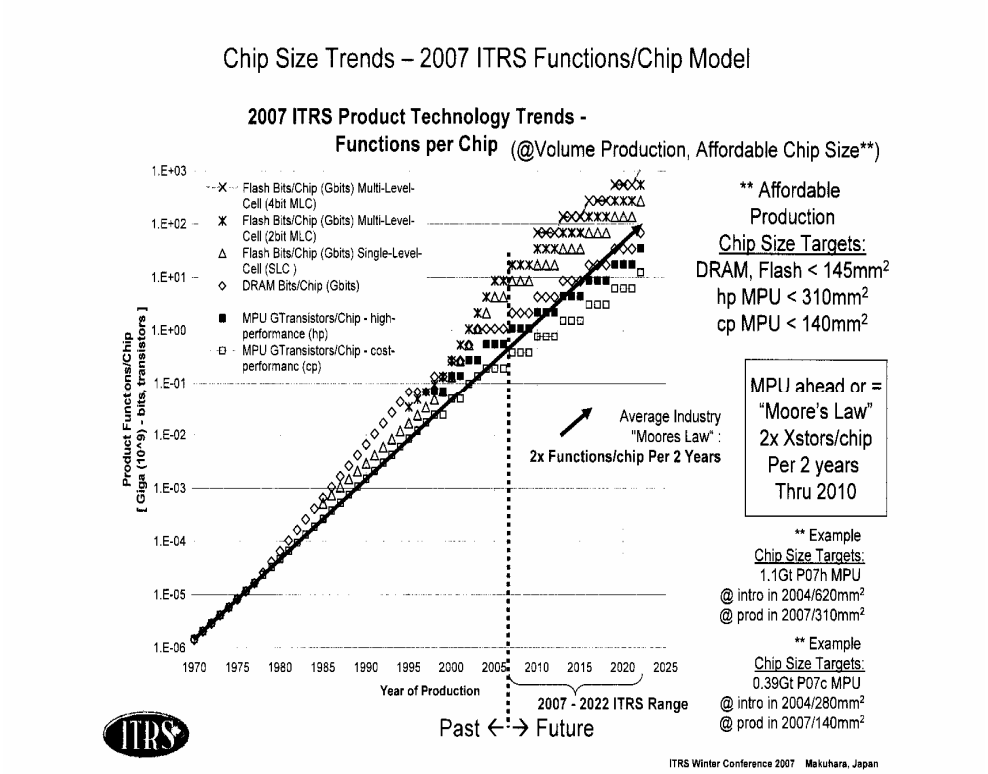
4. Forecast for IT

Each of the following subjects would well merit a monograph or dedicated session but we have to restrain ourselves to the timeframe of our IDIMT 2008 session.

4.1. The future of CMOS

The current ITRS Model 2007 confirms the extension of the exponential CMOS improvements for more than another decade.

The exponential increase will facilitate and is facilitated by developments some of which are spotlighted below:



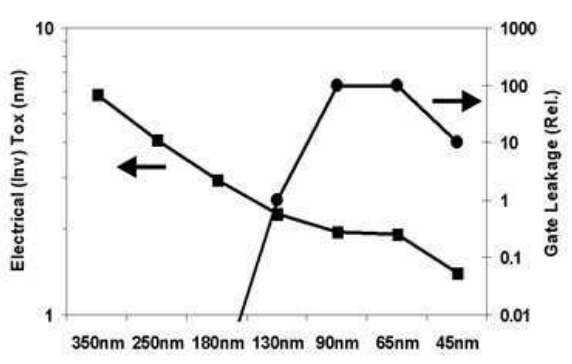
The Tera-scale Computing is one of the efforts for the next decade. . "Tera" means 10^{12} or performing trillions of calculations per second (teraflops) on trillions of bytes of data (terabytes). By scaling multicore architectures to 10s to 100s of cores and embracing a shift to parallel programming, it aims to enable applications and capabilities only dreamt of today [9]

This may mean hardware features as:

- Scalable multi-core architectures with 10-100s integrated processor cores,
- Memory sharing and stacking.
- High Bandwidth I/O and Communications.
- Software supporting model-based applications, make decisions, and synthesize virtual possibilities like ray tracing, physical modelling, visualization, computation, management of massive amounts of data as media mining [6]

4.2. Hafnium and Chips

The ongoing efforts for a continuation of "Moore's law" are still the main thrust in IT. One consequence of these efforts has been the explorations of the periodic table of elements – similar to European navigators search for Spice Islands half a millennium ago. Discoveries range from Indium-tin oxide for transparent and electrically conductive liquid crystal displays; Tantalum with luck unlike spice, the quantities required will not be worth fighting a war for it, to Hafnium a SiO_2 replacement as isolator for gates to solve the leakage problem. Penryn chips having twice as many transistors as their predecessors (a billion) use only one fifth of power.



Picture 4: ITJ vol. 12/02 2008

4.3. Scale out systems

Since system level performance though power dissipation is threatening to create a discontinuity in the development of microprocessor technology, scale out systems may be a solution in some areas. A scale out system is a collection of interconnected, modular low-cost computers that work as a single entity. But system management, reliability and Amdahl's law are challenges to scale-out systems. [1, 8] Applications range from life sciences: protein folding, climate modelling, digital entertainment, data analytics to military applications.

4.4. Cloud computing

Some experts as N. Carr have caught wide attention forecasting that the majority of business-IT will go to the width of Internet. An indication for this may be that in spite of the fact that SW is not ready for utility computing, but storage on demand is growing 33% pa. Users may be afraid of security lacks but data might be more secure in the net than on the computer of the user.

4.5. Rewritable holographic storage

Holographic systems having been announced since many years might finally become ready for sale. Starting with 12 times blue ray or 60 times DVD i.e. 300 GB, improving in few years to 1, 6 TB storage capacity. They can store multiple pages of digital data at slightly different angles in the material at a read/write speed of 160 Mb/sec

4.6. Software

Software will trend to become more complex as needs become more complex, Limitations such as computing power and infrastructure will not longer be concerns. The unprecedented growth in data, brought about by the Internet, will also impact the way how programmers design future software. The human side of programming will remain an issue, noting that factors such as huge computing power and the right infrastructure will not be a guarantee that software engineers will come up with the "right" software. [23]

With increasing needs and costs the pressure to improve SW will rise. Better software tools promise to produce better and low-defect software; this will help but not solve the SW productivity problem. There is plenty of room for improvement as two examples may show.

A recent IBM study tracked 50 developers and found that, 30% of their time was spent coding the rest talking to other members of the team.

The CHAOS Report of the Standish Group reports an improvement from 35% of SW projects on time and on budget in 2006 vs. 16% in 1994 or a project failure rate 19% vs. 31% .in the same timeframe. [24]

4.7. Fabricators

Knowledge intensive manufacturing is coming. Desktop manufacturing or personal fabrication is the use of a personal computer to drive a special printer that deposits (or catalyses) material in layers to form three-dimensional objects. It can be used for making prototypes or objects that have limited demand.

For example, a designer may load a digital design into a Fused Deposition Modelling (FDM) machine. The FDM then extrudes thin beads of ABS plastic in thin layers. That's where organic electronics comes into play. Organic electronics were born in the 1970s when researchers discovered that chemically doping organic polymers, or plastics, increases their electrical

conductivity. Since then, researchers have worked to develop effective and inexpensive organic compounds that can be patterned on flexible substrates to create useful circuits. In the private sector, companies ranging from Bell Labs or IBM to the UK start-up Plastic Logic are also working on the development of quality organic transistors that are fabricated far more cheaply than silicon circuits.

Another proposal is nanofactories also called fabbers that employ arrays of nanoscale machines to assemble macroscopic products from molecular feedstock. This level of control would enable production of high-performance materials that form structures of nearly perfect precision.

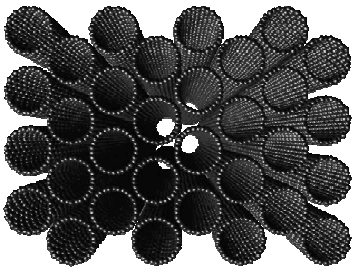
The term "fabber" is also used to refer to hypothetical devices that would be capable of Universal Fabrication. Given a sufficiently detailed set of plans, power and the correct raw feedstock, a universal fabber could produce any manufacturable item, including a copy of itself.

4.8. Nanotechnology

Nanotechnology can be viewed as an evolution from the micro- to the nano regime. To visualize the proportions: a nano-meter to a meter is as a soccer ball to the earth. It has entered microelectronics over a decade ago, so 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 already nanotechnologically enhanced products.

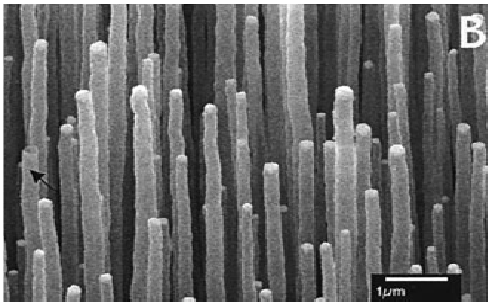
Carbon Nano Tube (CNT) is a revolutionary device, because for the first time dimension of the conducting Channel are controlled by chemically bond lengths and not by some manufacturing process; its electrical and mechanical properties are extraordinary; making the nanotube a contender for the post CMOS arena.

The ideal picture of nanotubes is shown in the picture A below,



Picture A

But as picture B below shows the reality looks a little bit different.

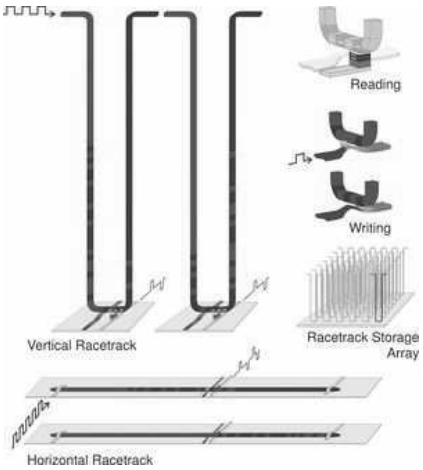


Picture B

Many challenges have to be overcome as the integration on a chip or the contacting of the CNTs. Additionally the expected ballistic nature of transport at sub micrometer dimensions opens a plateau for high frequency applications in the THz regime.

IBM RaceTrack memory

Recently IBM announced next-generation non-volatile memory dubbed "RaceTrack" which is expected to initially replace flash memory and eventually mechanical magnetic hard-disk drives. The prototype encodes bits into the magnetic domain walls along the length of a silicon nanowire, also known as RaceTrack. This method allows "massless motion" to move the magnetic domain walls along the silicon nanowire for the storage and retrieval of information. Such drives would be able to store data nearing 1 Terabytes on a single 3.5inch (8.9cm) drive.



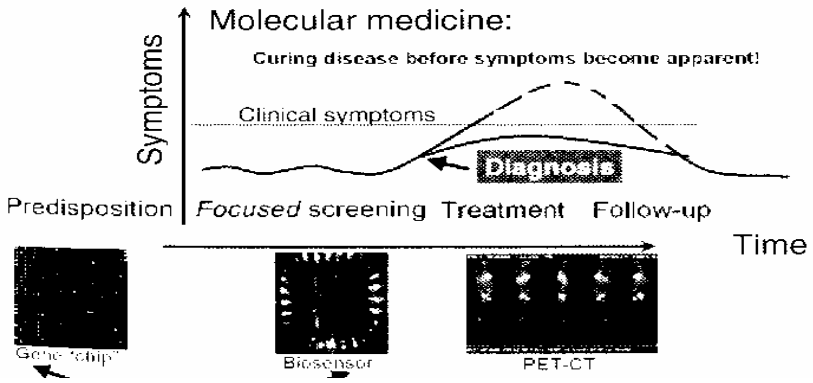
Picture 5: Racetrack memory [IBM Almaden Reseach Centre]

4.9. Medico electronics

Here we are entering a field of symbiosis of IT, physics, biology and medicine and encounter a plethora of potential new IT enabled applications.

The general vision is that IT enabled genetic predisposition testing and early diagnoses using molecular tests and more personalized treatment will lead to improved patient outcomes. Aspects of this vision are referred to as evidence based personalized medicine, or nano-medicine and bioinformatics. It might mean curing diseases before symptoms become apparent! Molecular diagnosis, molecular imaging, are based on microelectronics elements like biosensors, gene chips or may change the current practice of health care. This sector of the economy is projected to grow to 25% of the GDP of industrialized countries in the next the decade and could displace information in technology as a dominant sector of economy.

The promise of molecular medicine is earlier and faster diagnosis, better prognosis and tailored therapy with higher efficiency and reduced side effects, as compared to the present state of art which is based on trial and error basis after serious symptoms have developed. [7].

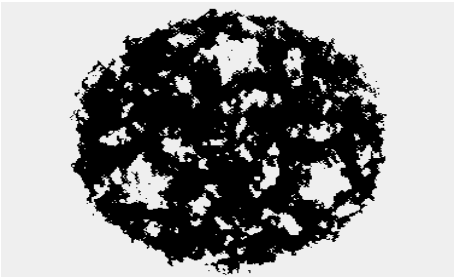


Picture 6: Molecular medicine [7]

Synthetic biology is another newly emerging scientific discipline compressing the knowledge of many disciplines to create novel biological systems with functions that do not exist in nature like derivatives of existing organism (bacteria, yeast, and viruses), designing novel building blocks for

engineering biological systems like viruses. One of the fundamental requirements is the computer assisted ability for large scale DNA analysis, sequencing and synthesis.

For example viruses can be described in chemical terms; the empirical formula of the organic matter of poliovirus being $C_{332,652}$ $H_{492,388}$ $N_{98,245}$ $O_{131,196}$ $P_{7,501}$ $S_{2,340}$ or as computer model of the virus.



Picture 7: Computer model of poliovirus [18]

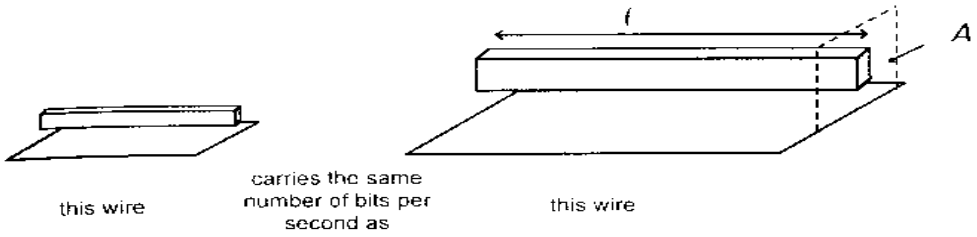
The intriguing dual nature of a poliovirus as an inanimate entity and a replicating organism has led to the question whether the virus can be synthesized in a test tube. Nuclear acid synthesis is already developed at a stage where individual genes can be assembled from their known sequence. [18]

Even more futuristic is the vision that engineered bacteria could become “living computers”, since DNA molecules have the natural ability to store and process information, which would mean the parallel processing power of a million computers all in the space of a water drop.

4.10. Photonics

Optics been around for several decades in many applications ranging from fibre to CD and DVDs and dominates long range communications since years. Basic issues of physics as shown in the picture below make optics attractive for communication of higher density of information over longer distances.

Apart from the advantages in power consumption there is a difference in the capacity for transmission of signals. Wires perform increasingly poorly at higher frequencies, showing signal attenuation and distortion. Scaling a wire in all three dimensions leaves its information capacity the same, through scaling transistors in the same way makes them faster. For many reasons now is optics increasingly considered for communication and interconnect now possible all the way to silicon chips. The implementation is challenging, but recent breakthroughs are promising for the ultimate construction of an integrated low-cost, low-power technology.



PICTURE 8: Wire transmission capacity [18]

4.11. Spintronics

Spintronics describes a technology that makes use 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 Exclusion Principle dictates that the quantum-mechanical wave function of two paired fermions must be antisymmetric, no two electrons can occupy the same quantum state, implying that an entangled pair of electrons cannot have the same spin.

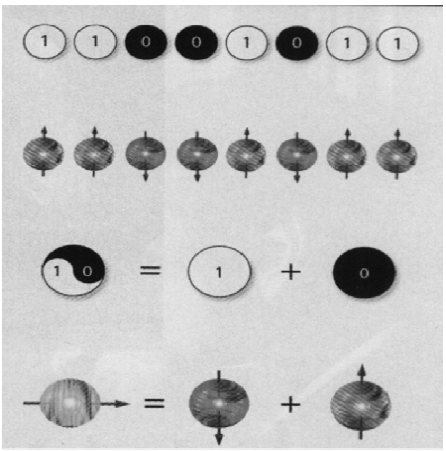
The most widespread application – majority of hard disk heads use it - is based on the giant magnetoresistance (GMR) effect. A typical GMR device consists of at least two layers of ferromagnetic materials separated by a spacer layer. When the two magnetization vectors of the ferromagnetic layers are aligned, an electrical current will flow freely, whereas if the magnetization vectors are antiparallel then the resistance of the system is higher.

Perhaps spintronics' biggest potential lies in embedded memories. Nonvolatile memory devices such as magnetoresistive random access memory (MRAM) will revolutionize the memory market and contribute to the development of sophisticated and versatile computing and personal devices. Promising to introduce innovations such as instantly bootable computers, MRAM looks poised for success.

Spintronics´ promise is very fast switching, reduced power consumption, as well logic gates with fewer element than needed for their charge based counterparts. [24]

The understanding of spin transport is yet not sufficient for digital logic and signal processing. Spin transport differs also from charge transport in that spin orientation is a non-conserved quantity due to spin-orbit and hyperfine coupling.

Future applications may include a spin-based transistor which requires the development of magnetic semiconductors exhibiting room temperature ferromagnetism. One possible material candidate is manganese doped gallium arsenide GaAsMn.



Picture 9: Spintronics basics [SciAm 73, 02]

Much 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.

4.12. Quantum Computing

We will shortly explore two key phenomena of the quantum world for computing and communication. 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 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 such as e.g. a configuration |1,1,0,0,1,0,0,1,0,1,0,0> where 5 electrons are distributed on 12 possible states. The state could be atomic orbital of the quantum material or we can think of them as quantum registers. The number of possible configuration for N_s =12 and N_e=5 is 12![5!(12-5)!]=792 however for only the double number if states and electrons N_s=24 and N_e= 10 gives rise to over a million configurations and rising it to the tenfold leads to 10**70 a number comparable to the number of all atoms on earth. Two qubits can be in four states and 20 particles in a million states. The new field of quantum algorithms has demonstrated that such devices can solve

arithmetic problems (factoring numbers) and search problems much faster than conventional computers by exploiting these properties of devices being in many states at once. During the steps 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. Manipulating one particle and then reading the spin of the other, linked particle is the basis of quantum information teleportation. This has been demonstrated in laboratory conditions and is quoted to be a feasible way to securely distribute cryptographic keys over distances.

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, new types of algorithms are needed that utilize being in multiple states, and new devices that have coherent spin states immune to environmental hazards are still to be invented. The advantages are counterbalanced by the unresolved problems of decoherescence and signal input/output. Error correction first thought impossible seems possible but with an enormous increase in complexity hence it seems only feasible to start with few-bit systems.

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.

Some compare the status of quantum computing today resembling the state before the Abacus, but only future will show if quantum computing will be able to assume a major role.

5. Summary

We perused the world of forecasting from the philosophical, physical and industry point of view and discussed some scenarios. Times have never been better for forecasting making FC an indispensable tool. In FC happened a shift from acute attention to technical astuteness to a growing awareness how to deliver and implement the message, a shift from analytic elegance to emphasis on the communication of results.

Technological forecasting for IC shows Moore’s Law looking healthy for at least another decade. INTEL expects at least another 10 years of biannual doubling, while AMD sees innovations on the horizon that could keep the trend on track through 2020 and is already developing new technology needed for 16 nm transistors, which is on the road map for 2014.

The industry is already looking for some new physics replacing or complementing “charge-based physics”’ by some new physical-switching mechanisms that do not require the movement of an electronic charge. It is too soon to tell, but this is the kind of work that could allow Moore’s Law to continue well beyond 2020.”

Thus there is no reason not to be optimistic in spite of problems to be overcome; but it is also wise not to be too optimistic, since some projects may prove to be just hype, and nobody could ever forecast completely new technologies for which there are no existing paradigms. The future is invented not predicted.

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OPEN SOURCE SOFTWARE - THE NEXT STRIVE FOR INDEPENDENCE IN THE SOFTWARE INDUSTRY

Gerhard Chroust[1], Hartmut Müller[2]

Abstract

Open Source Software is characterized by being independent from many restrictions historically existing in software. To show this point we go through the history of software achievements and order them according to the fields in which independence was achieved: from the separation of hardware and software to independence from intellectual property right. Many of these achievements were the basis for the success of the Open Source Movement and some them can even be found in the characteristics of Open Source.

1. The Start of Software Development

Computers were intended to automate computations by replacing the human control person by some mechanical device - as already exemplified in many other industries of that time. The initial machines were "hand-made" wonders of the (then existing) technology, built at various universities around the world [10], [12], [51], [65].

During the past 60 years tremendous achievements have been obtained. One way to look at these achievements is to interpret them as a strive of computer scientists, software engineers and users for independence from certain restrictions they felt as limiting their needs and their ambitions. The achievements usually had multiple consequences and triggered further achievements as discussed in [13], [14]. Already in 1992 four major directions for independence were identified [55]: independence from hardware, independence from problem type, independence from human variability, and independence from evolution over time.

We expand and evolve this list and associate with each dimension of independence some typical achievement of the software industry.

[1] J. Kepler University Linz, Austria, e-mail: GC@sea.uni-linz.ac.at
[2] RIT, Raiffeisen Informatik GmbH A-1020 Wien, Lilienbrunngasse 7-9 e-mail: hartmut.mueller@r-it.at

2. Striving for Independence

2.1. Independence from Hardware

The first objective was making the software independent of the underlying hardware.

1. **loadable programs**: Initially hardware and software (rather comparatively simple programs) were strongly interwoven. The programs were written for exactly one machine. The control of the hardware (the 'programme') was initially hardwired into the machine. Only by allowing *different* programs to be loaded into the control unit one created a universal computing machine.
2. **unstratified control**: Gorn [27] seems to have been the first one to recognize that analog to human speech, computers can also treat programs at first as processable text and only later use it for control purposes. This required abolishing the fixed separation between data and control, as 1946 implemented in the ENIAC [24].
3. **microprogramming**: In the early days, software programs were coded in a language directly corresponding to the control points of the machine they were intended to run on. This language was a direct reflection of the hardware design of the computer. Only with the concept of microprogramming [64], [36], [15] machine designers could create a different interface to the machine allowing the computer (hardware + microprogram) to behave in architecturally different ways.
4. **computer architecture**: Based on microprogramming an abstract interface, the 'machine architecture', could be designed independently of the specific computer [15], [66] on which it was actually implemented ("emulated"). Commercially the historic step was the introduction of the computer family System/360 by IBM [3], which provided a set of hardware machines of different power, speed and cost but with identical machine architecture. All software was able to run on all computers of that family.

Software became essentially independent from the actual hardware.

2.2. Independence from Administrative Work

When running a program on a computer there numerous technical details have to be thought of. This was cumbersome, time-consuming and needed special know how.

1. **operating system**: Very soon the administrative tasks for the transition between individual jobs was automated by so-called Monitors. Step by step the Monitors were given more and more task to unburden both the programmers and the programs. Typical tasks were allocation of storage, adapting addresses in programs when relocating them in the machine storage, taking care of communication with peripheral units (printer, readers, ...), etc. These functions were collected in the so-called "Operating System" [58].
2. **timesharing and virtual storage**: Timesharing was introduced in order to allow several users to work on a computer in parallel. The operating system gave to each user a small time-slot for computing and then activated the next user. To accommodate the growing storage demand, storage was also fragmented, each user being provided with enough storage (in "pages") for operating, but surplus information had to be stored on back-up media, all administered by the operating system.
3. **assembler**: Despite the delegation of many tasks to the operating system, the programmer had still to fight with unwieldy code. Assemblers were introduced ("second generation programming languages") which alleviated the burden by allowing mnemonic code, by automatically assign variable to storage and similar task.
4. **middleware**: Gradually the gap between the actual user code and the machine architecture was not only filled by the operating system; many more service functions were integrated into it for communication software for dislocated users, auxiliary, pre-fabricated code modules (components), etc.

2.3. Independence from Computer Specialists

1. **higher programming languages and compilers**: In the early days programming was a very difficult, error-prone undertaking due to the fact that the idiosyncrasies of the individual machine had to be taken into account. Very soon the wish arose to express the algorithms in terms nearer to the actual problem [57], [48]. New programming languages were invented ("3rd generation"): FORTRAN, COBOL, ALGOL, PL/I [56]. Interestingly the intention of COBOL was explicitly to make programs readable to non-programmers, i.e. business people. The ambition to engineer software [47] triggered a search for more systematically designed higher programming languages. Modula, Pascal and Oberon appeared. The development of these programming languages went hand in hand with a growth in compiler technology, one of the highlights of computer science [1], [28], [42], [45].

2. **4th generation Languages**: The old idea of having the users writing their own programs came back in the 1970's with the growth of data bases. Relatively simple, iterative programs were needed which basically fetched data from the database, processed them in simple ways, and stored them back into the data base. So called 4th-generation languages appeared, which were (almost) readable by non-programmers and allowed to describe the tasks in problem oriented terms. Some of the then used languages were ADABAS, NATURAL, Ramis, RPG.
3. **spread-sheet languages**: A special case are languages (and people forget that these are also programming languages) to manipulate (predominately numeric) data in tables (1979: VisiCalc Apple II, 1982: Microsoft Multiplan, 1987: EXCEL).
4. **relational databases**: Initially data bases had intrinsically complex data structures, often trimmed towards performance of a small set of applications. In analogy to the evolution of programming languages also more general, universal data base structures were invented which showed immunity against changes but admittedly needed higher computing power. It culminated in an elegant theory of Normal Forms [20] and on the application side in relational databases [19], and the invention of the query language SQL.

2.4. Independence from Human Variability

One of the key hindrance of cooperation in programming teams for effective, high quality software development and maintenance is the individuality of humans with respect to the methods in software development and the structure and appearance of program.

1. **egoless programming**: Very early G. Weinberg proposed the concept of so-called "ego-less programming", the idea that everybody could and should(!) read code written by others [63]. An early attempt at openness.
2. **structured programming**: Another critical barrier to understanding code and a reason for complexity were entangled programs. Based on the ideas that go-to's are one of the major sources of errors Dijkstra offered the idea of well-structured goto-free programs [21].
3. **software process models**: Not only the individual code modules needed structure. The program development process itself came under scrutiny [35]. Attempts were made to define and require the individual steps and their sequence in the development of a program (1985:

VIDOC [37]) leading up to complex process models (Maestro II [44], ADPS [16], [17], VM-XT [40].

4. **software engineering standards**: A logical consequence of the wide-spread use of software process models was the creation of software standards for developing software, both de jure (ISO 12207, ISO 15504, ISO 15288) and de-facto (UML [11]). A further consequence was that one could now compare and evaluate the quality of a company's processes: ISO 9000, CMM [50], Bootstrap [29] and SPICE(ISO15504) [23].
5. **software engineering environments**: The complexity of software processes requires computer support for the administrative work. Numerous Software Engineering Environments have been created in the past, from simple Workbenches supporting easy access to tools up to sophisticated support environments aiding in enacting the software process, automatically providing the correct tools, providing the necessary inputs and storing the created outputs largely automatically [34] [30] [17] [62].

2.5. Independence from Evolution over Time

Software notoriously has to be changed due to adaptation to new requirements, mostly from business (65%) and to a lesser extent due to inherent mistakes (22%).

1. **abstract data types**: In order to prevent modules to be forced to change their internals due to the changes of internals of some other module the concept of modularization and abstract interfaces (plus restrictions of access) were defined [46].
2. **object oriented programming**: A further development was the concept of objects which contains both data and their access functions, implementing the principle of data hiding [49]. In the meantime object orientation is a standard best practice with implications even on the business level [2], [61].
3. **agile development processes**: Problems with classical software development process models (rigidity, inflexibility, little user involvement, bureaucratic overhead, ...) fostered the search for alternative models. So-called Agile Processes [6], [7], [32] were based on strong consideration of the human factor in development, on user guided development, adaption to necessary changes of objectives and environments 'on-the-fly' and little documentation. Well-known models are XP [6] and SCRUM.

2.6. Independence from Growing Complexity

The last decades have seen an enormous explosion of the cost of software development. A large percentage of newly constructed software contains functionality and programs already programmed (often several times). Re-use of these artefacts is one approach to faster, cheaper, and qualitatively better software development [4], [9].

1. **program libraries**: For often used functions (both to support other software) and for complicated, but standardized functions (especially in physics) standardized program libraries were established with the needed functions.
2. **commercial of the shelf (COTS), component based programming**: Following other industries (especially the car industry) the concept of providing standard modules which can be utilized in other environments with comparatively little additional effort was introduced. [5], [8], [60], [61].
3. **product lines**: A logical consequence (also following the car industry) is to conceptualize families of products with similar characteristics allowing the systematic and planned reuse of artifacts based on strict control of variability [18], [33].

2.7. Independence from Intellectual Property Monopolies

Both books, journal articles, and software programs are artefacts subjected to intellectual property rights, e.g. copyrights, patents, ... [31], [59]. As long as these artefacts were bound to some concrete physical medium (paper, tape, ...) the control was relatively easy. The enormous growth of the internet and its possibility for seamless interchange of such information together with some tendencies for ’democratization’ have eroded the believe in unrestricted property rights. Pirating of music and of software programs is notorious, especially if performed cross borders. This has brought about the new philosophy of unrestricted access for everybody. It also promoted the idea of ’grassroot’ aggregation of information.

1. **World Wide Web**: The information on the Web is usually free, partially due to technical difficulties to enforce property rights.
2. **Wikipedia**: Wikipedia is a relatively new phenomenon: all information is free and everybody is encouraged to add and to change (with very little control). Comparisons have shown that the breath, depth and quality of Wikipedia can easily compete with standard encyclopedias like Encyclopedia Britannica, Duden, Brockhaus, etc.

3. **Youtube**: Starting in an illegal fashion downloads for music were offered on the internet, initially under strong opposition of the music industry. In the meantime some change of mindset to more free access occurs.
4. **open source software (OSS)**: OSS seems to be the latest in the strive for independence. Chapter 3 will be devoted to it.

3. The Open Source Software Phenomenon

OSI, the Open Source Initative [http://www.opensource.org] declares the aims of OSS as follows: *The basic idea behind open source is very simple: When programmers can read, redistribute, and modify the source code for a piece of software, the software evolves. People improve it, people adapt it, people fix bugs. And this can happen at a speed that, if one is used to the slow pace of conventional software development, seems astonishing.*

In 1985 Richard Stallman had the idea to create a free operating system on basis of Linux: the GNU Project. The metaphor of OSS goes back to Eric Steven Raymond [53], [52], [41]. Initially ridiculed, Open Source Software (OSS) gains growing acceptance and distribution.

3.1. What is Open Source Software (OSS)?

Open Source software is also licensed [26], but the license must obey most or all of the criteria below Open Source Initiative defines 10 characteristics for a product to be open source [http://www.opensource.org/docs/definition.php].

1. Free Redistribution
2. Source Code must be available
3. Derived Works permitted
4. Integrity of the Author's Source Code must be maintained
5. No Discrimination Against Persons or Groups
6. No Discrimination Against Fields of Endeavor
7. Distribution (persistence) of License over time
8. License Must Not Be Specific to a Product (e.g. an operating system)
9. License Must Not Restrict Other Software

10. License Must Be Technology-Neutral

3.2. Advantages of the Use of OSS

Usually the following advantages are seen [22], [38], [41], [54]. These advantages provide much of the independence, previously already introduced as achievements in the history of computers. We will (in angle brackets) point to the respective achievements in chapter 2.

- access to source code : section 2.4.-1, section 2.5.-3
- no patent or licence fees or restrictions, open standards : section 2.7.-1, section 2.7.-2
- easy re-use of code : section 2.5.-2, section 2.6.-1, section 2.6.-2
- implicit peer review and therefore higher quality : section 2.4.-1, section 2.5.-3
- higher security (hidden malware, e.g. spy software), : section 2.5.-3, section 2.4.-1
- well-documented, community supported support : section 2.5.-3, section 2.7.-1
- free sub-distribution with the permission to adapt, modify, and derive : section 2.5.-3
- no dependency on a software vendor : section 2.6.-1, section 2.6.-2 section 2.7.-1
- no discrimination : section 2.7.-1, section 2.7.-2
- less total cost (often only marginal!) : section 2.7.-1
- compatible with the wish for soveranity (public institutions) : section 2.7.-2
- the ideal of a ’free developer’ in a free economy : section 2.7.-1
- support local software consultants instead of (mostly far away) software vendors (used by public institutions) [43] : section 2.5.-3, section 2.7.-2
- preferred option by the European Union [38], [39], [25] : section 2.7.-4
- user-oriented, demand-oriented development : section 2.4.-1, section 2.5.-2, section 2.5.-3, section 2.6.-1, section 2.6.-2, section 2.6.-3

3.3. Disadvantages of the Use of OSS

Disadvantages are to some extent a consequence of the above advantages. Usually on cites [54]:

- no warranty or guarantee
- no guaranteed support by developer
- higher training costs
- uncertain evolution and maintenance
- difficult interoperability with commercial software

- unclear situation due to changing patent and intellectual property rights
- expensive migration to open source

4. Outlook and Trends

In this paper we showed basic achievements in software development and argue that they can be interpreted as attempts to gain independence from specific restrictions, constraints and dependencies. Basically this independence is achieved by abstracting from individual idiosyncrasies, but defining general architectures and by standardization. Open Source seems currently to be the last of these achievements. When in 1999 Eric Raymond [53] published his famous treatise, he compared the development of open-source software to the market conditions found in a bazaar, to the development of commercial software as a secret, almost religious experience. One has, however, concede, that Open Source Software movement has gained a certain religious aura, too.

In the meantime some 200.000 Open Source projects exist, from simple academic pursuits to industry strength products.

Due to the novelty of this concepts and its closer relation to business and software industry and usage as a whole, many questions remain open. [41] lists:

- Open-Source Adoption Decision-Making and Business Value Proposition
- Legal Issues (Licensing and Intellectual Property)
- Qualities of Open-Source Software
- Open-Source Community Characteristics
- Source Code Structure and Evolution
- Tools for Enabling OSS and Applications
- Philosophical and Ethical Issues

The list above shows that there is still plenty to understand with respect to Open Source, it final position in the world is still largely to be understood.

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A GOOD FUTURE – BY SOCIAL RESPONSIBILITY, NOT TECHNOLOGY ALONE

Matjaž Mulej[1], Anita Hrast[2], Damjan Prosenak[3]

Abstract

Humankind is moving from routine via knowledge to creative society. This is based on a new economy and requires new values – self-interest realized by socially responsible and therefore requisitely holistic monitoring, perception, thinking, emotional and spiritual life, decision making, and action rather than on a one-sided and short-term basis. Technology supports rather than creates future and development into it, and can be used with social responsibility 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 and humankind's future.

Key words: new economy, requisite holism, social responsibility, technology

1. The Selected Problem and Viewpoint of Consideration of it here

Does technology alone create the future, as it seems to be from the notions of the industrial, post-industrial, information revolutions, etc., or is it a tool of decisive humans? If it is a tool, do one-sided or requisitely holistic (RH) people and teams make a promising future? Data about the results of the recent decades expose the dangerous impact of one-sided decision makers and the need for RH. Our thesis reads: values of social responsibility (SR) might help humans to switch from a too narrow and therefore dangerous/detrimental behavior to RH and thus to enable survival of humankind or, at least, its way out of the current crisis.

[1] University of MARIBOR, Faculty of Economics and Business (EPF), MARIBOR, SLOVENIA; mulej@uni-mb.si
[2] IRDO Institute for Development of Social Responsibility, MARIBOR, SLOVENIA
[3] Sole entrepreneur, SLOVENSKA BISTRICA, SLOVENIA

2. The New Economy and Social Responsibility

A discussion about the 'new economy' (Ing et al, 2008) brought several insights that can be summarized as follows: the new economy' faces property revolution (because ownership of knowledge and creativity differs from knowledge of tangible properties), information revolution (due to information/communication technology, etc.), serious new problems (due to piling up rather than covering cost of care for natural precondition of humankind's survival beyond the cost of both world wars combined or even much more), the need for much more transparency and participatory democracy in all organizations from families via enterprises, countries, to international associations (for RH in monitoring, perception, thinking, emotional and spiritual life, decision making, and action), and SR (for less of the detrimental abuse/misuse of Adam Smith's concepts of self-interest and invisible hand, of the law of external economics, and trust). On the basis of economics and economy of so far, namely, according to official data, 20% of humankind – the so called West and Japan and Pacific Rim Tigers – enjoy results of the end of monopolies of 1870s much more than the other 80%. They are much richer because they innovate much more, but they are not holistic enough to avoid the danger of blind alley. Their current crisis seems to require innovation of the concept of innovation of so far to include RH. (See also several contributions in ISSS 2008; Mulej et al, editors, 2008; etc.). SR may support RH better.

3. Technology Matters, but as a Human Tool

Collins (2001) and Collins & Porras (1994) concluded from their large field research on the reasons for the long-term world-best companies to be so and on their way of becoming and remaining so, among other crucial attributes, that technology matters, but as a human tool, not as an independent cause of economic success. Hence, one should better speak about the entrepreneurial revolution than about the industrial revolution: the most entrepreneurial individuals have created all new technology and made it become innovation rather than invention/toy of weird persons only. Have these people attained RH in their monitoring, perception, thinking, emotional and spiritual life, decision making, and action for their influence to be beneficial, only, rather than detrimental, too? Not really (Bourg, interviewed by Sciama, 2007: 16; Božičnik, 2007; Ećimović, editor, 2008; Goerner et al, 2008; Hilton, 2008; Mulej et al, editors, 2008; Stern, interviewed by Stein, 2007, 14-15; etc.): the dangerous consequences of their lack of holism result from one-sidedness causing a too narrow view and resulting assessment what is essential in the current conditions.

All specialized knowledge is both beneficial and unavoidably narrow, but none is either self-sufficient or sufficient (Metcalf, 2008; Mulej, 1974, 1975, 1979, 2007 a, 2007 b; Potočan, Mulej, 2007). With a lack of RH it helps less than it is able to help in interdisciplinary creative co-operation. Perhaps, SR can show a new way out of the current world-wide economic crisis. It may matter, because the use of knowledge, including technology, depends a lot on users' values.

4. Ethic of Interdependence, New Economy, Affluence, and RH by Social Responsibility

In preparation, passing, and realizing of decisions one succeeds, it one has attained RH. This does not depend on knowledge alone, but an equal importance belongs to values, because they direct the application of knowledge. The RH of specialists who need each other is expressed in their ethic of interdependence (Mulej, Kajzer, 1998a, b). It expresses the specialists' feeling that they complete each other up with their differences in order to make the RH and therefore success attainable. Due to these differences, clear boundaries and isomorphisms are not enough: viewing the world 'through the eyes of the others extends vision' is needed (Churchman, 1993, quoted by Lopez Garza, 2008), leading toward the dialectical systems approach (Mulej, 1974, 1975, 1979, etc.) and resulting RH. RH is in line with EU's definition of systemic thinking (EU, 2000: 6).

EU is trying to become a sustainable and knowledge/innovation-based society; the concept includes for sure the SR. In its document EU (2001) defines SR as the integration of the care for society and environment in the daily business of enterprises and their relations with stake-holders, on a voluntary basis. Its messages include the crucial statement that in a longer run the economic growth, social cohesion, and environmental protection complete each other up and support each other. EU stresses too, that SR-behavior reaches beyond matching the legal obligations, hence it reflects organizations' additional efforts to meet expectations of numerous/all stake-holders. EU passed also several other documents that support development of SR (EU, 2000b; EU, 2006). They only partially cover the real contemporary needs: (1) the creativity-based society is replacing the knowledge-based one that has replaced the routine-based one (Chesbrough, 2003); (2) the concept of sustainable future needs to replace the concept of sustainable development (Ećimović, editor, 2008; Goerner et al, 2008; Hrast, Mulej, editors, 2008; ISSS, 2008; etc.), for humankind to survive.

EU defined for the period until 2010 'A European Roadmap', stressing the sustainable and competitive enterprise, which considers both the short-term and long-term creation of value (Knez-

Riedl, 2007b). The corporate SR can fortify the competitive position of single enterprises as well as local and regional communities, countries and EU (Knez Riedl, 2007a). We prefer no limitation of SR to companies: they act along with influential humans' decisions.

For SR to become more than a word, a strategy of promotion of SR might be needed.

5. Strategy of Promotion of SR

SR is a demanding concept of promotion of a specific case of RH having to do with the human approach to other people and nature. For success many influential people should practice RH via SR. Work of a few individuals – professionals is not enough, a general social support based on a clear strategy is needed, e.g. on the national level.

SR Mission should be to promote global ethics in order to help humankind, including one-self, survive by doing good to all stakeholders (based on RH) rather than evil (based on one-sidedness) beyond the official legal obligation.

A working group with an interdisciplinary composition should prepare a draft strategy, and later on a special Agency for Promotion of SR might have to be established, e.g. in Slovenia and in EU etc. Its tasks should include co-ordination of country-wide or EU-wide SR-related activities in co-operation with several professionals and institutions. Thus, the following goals should/could be met:

1. To create a basic interdisciplinary core of researchers working on monitoring the situation concerning SR in the area under investigation, to compare the collected findings and suggest changes in the given area.

2. To prepare legal bases for draft legislation changes, where they are needed to cover SR everywhere per areas.

3. To prepare professional, requisitely holistic bases for making up the SR program in all ministries.

4. To establish dialogue with professional associations, government bodies, public institutions, non-governmental organizations, businesses and other parts of society in order to attain a shared activity for promotion of SR.

5. To include topics on SR in primary, secondary and higher education, and to promote values of SR in daily mutual contacts of youngsters.

6. To create and implement a nation or EU wide program of public relations communication about SR in order to promote general awareness on how crucial a SR-based behavior of all humans and their organizations is for getting the society out of the current crisis and to prevent long-term crises.

7. To establish a portal for both-way communication in public relations concerning the SR-based behavior with both good and bad examples.

8. To collect good and bad examples of SR and related practices of RH and innovation based on SR rather than on one-sidedness, for the society to become, be and remain an RH/innovative society with SR as a basic criterion of its excellence.

9. To collect information on development of SR anywhere and in the area under investigation in order to report about them.

10. To support initiatives of various stake-holders promoting SR and practicing it.

Tactics and operation should be defined later on per areas, but in the style of a coordinated decentralization.

Ethic of interdependence expresses values enabling this strategy. This includes weighing and concerting of solidarity and economic efficiency by RH via SR, in order to provide to humans an equilibrium with no resulting need for too much solidarity or too much protesting against the one-sided decisions and actions of authorities all way to terrorism.

As ways to make such equilibrium attainable, one can use three essential recent findings in economic literature:

- Florida (2002, 2005) found in a comparative analysis of US regions that the best development had been attained in regions with the highest 3T: it is tolerance for differences between habits of people that attracts talents and thus it makes sense to invest in technology there. Malačič et al. (2006) found equal situation in Slovenia. The creative class is growing beyond 35% and becoming essential, the working class is diminishing, and the service class only works on preconditions for the creative class to create for all.

- Porter (1990, 2006) pointed out that the basis of competitiveness evolves in four phases: from natural resources via investment to innovation and hence to affluence, which people have always wished to have. But affluence has a crucial side-effect: affluent people have no motive any longer to work in order to have, which results in a growing need of many citizens for solidarity etc. In affluence sources are not scarce, but real needs, while marketing and advertisement try to persuade

people to have wants and try to buy like wants would be needs. (See also: James, 2007). Baumol et al. (2007) do not even mention or quote Porter, but they remind of this danger with a single quote (p. 288).

- The innovation of the traditional incentives for Total Quality as a way to innovation that are often taken in a too bureaucratic way to really work as incentives for contemporary excellent quality as an incentive for innovation and RH to flourish (Pivka, Mulej, 2004; Škafar, 2006) and practice systemic thinking (SZK, 2007).

The problem lies in mentality very much – in humans' thinking and worldview as well as other values/emotions. One-sidedness results in a lack of contemporary excellence, which requires more RH of observation, thinking, decision-making, and action for the humankind's future to exist. Baumol et al (2007) fail to see this.

6. Future – Well-being by Creativity and SR?

There is an interesting view of economic development phases that stresses the notions summarized above. See Figure 1. Porter (1990, in Brglez, 1999: 23-24) speaks of competitiveness; we extend the idea to development and add our ideas about the related culture and phase 5. Obviously, the affluence phase in Figure 1 is not the highest development phase so far, only; it is also the phase of growing problems of employment, supporting everybody, growing lack of ambition and related drug etc. abuse, etc. Conclusion: one must attain and keep capacity of RH in order to enter the innovation phase quickly and remain in it as long as possible, and/or renew its culture. The latter may make room for a 5th phase, which is needed: the 4th phase can hardly be avoided. (Mulej, Prosenak, 2007). Porter and Kramer (2006) do not mention phase 5.

PHASE	ECONOMIC BASIS FOR DEVELOPMENT	RELATED CULTURE
1. Natural factors	Natural resources and cheap labor, providing for a rather poor life for millennia	Scarcity and solidarity, collectivism, tradition rather than innovation
2. Investment in modern technology	Foreign investment into the area's economic development; hardly/poor competitiveness in international markets	Growing differences, local competition, individualism, ambition to have more, be rich
3. Innovation based on local knowledge	Nation or region lives on its own progress and attains a better and better standard of living by international competitiveness	Growing differences and standard of living, global competition, ethic of interdependence, social responsibility, ambition to create
4. Affluence	People have finally become rich, which makes them happy in material well-being as a blind alley	Complacency, no more ambition, consumerism; what is quality, then?
5. Holistic creation and social responsibility (SR)	Material wealth suffices; effort aimed at spiritual wealth, healthy natural and social environment as requisitely holistic well-being	Ethic of interdependence and SR, ambition to create, diminish social differences to those caused by creation, including innovation

Figure 1: From scarcity via complacency to the danger of a new scarcity or a new, 5th phase

In other words: (informal) systems thinking is the back-ground of the creative class and innovative society. But it causes difference, obviously, because not all people are equally capable of RH and creation, including innovation.

But the affluence phase might be a dead alley, if people lose ambition for creation (so far they did so, in history). People therefore need either a prolonged innovation phase based on RH invention-innovation-diffusion rather than one-sided processes, or a new phase, a 5th one, of creative happiness based on ethics of interdependence and interdisciplinary creative co-operation with SR replacing the phase of affluence; for selfish reasons, people are less selfish, short-term thinking, and narrow-minded, and they apply more RH.

To make this innovation of culture and economy happen, a part of population must become the core of the creative class: Lester (2005) found authors detecting that about 15-20% of people are willing to take risk and cooperate, about the same many want to be (abusing) free-riders, and the majority just waits to see, what will the opinion makers undertake. But this majority includes many humans with creative potential. Leaders providing role-model of interdisciplinary creative co-operation can activate this potential rather than the commanding managers who do not. This would make humans happy and society prosperous. But it requires RH behavior.

This might lead to RH society and economy by SR. Namely: SR is in the EU's definition a concept for enterprises to integrate, on the basis of their free will, social and economic concerns into their business (including sustainability) and relations with stakeholders. IRDO reaches beyond enterprises (ibid.): SR of individuals, organizations of all kinds, professional groups, nations, peoples, unions (IRDO, 2006). Following several authors IRDO defines SR as the human obligation to realize shared objectives of the society and to do good beyond legal obligation. (Hrast et al, 2006, 2007; Hrast, 2007; Knez-Riedl, Mulej, Ženko, 2001; Knez-Riedl, 2003a, b, c, d, 2006; Knez-Riedl et a, 2006). Such attributes of behavior create new ambition, reaching beyond complacency of the affluent ones. No short-term efficiency, including e.g. abuse of external economics, is enough. Then, a new economy can succeed.

7. Conclusions

The innovative society of today is not found successful, once criteria of sustainability are added to the one-sided economic criteria of so far. Even if the 'West' considers itself successful, research and public press report about increasing numbers of humans feeling unhappy and hence abusing

drugs from alcohol to marihuana etc, and doing so at an increasingly young age. This is a sign that there is a lack of incentive for creation, for the Fromm's transition from 'owner to creator', as the most human attribute (James, 2007). Such processes have been around before. The Roman and other empires have faced ruining, once their people entered affluence and became complacent. Hopefully, SR reaching beyond CSR to SR of all, and incentives, such as happiness based on creativity, can be a way out of the blind alley toward RH. Technology alone does not make it.

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VIRTUAL ORGANIZATIONS: HORIZONTAL IS/ICT INFRASTRUCTURES FOR ORGANIZATIONAL COOPERATION

Jan Klas[1]

Abstract

Theory of virtual organization brings many new and interesting approaches to organizational cooperation, usually based on flexible relations within networked structures of organizational sets.

This contribution takes closer look on the role of IS/ICT horizontal infrastructures in selected virtual organizational concepts, which evolved during the time, and closer look on underlying principles of virtual organizational networks formation, where a slight, but important paradigm shift can be perceived.

Acknowlegements: This contribution presents research supported by the Czech Science Foundation GACR – project no. 201/07/0455.

1. Selected basic VO approaches

In my opinion, the diverse theory of virtual organization nowadays provides following three most important basic approaches, based on different organizational principles, which rely on supporting horizontal IS/ICT infrastructures:

- Virtual Breeding Environment
- Digital Business Ecosystem
- Electronic Market place

For purpose of discussion in this positional paper, these concepts demonstrate important features as described in following parts.

[1] University of Economics, Prague, Czech Republic; klas@vse.cz

1.1. Virtual Breeding Environment

Virtual Breeding Environment concept, usually abbreviated as VBE, is in my opinion based on axiom, that organizational cooperation can be much more easily facilitated among subjects (organizations), who are part of some sort of supporting environment, than among subjects, who lives in "wild dangerous nature". In VBE concept this environment is called breeding environment, or virtual breeding environment. Main goals of breeding environment is to support mutual interaction among organizations in a way they are able to form ad-hoc alliances for exploiting business opportunities – these alliances are disbanded after finishing exploiting selected business opportunity. These ad-hoc alliances are sometimes called virtual organizations.

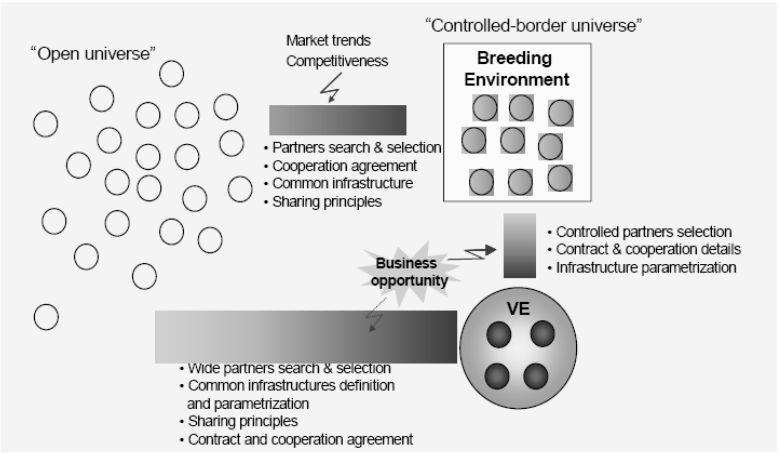

Figure 1: VO Formation [10, p. 30]

Among interesting features of VBE in my opinion belong:

- single organization can be part of more ad-hoc alliance at the same time,
- single organization can even be (theoretically) part of more breeding environments,
- specialization of organizations emerges,
- supporting IS/ICT infrastructures concentrates on creating common frame for communication and interaction.

Specialization of organizations is in my opinion crucial point in this concept and can be seen from different view points, which may sometimes mix up:

- member organizations – organizations whose main aim is to actively participate in formed ad-hoc alliance.

- service organizations – organizations whose main aim is to support the breeding environment itself, to support creation of ad-hoc alliances and in some cases to take active part in these ad-hoc alliances.

Service organizations include organizations, who (inspired by the ECOLEAD project (www.ecolead.org)):

- provide and service supporting horizontal infrastructures (incl. IS/ICT ones),
- promote and maintain breeding environment, acquire new members
- promote organizations within breeding environment, acquire contracts from outside,
- facilitate creation of ad-hoc alliance, select participating members, create rules,
- leads ad-hoc alliances (like project leaders or system integrators),
- and many other roles.

Above incomplete enumeration is based on the role principles, so in selected case one organization can perform all these tasks or roles, in other cases each role can be played by more organizations at the same, like promoters acquiring contracts, forming ad-hoc alliances and leading them through the project.

1.2. Digital business ecosystems

Basic idea of the Digital Business Ecosystem concept is idea that independent organization can be coordinated by series of services provided by IS/ICT (see e.g. [7]). This is even more emphasized with idea, that relatively common problem of many SMEs, obsolete technology, could be overcome in digital business ecosystem easily – if the function, which the technology provides, is provided digital business ecosystems' IS/ICT, then innovation in digital business ecosystems' IS/ICT will bring this innovation into all member organizations in digital business ecosystem.

Technically, digital business ecosystem can be created with different kinds of technologies, but very interesting is the understanding of DBE project [see 4]. In this understanding, each, let's say, workstation in SME is understood as a peer node, with server part and client part integrated together (called Servent (SERVer + cliENT)). Via its servents each SME is able to dynamically inform other member SMEs about products and services it currently offers and also to dynamically find partners or supplier for specific projects and actions.

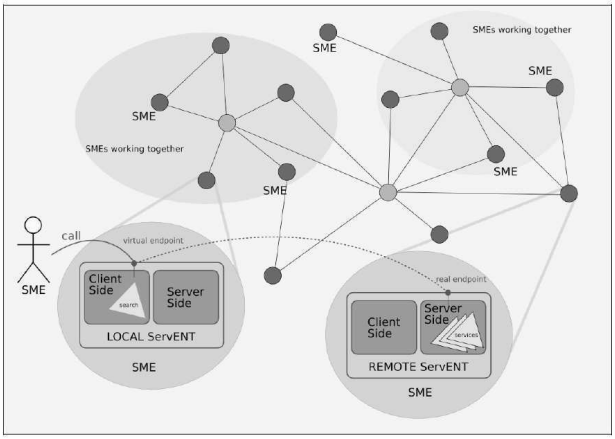

Figure 2 – Digital Business Ecosystem according to the DBE project [4]

These Servents also in my opinion supply specific functions provided by virtual breeding environments members, like ad-hod alliances formation (specific organization finds its "colleagues" in digital business ecosystem environment via the servents), project management (specific organization together with IS/ICT services provided by servents), etc.

1.3. E-hub

E-hub is among virtual organizations interesting concept, because the coordinating element is now not an organization or organizational network, but software agent or industry consortia. I understand e-hub similarly to Davenport [6] as an "interconnecting hub".

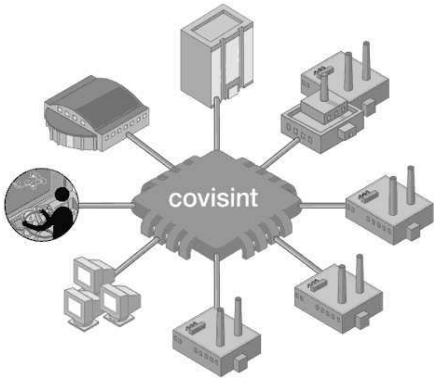

Figure 3 – General scheme of e-hub – Covisint example [2]

The e-hub could be in my opinion structure or organizational element itself, but nowadays is often combined with electronic market places, or (as Davenport says), electronic marketplaces are evolving into hubs. So the interconnection function is also combined with trade or business function.

As an interconnecting hub, the e-hub serves as tool or platform for interconnecting various heterogeneous resources, applications and services. For partnering organizations this provides one very important feature and gain – they have to interconnect their systems only with the e-hub (or with e-hub interface) and do not need to interconnect each proprietary system with another. This provides various savings in interconnection and transaction costs and provides other additional benefits.

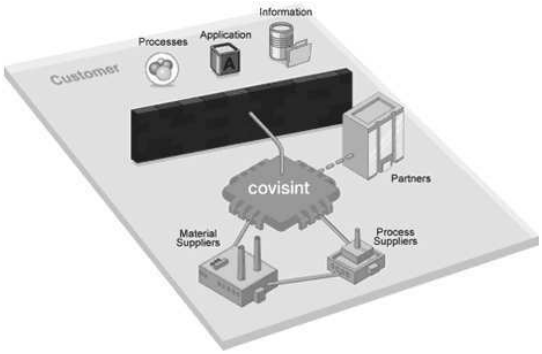

Figure 4 – General e-hub scheme – single organization viewpoint – Covisint example [1]

Common functions of these kinds of structures is in my opinion also identity and access management. The distributed nature of these kinds of systems usually requires techniques like federated identity management (There is no central identity management, but identities are managed in single federated nodes). Identity and access management is usually based on current standards and industry solutions, like SAML for secure authentication information interchange based on XML.

2. Supported horizontal IS/ICT areas in selected concepts

Aim of this part of contribution is to abstractly describe and compare the differences and common features among the three above selected and described concepts. This comparison is made especially for illustrational purposes. It is important to state, the these comparison and descriptions

present my position and opinion to the concepts and does not have be support with scientific evidence and/or theory.

2.1. Underlying hypotheses

The underlying hypothesis (axioms) for these illustrations are:

- horizontal IS/ICT infrastructures (and services they provide) plays very important role in "daily life" and business success of virtual organizational structures,
- business success of virtual organizational structure is desirable, because virtual organizational structures are the ways organization are pioneering today and will traditionally implement tomorrow,
- it is desirable and from business point of view important to stimulate and support organizational cooperation within virtual organizational structures with underlying IS/ICT.

2.2. Role of IS/ICT in selected concepts

2.2.1. General role of IS/ICT

Virtual organizational concept	*General IS/ICT role*
Digital business ecosystem (DBE)	Important: based on IS/ICT; IS/ICT supports coordination, data interchange, and ad-hoc coallitions formation
E-hub	Important: based on IS/ICT; IS/ICT enables share multiple heterogeneous resources, application and services
Virtual breeding environment (VBE)	Important: based on IS/ICT; IS/ICT provides sets of services for various roles within virtual breeding environment and for ad-hoc alliances within the virtual organization life cycle

Table 1 – General IS/ICT role in selected virtual organizational concepts

Comments: All selected concepts demonstrate important role of IS/ICT – all selected concepts are based on IS/ICT. Among the concepts, there differences in areas supported with IS/ICT. Most areas seem to be supported within the virtual breeding environment concept.

2.2.2. Support of virtual organization life cycle

Virtual organizational concept	*DBE*	*E-hub*	*VBE*
VO environment formation	No	No	Yes
Ad-hoc alliances formation	Yes	No	Yes
Ad-hoc alliances "life"	Yes	Yes	Yes

Table 2 – Support of virtual organizational stages in lifecycle

The second comparison demonstrates that each concept is targeted on different range of virtual organizational lifecycle. Most comprehensive is again the concept of virtual breeding environment which is targeted on all phases – creation of group of organization, which want to potentially cooperate, creation of ad-hoc alliances, which cooperate, and daily "life" of such alliances.

The digital business ecosystem concept in my opinion does not deal with the problematics of introducing new members into potential pool of organizations, but pretends that all are "on-board" and therefore supports processes like looking for new partners, establishing working relationships and daily life of such alliances.

The e-hub concept does not deal with formation at all, in my opinion. Its aim is to establish and support access to resources, application and services among various partners, i.e. daily life of the "alliance", allows new members to come, but does not deal with respective processes.

3. Influence and future of virtual organizational concepts and horizontal IS/ICT infrastructures

This section comes instead of traditional discussion and may be even a conclusion. In my opinion, virtual organizational concepts play more and more important in nowadays business life and this way influencing daily life of all.

Concept of virtual breeding environment evolved from the former Porter's concept of cluster, just by application of idea, why don't to support our clusters with IS/ICT, so they are even more successful. This idea is/was heavily supported by European Commission in Europe and also projects on similar topics have been supported by DARPA in United States, especially orienting on manufacturing issues. Chinese research seems to orientate especially on IS issues and electronic commerce in this sector.

Important problem of virtual breeding environments, found by European research (researches from the Ecolead project) is that they are successful, not as successful as they should be. So research identifying sources of these problems is now in progress.

Concept of digital business ecosystem brings in my opinion interesting idea: innovating various clusters or business ecosystems at the same time, by innovating supporting IS/ICT infrastructures. This is at the same very advantageous and very dangerous, because the owner of the IS/ICT infrastructures will determine levels of all dependent clusters. Perhaps the future way is to

implement model similar to internet, where the parts are privately owned but internet as a whole seems to be independent.

Concept of e-hub simply emerged from marketplace simply as evolutionary reaction on business needs. Contrary to the previous concepts, e-hub concept is empirically evident mostly among large enterprise, like automobile producers.

The future of these concepts is in my opinion both relatively simple and complicated. In my opinion these three concepts should be combined in order to achieve the most desirable benefits. I would offer for basis of future development the concept of virtual breeding environment, together with complex methodologies of organizational relationships establishing, combined with federated identity and access to heterogeneous resources successfully pioneered within the e-hub concept and combined with shared horizontal infrastructures from digital business ecosystem, which would enable to develop organizations, which are from various reasons “lazy” or unable to develop themselves. Also application of peer to peer approach, but only among single organizations but among parts of virtual breeding environment would be desirable, in order to provide enough material for Darwinist evolution and other phenomenons known from system theories.

This future would provide interconnect sets of organizational systems intensively supported with IS/ICT, cooperating, competing and evolving at the same time. Transaction costs should be somewhat lowered and benefits from former Davidow and Malone’s vision of virtual organization could become available.

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Software Project Management and Human Factors

LEADERSHIP CONCEPTS IN SOFTWARE PROJECT MANAGEMENT

Sonja Koppensteiner[1]

"Inventories can be managed, but people must be led" (Ross Perot).

Abstract

Globalization and increased competition require that software products are introduced to the market as early as possible. Hardly any company can afford to release their products late.

As a consequence many organizations feel the pressure to streamline their operations on an ongoing basis in order to reduce the duration of their product development cycle. They continuously refine their processes and standards in order to reduce their time to market. As part of this course of action companies often forget to account for the human factors in this effort. Human factors are the fundamental component of human actions that affect organizational performance and therefore projects that take place in or across companies. Projects are typically executed in team settings that require team members to interact with each other.

Project leadership creates either an environment that embraces or deteriorates the impact of human factors. Poor leadership can significantly contribute to or cause project failure.

This presentation/paper explains what leadership means to projects. It focuses on the leadership role of the project sponsor and project manager throughout the entire lifecycle of a software project. Each project phase requires a specific set of leadership skills and responsibilities of the project leader. Therefore the project leaders have to acquire certain versatility in their leadership style. "Leaders aren't born, they are made" (Vince Lombardi) and project leadership can be acquired by any organization.

[1] Interglobe Consulting Com., Silicon Valley,CA, USA; sonja@interglobeconsulting.com

1. Introduction

One of the main challenges software development faces is the misperception that changes can be done easily. Frequently systems and hardware problems are addressed by developing software "fixes" [9]. As a result some projects get delayed, are over budget and do not meet the requirements. Another misperception in the software industry is that project management is something that can be done by one of the team members and should not add too much planning and meeting time. Hence many software projects are done without proper project management attention. Last but not least the third biggest misperception is that software developers do not need much management or leadership. These are people who like to work by "themselves". As a consequence many companies do "forget" team building activities and training of interpersonal skills in engineering organizations. Many books have been written to point out some of these misperceptions and their consequences [2], [5]. More than half of all software projects executed by organizations are either challenged or failed [17], some due to these misperceptions. In order to introduce the role of leadership concepts in software projects we specify a basic definition for a software project, explain how human factors affect the success of a project, provide an overview of different common leadership styles and then describe detailed role and responsibilities of the two main leaders almost every software project should have: an executive sponsor and a project manager.

2. What is a project?

In general a project is a temporary endeavor undertaken to create a unique product or service [15].

At times the definition of a project can be blurry. Some software development organizations might consider the resolution of errors (bugs) as small projects, specifically when these are corrections of malfunction of functionality. In general some of the work might be organized in projects and other can be considered part of ongoing operations. Often software bugs are corrected on a daily basis and can be managed as part of daily operational activities. Projects are often managed applying project management methods. Actually all the traditional project management tools and techniques apply to software projects in the same way as they do to other projects [9].

Typically a software project generates a software product that has to meet specified requirements, follows a software development life cycle and can be managed following a project life cycle [11].

A project life cycle usually shows distinct sequential phases a project passes through as it progresses [15]. In this paper we apply a project life cycle based on the description in the Project Management Book of Knowledge in [14] that consists of the following phases: Initiating, Planning, Executing and Closing.

Monitoring and controlling take place as part of all phases to a different degree with expected importance during the executing phase.

3. How do human factors influence project success?

Project success is often defined based on performance goals [19]. In this case the project is assessed against planned values for budget, schedule and cost. Project success is also referred to meeting stakeholders' expectations [15]. Stakeholders are all people or organizations that can be positively or negatively impacted by the outcome of a project.

Besides meeting performance goals, projects also have to meet people's expectations. This refers to respecting the people involved in the project and making them succeed as a team. If people's expectations cannot be met, a company can expect that the violation of respect and human factors will impact the team dynamics of a project team. Human factors refer to the values, personalities, experiences, culture and beliefs of each individual contributor to the project. Dysfunctional teams can lead to project failure.

4. What is leadership? What are the common leadership styles?

Project Managers manage projects and people. This role requires management and leadership skills where the emphasize lies on managing the project data and leading the project team members.

How can leadership and management be differentiated?

Leaders establish direction for the future, communicate through vision, and forge aligned high-performance teams [6]. The Project manager's "leadership function" is specifically used to communicate the project vision [7].

Managers focus on planning and short-term horizons, devise processes and structures, and solve problems [6]. The project manager plans a project, measures project performance and solves any roadblock issues. Management and leadership style can vary. Some of the main leadership styles are summarized in Table 1. A style can be referred to as a way of behavior.

Leadership Style	Description
Charismatic	Charismatic Leaders posses a very persuasive personality that attracts followers through charm. These leaders show great confidence in their followers and create a group image that is far superior to all others.
Participative	Participative Leaders seek to involve other people in the decision process, possibly including subordinates, peers, superiors and other stakeholders.
Situational	Situational Leaders do not just have a single preferred leadership style. Factors that affect situational decisions include motivation and capability of followers.
Transactional	Transactional leaders create clear structures that make clear what is required of their subordinates. These leaders reward subordinates who following orders. When things go wrong, then the subordinates are considered to be personally at fault, and are punished for their failure.
Transformational	Transformational leaders have a vision for the future that will excite and convert potential followers. These leaders try to convince others of their vision. They are always visible and act as role model. They also make continued efforts to motivate and rally their followers, constantly doing the rounds, listening, soothing and enthusing.
Autocratic	Autocratic leaders make decisions without consulting with others or considering any other view.
Democratic	Democratic leaders involve all people in the decision-making, although the process for the final decision may vary from the leader having the final say to them facilitating consensus in the group.
Laissez Faire	Leaders with a Laissez Faire leadership style minimize their involvement in decision-making, and hence allowing people to make their own decisions, although they may still be responsible for the outcome.

Table 1: Summary of different leadership styles [4], [8].

Leaders can adapt to different styles but need to make sure to stay their true self.

Kippenberge [10] states “how we lead is a reflection of our own character, personally and experience.” Leaders need to understand who they are in order to be able to adapt to different leadership styles. Projects with their unpredictable nature require leaders that are able to adapt to different leadership styles.

Project management is a team-based approach. Hence the project scope and project plan cannot be defined and developed in isolation. Autocratic leaders would come up with a plan for the team without consulting the team members. On the other side people should not be allowed to make their own decisions about project issues during the project executing phase. Leaders with a laissez faire leadership style would let the team figure out how to respond to the challenges of a project without providing any guidelines. Although leadership styles like the autocratic or laissez faire leadership behaviour can be observed in some organization they are not well suited for leading projects and project team members.

Democratic leaders go through an elaborate decision finding process that involves several stakeholders of different organizational background and levels. As a result democratic leadership behavior often leads to extreme delays in large projects, because all team members get involved in

all decisions of a project. The more people are part of a project team the longer it takes until a decision is made.

Charismatic leadership works often well at the beginning of a project when it is important to get support from the overall organization. Charismatic leaders are driven by their believe that their vision is correct. Hence Charismatic leadership works as long as the leader's vision is aligned with the project and organizational goals.

Participative, situational, transactional and transformational leadership styles seem to work most effective when managing projects and leading people. Participative leaders typically seek other people views and opinions in order to form their own opinion about a situation and then make their decision. Project sponsors, for example, often make their decision after listening to multiple people in the organization. Blanchard [1] describes the situational leadership model which includes four different leadership behaviors that are dependent on the maturity and knowledge of the employee. These are telling, coaching, supporting, and delegating. Project teams include members of different backgrounds and experiences requiring different management styles. Situational leadership seems to fit the changing nature of a project very well. Burns [13] differentiates between transactional and transformational leadership behavior. Transactional leaders communicate clear goals to their subordinates. This leadership style relies on organizational structures and processes to help resolve problems [10]. Well organized projects have a structure in place that allows the project teams to solve problems. Transactional leadership works well for some aspects of a project such as e.g.: managing changes through a change management committee. Transformational leadership style empowers people to do their work. Transformational leaders facilitate the process of people to learn and to seek change and improvement [10]. In general this leadership style is most applicable for organizations that manage projects through self-managed teams [3].

5. What are the common leadership roles in software projects?

Software projects like other projects require leadership from the executive sponsor and an experienced project manager. The Standish group lists both of them under the top ten project success factors [18]. The role of project manager and executive sponsor changes in the course of the project phases. Some of the project management tools support the project sponsor and project manager in their leadership role (Table 2).

	Initiating	Planning	Executing	Closing
1.1.1. Project Key Activities	Create project mandate	Identify specifications for the software product.	Carry out project plan.	Review project outcome for formal acceptance.
	Identify project requirements, limitations, and constraints.	Create project schedule and project plan.	Monitor, measure and track progress of the project.	Achieve all project and product information.
	Assign project manager and key staff to project.			
Project Manager's Primary Role	Not existing	Translates project charter into project plan. Helps team to define ground rules for team communication.	Drives project execution. Encourages information flow and team work.	Makes sure that deliverables meet stakeholder expectations and get formally approved.
Project Manager's Leadership Behavior	Not existing	Participative and situational leadership style.	Situational leadership style.	Transactional leadership style.
Executive Sponsor's Primary Role	Reflect his/her vision in project charter. Sells project to other organizational leader to get buy in.	Coaches project manager and team in the planning effort.	Holds the team accountable for results. Makes project related decisions.	Makes sure that the project finishes strong. Rewards team for successful delivery.
Executive Sponsor's Leadership Behavior	Transformational leadership style.	Transformational and situational leadership style	Situational and transactional leadership style.	Transactional leadership style.
Tools to Support Leadership	Project charter.	Project plan, project planning meetings, open issue log, kick off meeting, team guidelines.	Project status meeting, change management, project reports, reviews.	Lesson's learned.

Table 2: Roles and leadership styles for project leaders.

Table 2 relates each project phase (Initiating, Planning, Executing and Closing) to the key activities, the role of the two main leadership roles: project sponsor and project manager, and the key project management tools that support their leadership role in the specific project phase. Further the table concludes the key leadership styles for each role and phase.

5.1. Initiating

During The initiating phase the executive sponsor is the main leader of a project. The executive sponsor is usually a decision maker with some influence in the organization. He/She knows the business and has a vision of the future [6]. The executive sponsor funds the resources of a project [15] and needs to be able to convey his vision for the project to other leaders in the organization. He/She needs to convince other stakeholders of the organization to support his project. Therefore he/she has to communicate his vision to the organization. This corresponds to the transformational

leadership style where the leader transforms his vision into action. Conversations and meetings to discuss a new project are good starting points. The use of a formal communication tool like a project charter document makes the project more official. The executive sponsor typically develops a project charter that he can use as a "sales tool". A project charter is a document that authorizes a project. It explains the project's overall vision and is used to communicate the purpose and high-level objectives of the project to other stakeholder across the organization. A project charter typically includes a scope statement, objectives, requirements, business need, participating organizations, assumptions and constraints, summary budget, and target delivery date [6].

As part of the initiating phase the executive sponsor appoints a project manager. The project charter authorizes the project manager to lead a project. It enables the project manager to lead the project through planning, executing and closing.

5.2. Planning

In the planning phase the project sponsor and project manager identify the team members with the input and approval of other stakeholders. In this phase the main responsibilities of a project manager includes the transformation of a project charter into a project plan and the building of a project team. The project manager leads the project team through the planning efforts and brings the team through all stages of the team building process. The team building process usually starts when all team members become part of planning the project. Every team goes through a number of stages before they become fully productive. These stages are Forming, Storming, Norming, and Performing [16].

In order to achieve optimal results for the project the team should move through all three stages and get to the performance stage by the end of the planning phase.

The responsibilities of a project manager are to make sure that the team has sufficient time available to get to know each other and identify their roles and responsibilities for their project. (Forming). The project manager should provide a way of informal meetings for the team members. He/She can set up a kick-off meeting, conduct project lunches or set up an espresso machine in a space where people can meet and chat with each other. The project manager has a more directive role in this stage [12].

After the team members found their position within the team they start seeking more information about the project goal. They start noticing that not all information might be available to them in the planning stage. As a result their level of nervousness and insecurity might increase and they start

challenging the project goal, other team members and /or some of the project's leaders. Conflicts arise in this stage (Storming). In order to steer the project team through this difficult stage the project manager needs to support the team in their information finding. Setting up meetings with the right people in the organization and keeping an open issue log for the team are just two of the tools that reassures the team that they are on the right track for their project. Confusion about roles and responsibilities of team members add to these conflicts. It is very important that a project manager makes sure that each team member stays within the boundaries of his role and does not crossover into responsibilities of other team members. A team can be very sensitive in this stage. Guiding the team members through influence rather than through assertive behavior will help to keep the team aligned to their roles in a project.

As the project team members become more confident in their roles and start to understand the project goal in more detail they develop the need for more formal structure. At this point the project manager needs to facilitate the process of coming up with meeting, communication and decision guidelines (Norming). In this stage the preferred leadership behavior is participative leadership. A project manager has to consolidate and understand the needs of the project team before deciding on the ground rules. After the team has clarified their purpose on the project, decided what to do and how to interact with each other it is ready to get work done (Performing).

One of the challenges in software projects is that resources are often changed throughout the duration of a project. Whenever a new team member joins a team, the team can be set back from performing to one of the previous team building stages. A team may become unproductive and the progress of the project can deteriorate. Often software engineers are assigned to multiple projects. As priorities of different projects change, the assigned resources might be exchanged against others who are currently available. The author's experience showed that short time assignments of resources on a project typically create a team with little cohesion and often with low performance. In a case like this a project manager needs to negotiate resources and seek organizational commitment for these resources. Any risks related to the assignment of the team members or conflicting priorities of the project with other endeavors in the organization have to be listed in the risk log of the project. Further a project manager escalates problems that cannot be resolved by him or the project team to the executive sponsor. During the planning phase the key leadership styles of the project manager are situational and participative.

The main role of the project sponsor is to enable the project manager and project team to successfully come up with a realistic project plan that includes the controlling tools, communication plan and risk plan besides, resource, time management and cost plan.

The preferred leadership style of the executive sponsor is situational and transformational.

The project sponsor removes roadblocks that the team cannot resolve by themselves. Common issues during the planning phase are resource limitations, cost restrictions, unrealistic delivery dates, or change of requirements. The executive sponsor coaches the project manager, refocuses the team on the vision of they move away from it. The executive sponsor provides his leadership by having regular meetings with the project manager and other stakeholder. Further he needs to attend key team meeting such as project kick-off meetings or project lunches in order to continue to communicate his vision and demonstrate his support for this project.

5.3. Executing

After the project team, and key stakeholders approved the project plan the project moves into the project executing phase. The role of a project manager is to drive the project execution. Therefore the project manager tracks and monitors the project. Project reports become essential to communicate the project progress to the project stakeholders. Other effective communication tools for the project besides e-mail are a project web page that keeps track of project documents, a web based project dashboard, or a project war room, where project artifacts are shown on the wall.

The executing phase is often prone to changes that affect the project scope, timeline or budget.

As mentioned above the misperception that software can be changed easily leads often to scope creep and undocumented changes in software projects. The impact of changes on a project in this phase depends on the chosen development methodology. Agile development methodologies are less prone to scope creep than more conventional methods as e.g. waterfall methodology [11]. Further a project manager needs to make sure that the team understands and follows the defined change management process.

The executing phase requires the project manager to direct the team according to the project plan, influence stakeholders in order to get roadblocks resolved and delegates the project work to the project team. During this phase the PM’s key leadership style is situational leadership. The project manager has to be versatile and experienced to understand when to take on what leadership style.

In this phase the executive sponsor leads the project team towards success full project completion. Therefore his main responsibility is to keep the team accountable for results. He follows up on any significant deviation from the plan. Typically he rewards the team for any met milestone with a project celebration or other incentives. If things do not work well the executive sponsor usually requests additional root cause analysis. As he is the one who justifies the investment in this project to the rest of the organization he needs to set corrective action. This can be in the form of exchanging any team members who are not performing well, or even canceling the project if it is no longer required. In this phase the executive sponsor acts primarily as a transactional leader.

5.4. Closing

During project closing the project manager has to make sure that the project deliverables are reviewed and formally approved by the project stakeholder. For software projects this typically means that the software executable passes an acceptance test that is either internal held in the organization or on a customer site. All deviations of the test are documented. At this stage the relationship between the executive sponsor and management of internal or external customers is of importance to finish the project. Any deviations of the outcome need to be addressed and possibly negotiated between the executing organization and the customer. It is in the best interest of the project sponsor to help in the negotiation of terms for closing any open items discovered in the test. In case rework is requires both project manager and sponsor have to assure that the resources stay in place until all project activities are completed.

Keeping all stakeholders accountable for results is key for the leadership style in this phase. The preferable leadership style for a project manager as well as a project sponsor is the transactional leadership style.

At the end of the project the project team and key stakeholders meet to conduct a lesson's learned meeting which identifies all the aspect that worked well and didn't work well during the project.

Finally the results of the lesson's learned session is used as a feedback to improve the processes and work practices in an organization. Every project success must be celebrated in an organization.

6. Conclusion

This work outlines how project leaders need to adapt to different leadership styles throughout the different project phases: Initiating, Planning, Executing, and Closing. One of the main success

factors in becoming an effective leader is to know oneself. Further leaders need to understand the characteristics and associated activities with each leadership style (refer to Table 1 and Table 2). Besides this project managers and project sponsors need to develop an awareness of the challenges that are associated with executing a project. They have to be willing to adapt to different situations and take on the leadership style that is required for each project phase. Project management provides some tools (see Table 2) that support the role, responsibility and leadership style for project leaders. In summary the leader has to be able and willing to adapt to the nature of a project rather then trying to adapt a project and it's team to one's leadership and management style. Project leaders who understand the nature of a project, a project team and processes build the foundation for a successful outcome.

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INFORMATION SYSTEM COMPETENCIES IN SMALL AND MEDIUM ENTERPRISES

Klára Antlová[1]

Abstract

The main issue of this contribution is to discover the main differences between less successful and more successful enterprises with respect to information systems (IS) competencies. The successful implementation of IS is one of the key factors of their long term growth. During the survey data have been collected within 30 small and medium enterprises using multiple interviews in the long term period. These companies were analyzed using the Peppard and Ward framework of 26 IS competencies. Some companies had developed significantly more IS competencies than the others and these competencies helped them in their competitiveness and successful growth.

1. Introduction

Small and medium companies play an important role in the economy. They employ an increasing proportion of the total working population, bring the new products and new services. They contribute to exports, national wealth, and competitiveness. When compared with large enterprises, SMEs have a simpler organizational structure with less specialized tasks, poor human, financial and material resources. They also have more limited use of information and communication technology and the employees have less knowledge and skills capabilities. This low level of organizational readiness, insufficient skills and knowledge are the reasons for slow adoption of information and communication technology. When the IS are successfully implemented and used, the companies improve the following areas of businesses: reduced costs, less errors and better communication with partners, customers and suppliers, reduced inventories, creation of new market opportunities and better cooperation with customers and suppliers.

The survey of IS competencies in SME's was realized in 30 organizations cooperating in one-year education industrial trainee program during the studying course called Computing and Business (in

[1] Technical University Liberec, Czech Republic; klara.antlova@tul.cz

the third school year). This cooperation has been pursued for 15 years, enabling students and their teachers to participate in projects dealing with current problems. At present, this cooperation is supported and financed by the European Social Fond Operational Program Human Resources 3.2. (CZ.04.1.03/3.2.15.2/0211): *„Increasing the education process efficiency in the context of cooperation between the university and the business environment“.*

Peppard and Ward [3] argue that IS resources are combined (through structures, processes and roles) at the organization level to develop IS competencies. They summarized six competencies which cover business strategy, information and IT strategy, exploitation, deliver solution and supply. These six domains contain together 26 competencies which can help organization to use information system strategically and exploit its benefits. During the survey of 30 SMEs the seventh domain has been added. This domain covers external competency which is connected to the external communication with the customers and partners. This external competency is quite often one of the reasons why the companies are buying and improving their IS. The pressure for the electronic communication from their partners is strong especially in the automotive companies or in the companies which are partners of big retails chains.

The IS competencies refer to a firm capacity to deploy their material and intangible resources, usually in combination with skills, to reach desired goals. This view is presented by resource based theory [1]. This theory has been developed to explain how organizations can achieve competitive advantage. Organizations' resources that are valuable and cannot be easily purchased require long learning process. Resource based theory explains why some firms had evolved to become more successful than the others.

2. Peppard and Ward IS competencies:

Peppard and Ward [3] identify the following six domains of IS competence: formulate strategy, define IS contribution and strategy, exploitation, and deliver solutions and IS supply. The first four competencies reflect strategy development and organizational governance. The last two competencies cover IS implementation.

1. Formulate business strategy

Strategy formulation in the smaller companies is very informal, than in the bigger companies. In the growing companies we can see the shift towards the looking for the new business strategy and how to incorporate the new IS strategically in the business processes.

1.1 Business strategy (ensure that business strategy formulation identifies uses of IS),
1.2 Innovation (incorporate the potential of new technologies in long term business development),
1.3 Investment to information technology (establish appropriate criteria for decision making on investment in IS),
1.4 Information governance (define IS management and the roles and responsibilities).

2. Information strategy

Information strategy is developed and aligned with business strategy in bigger and matured organizations. In table 1 we can see that 13 growing companies have adopted IS strategy. On the other hand in other companies where the IS strategy is missing the companies are not growing.
2.1 Prioritization (ensure that the portfolio of investment in application and technology produce the maximum return from resources available),
2.2 IS strategy alignment (ensure that IS development plans are integrated with organizational and functional strategic plans),
2.3 Business process design (determine how IS can deliver best practice in operational processes and organizational activities),
2.4 Business processes improvement (identify the knowledge and information needed to deliver the strategic objectives through improved management processes),
2.5 System and process innovation (carry out relevant R&D into how IS can be used
to create new ways of conducting business and new products or services).

3. Information technology strategy

Infrastructure development has relatively low resources (human and financial). The companies that better adopted and used IS are able to understand technology trends and properly manage technology acquisition and implementation.
3.1 Infrastructure development (define and design information, application and technology architectures and organizations structures and processes to manage the resources),
3.2 Technology analysis resources (understand technology trends and make appropriate recommendations for organizational acquisition of technology associated),
3.3 Sourcing strategies (establish criteria and processes to evaluate supply options and contract with suppliers).

4. Exploitation

Benefits of IS require IS management and financial control. In smaller companies the owner, chief of IS is frequently the same person. These people use very informal managerial techniques. In more successful companies with IS adoption and use the managers have bigger IS knowledge.

4.1 Benefits planning (explicitly identify and plan to realize the benefits from IS investment),

4.2 Benefits delivery (monitor, measure and evaluate the benefits derived from IS investment),

4.3 Managing change (make the business and organizational changes required to maximize the benefits).

5. Deliver solution

Small companies have limited financial resources compared to their larger counterparts, therefore some of them developed their IS applications in house.

5.1 Application development (develop/acquire and implement information, systems and technology solutions that satisfy business needs),

5.2 Service management (define service arrangement and performance criteria to match business requirements including project management),

5.3 Information asset management (establish and operate processes that ensure data information and knowledge management activities meet organizational needs and satisfy corporate policy),

5.4 Implementation management (ensure that new processes and way of working are designed and implemented effectively in conjunction with new technology),

5.5 Apply technology (deploy new/changed technology in the most cost effective mode
to deliver application benefits).

5.6 Business continuity and security

6. Supply of IS

Most of the SMEs did not feel completely comfortable in terms in IS knowledge to select the proper IS vendors. Therefore it is very important to develop technical and managerial IS skills especially in the smaller companies.

6.1 Supplier relationship (manage contracts and develop value added relationship with suppliers),

6.2 Technology standards (develop and maintain appropriate standards, methods, controls and procedures for the use of IS and associate resources),

6.3 Technology acquisition (develop and apply procurement policies and procedures for the organizational acquisition of infrastructure components),

6.4 Asset and cost management (ensure technology, information and application assets
are effectively maintained and cost of acquisition and ownership are understood and managed),

6.5 IS staff development (IS staff development – recruit, train and deploy
appropriate staff and ensure technical, business and personal skills meet the needs of the organization).

7. Communication with customers and partners

This competence has been added to the original framework because trust and customers satisfaction are very important factors. These good relationships or partnerships can be based on personal contacts or on the IS applications for customer's relationship management.

7.1 Customers relationship (develop and maintain the relationship with customers).

3. Stages of growth in SMEs

In the table 1 the companies are arranged according their size (the number of employees: they have more then 9 and less then 200 employees), long term growth, their organizational development and IS adoption. SME growth can be viewed through five stages of company development [2]. This model is based on the hypothesis that SME grow from small entities that are managed closely by the owner or the manager to larger ones. When the companies are growing the management style and using of IS are changing. From research we can see also that in the bigger and more successful companies the IS competencies are more presented. All companies have been divided according above mentioned model. In table 1 the existence of the competencies within organization is indicated with "X" and "-" means that it does not exist.

The first stage of companies (existence) is characterized with business strategy: staying alive (in the table 1 the companies 1-4). The company is working hard to find customers and to deliver orders. The organization is relatively simple, strategic decision is made in short term horizon and there is no strategic planning. There is minimal investment in IS. As the business continues the owners find they have to spend more time on administration. So they have to focus on profitability and improving administration processes. This leads owners towards the next stage.

The second stage of companies (survival - the companies 5-6) is characterized wit establishing of the company and with the growing of customer base. In this stage the information systems are simple: spreadsheets, mails, database of customers. The owner finds more difficult to manage the growing number of stuff. There is also a need to better management information for monitoring the market.

The third stage of companies (success - the companies 8-13) is where the company is well established, owners need to have a vision about their future, and to have bigger control of the company. Information systems are more important for managing of expanding customer base and increasing complexity of business processes.

The forth stage of companies (expansion - companies 14-19) requires great skills of planning and leadership. The owner often recognizes the need for information system to improve communication and access to data within the company.

The last stage of companies (maturity - companies 20-30) occurs when the company has grown to the size which has to be directed by the management team. Strategic planning is well established. The company has good relationship with their customers and suppliers, and IS is strategically aligned with business strategy.

The IS competencies characterized by 26 attributes (i.e. competencies as described above) have been analyzed in thirty companies and the results are displayed in table 1. The existence of competencies in the company is signed as (X) and no existence as (-). In the last column we can see the long term of growth as (yes) and the companies which are not growing (no).

	IS competenices:																											
Org.	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	5.6	6.1	6.2	6.3	6.4	6.5	7.1	Growth
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
3	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	No
4	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	No
6	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	No
7	X	X	-	-	X	X	-	-	-	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	No
8	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
9	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	No
10	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
11	X	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
12	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
13	-	-	-	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
14	X	X	X	X	X	X	-	-	X	X	-	X	X	-	-	X	-	-	-	-	X	X	-	-	-	-	X	No
15	X	X	-	-	-	-	-	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No
16	X	X	-	-	X	-	-	X	-	X	X	-	-	-	-	X	-	-	-	-	X	X	-	-	-	-	X	Yes
17	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	Yes
18	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X	-	-	X	X	Yes
19	X	X			X	X	X	X	-		X	-	X	-	X	X	-	-	X	-	-	X	X	X	-	X	X	Yes
20	X	X	X	-	X	X	X	-	X	X	-	X	X	-	-	X	-	-	-	-	-	X	X	-	-	X	X	Yes
21	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	-	X	X	-	X	X	X	X	X	X	Yes
22	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	-	X	X	X	X	X	X	-	X	X	Yes
23	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
24	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	X	X	Yes
25	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
26	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
27	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
29	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes
30	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Yes

Table 1 IS competencies in SMEs Own source

In table 1 we can see a great variability between these 30 firms. Also we can see the causal relationship of some competencies and the company's growth. Especially the presence of business strategy (competence 1) and information strategy (competence 2-3) are essential. Very interesting is

also the strong dependency in 93% companies between the business strategy and developing of good relationship with customers and suppliers. This external orientation is one of the important reasons of the long term growth. There is also very interesting correlation between insufficient financial resources and IS knowledge with stagnation. In 75 % companies we can find problems connecting with delivering of convenient IS solutions and lack of IS skills and knowledge (competencies 4 - 6). Therefore the companies try to develop their IS applications in – house (sometimes not in the sophisticated form).

Employees who fulfill all the competencies are the last five companies in table 1. We can see relationship between all these competencies and long term growth. One example is a company (number 26) which is running business on the Internet, appreciating the importance of its employees' IS competencies. This company was established by three students within the framework of industrial trainee 12 years ago. Now the company has 70 permanent employees and a large number of outside collaborators. In the past two years, the company reported a turnover growth of 100 per cent. In this company all people are encouraged to share all the IS skills and knowledge through internal Wikipedia, their contributions are monitored and also financially motivated.

The dependence of the presence of the corporate strategy (competence 1), information strategy (competence 2 and 3) and knowledge management (competence 4 - 6) and the steady growth of the organization was monitored with the statistic test χ^2 chi-quadrant. Table number 2 specifies the number of surveyed organizations with no, at least one, two or all three strategies in place which are growing or which stagnate.

Number of organizations	Growth	Stagnation	$\sum$
Existence of 0 factors	0	3	3
Existence of 1 factors	1	8	9
Existence of 2 factors	2	4	6
Existence of 3 factors	12	0	12

Table 2 Contingency table Own source

The null hypothesis has been formulated: Growth of organization does not depend on the key strategies (business, information and knowledge). Hypothesis H1 negating hypothesis H0 was also determined.

On the level of significance, the independence hypothesis H0 is rejected if

$G > \chi^2_{1-\alpha}[(r-1)(s-1)]$

i.e. if the tested criterion value is greater than $100(1-\alpha)\%$ - division quantile χ^2 with (r-1)(s-1) degrees of freedom, with $\alpha =$ the level of significance (most frequently used 5%), with r = number of rows and s = number of columns.

$$G = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{(n_{i,j} - n'_{i,j})^2}{n'_{i,j}}$$

The dependences of variables are measured according to the above-specified formula. If the dependence of the monitored and hypothetical variables are small, the differences are minor.

If $G > \chi^2_{0,95}$, null hypothesis H0 can be rejected.

Table 3 specifies the results of calculation according to statistic application Statgraphic.

G	21,11
χ^2	5,99
Contingency coefficient (CP)	0,64
Cramer coefficient(CCR)	0,84

Table 3 Results of χ^2 test Own source

CP and CC must be from interval (0.1). Considering the fact that value $G > \chi^2_{0,95}$ (21.111> 5.99), and both coefficients (Cramer and Contingency) show a strong dependency, hypothesis H0 can be rejected, thus proving hypothesis H1. This implies a relatively strong dependence of the organization's growth on all three strategies (business, information and knowledge strategy) with a significance level of 5 per cent.

4. Conclusion

Main important results of this survey of successful and less successful small and medium enterprises indicate the strategic role of IS. Insufficient IS knowledge and deliver of IS solutions can be one of the reasons of the company stagnation. These problems we can find almost in 75 % of collected companies. We can also see strong relationship between IS infrastructure and developing a good relationship with suppliers. In companies where the potential of new technologies is incorporated in long term business development and where the relationship with customers is developed, we can see the long term successful growth. Therefore it is very important to improve

the IS competencies of management and employees. This is also an opportunity for the universities to help SME with the IS and management skills in the projects of further education.

The importance of IS as a factor for competitiveness and productivity growth is emphasized also by European Commission in Lisbon strategy which was revised in 2005 with the new initiative i2010. Its purpose is to facilitate innovation and the take – up of IS in Europe.

This study did not involved the variety of industries (some company are service oriented and the others are producers). This different view on the companies connecting with type of industry and services can bring some other interesting results. This requires further research particularly to identify which competencies are relevant for service oriented or producing companies.

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IMPROVING COMPANY PROCESSES BY APPLYING A LIGHTWEIGHT PROCESS APPROACH BASED ON THE SPICE MATURITY MODEL

Klaus John[1], Dietmar Winkler[2], Stefan Biffl[2]

Abstract

Company best practices and information availability are the backbone of successful software development companies in the IT service domain. Typically, projects focus on the development of individual and independent products. Reuse of software by applying modules or components requires additional structured information and best-practice application approaches to deliver quality products e.g. software in the financial sector for money transactions. Major challenges to enable the construction of high-quality software products are (a) to implement and introduce an effective and efficient information management system to support management processes, e.g., software development, and (b) to manage Best-Practices for further improvement of products and processes. Quality Management Systems, e.g. SPICE, CMMI and the ISO 9001 series, are common approaches for information frameworks within companies. Nevertheless, common critics of heavyweight quality management systems focus on process definitions (and documentation) under strict administrative conditions. These restrictions and constraints are considered as barriers for software development rather than supporting developers in their work. Thus, the acceptance of applying and improving process definitions by means of continuous improving a quality management system is quite low. To address theses issues, a lightweight process model seems to be a reasonable approach for improving products and processes based on feedback.

This paper introduces a lightweight process approach based on the SPICE maturity model. Instead of mapping as normally ISO 12207 reference model and SPICE to identify the maturity level, the lightweight approach adopts company processes as reference model as a lightweight starting point for process maturity evaluation and improvement. The identification of a process maturity model is based

[1] Bundesrechenzentrum GesmbH, Austria; Klaus.John@brz.gv.at
[2] Vienna University of Technology, Austria; {Dietmar.Winkler, Stefan.Biffl}@tuwien.ac.at

on the compliance of current processes and the SPICE assessment framework. This lightweight process approach promises to achieve a better acceptance of implementation into daily work by the employees. To identify the impact of this lightweight process model approach we conducted a series of interviews at an Austrian IT service provider by selecting three representative projects in the public application domain.

Keywords: SPICE, process assessment, process maturity, lightweight process framework.

1. Introduction

Market requirements and competitiveness of products are important issues in common software engineering practice. Software engineering strategies support effective and efficient product development under constraints like cost, time, quality, and quantity.

The development of individual products requires a selective experience of best-practice approaches and focuses on current customer requirements as well as the "value of products" for individual stakeholders. Values are defined to help manufacturing products, this can be supported like requirements, changes, configurations, and codes are documented or software will be always tested after a scheme before it will be delivered etc. Companies found out that their manufacturing quality was not always the same and differs from project to project. There is a high risk that projects would over stretch project budgets. Companies found out as well that staff, which is involved has also an enormous influence and only on the behalf of personal engagement, product quality is high. By trying to repeat the success standards (e.g. ISO 9000 series, ISO 12207, etc.) and best practice models (e.g. CMMI, etc.) have been developed to introduce a more common and repeatable way of producing highest quality for the customers. In addition, this proceeding strengthens companies, when employees will be transferred into another department or leave the company. At least their work is documented and enables their successor to take over in a shorter period. In our days, if a company is a supplier e.g. for car industry than this company has to reach a defined auditable process level, e.g. in defined process maturity, defined process repeatability and defined processes for automotive SPICE.

Strategic planning approaches require information with respect to an appropriate and stable process supporting planning and engineering activities. Quality Management Systems (QMS) like ISO 9000 series, CMMI, and SPICE are standards to support planning and monitoring of software engineering projects [1]. The implementation and maintenance of a Quality Management System (QMS)

requires a high effort and experienced engineers. To make implementation easer a lightweight process approach enables an easy implementation of a defined SPICE Quality Management System, which promises to support the advantages of QMS and avoiding disadvantages and barriers to users. Sometimes, these standards and best practice models have also a bad habit, employees feel domineered through these introduced procedures. They think this is a data collection only management will need.

The general idea of the lightweight process approach gives employees detailed information how daily work is congruent to company's processes. When this is clear to every one, who is involved in the manufacturing process, than the lightweight approach only analyses selected processes in SPICE processes model. The analysed processes are (a) Engineering, (b) Change Management, (c) Project Management, (d) Configuration Management and (e) Quality Assurance - than at a later stage, the company processes will be exchanged towards SPICE reference model ISO 12207.

The SPICE reference model is used to have a broad possibility to compare process maturity to the same level at every company. Reference model ISO 12207 from SPICE helps to have a better understanding at negotiations and contracts between customers and suppliers. Focus is on project development, operating and maintenance of software systems. ISO 12207 is not applicable when buying standard software or standard software systems.

After a phase of recognition of the above-evaluated company's manufacturing processes (a) to (e), they can be exchanged towards SPICE reference model ISO 12207. Now, measuring process maturity within SPICE processes, than possible leaks can be found where companies processes needs to be adopted to reach requested maturity in SPICE.

The remainder of this paper is structured as follows: Section 3 defines the related work on Quality Management Systems (QMS), section 4 illustrates the implementation, introduction and evaluation of a lightweight approach methodology and section 5 concludes.

2. Related Work

Quality Management Systems, e.g., ISO 9000 series, CMMI, and ISO 15504 known as SPICE provide company wide frameworks for managing the processes, information, and data. The application of a QMS, (a) defines individual processes within a company, (b) assesses the processes against an excellent model (e.g. compliance with ISO 9000, CMMI [2] or ISO 15504 known as SPICE) and (c) to derive maturity and capability levels for each process as a quality statement for

the whole company. Practice shows that small software developing companies do not benefit from process improvement where as larger companies do. A report from SEI [8] July 2005 describes from 782 organisations (59,0% non-USA organisations), 438 companies and 3.250 projects the following results. “Small organizations (<25 employees) 70.5% are assessed at CMMI level 2: Managed. Large organizations (1001–2000 employees) 52.8% are rated at the highest CMMI level (5: Optimizing)”.

Based on SEI [8] Report from 438 companies 70,5% had implemented processes mainly at “CMMI level 2: Managed”. For some companies it is common, to provide a certificate (e.g. ISO 9000 series, Automotive SPICE [3], etc.) as a supplier which certifies their processes.

When there are no processes implemented in a company, than the burden is that the complete manufacturing process is dependent on the personal engagement of the involved employees as well as their experiences from manufacturing. What would be a typical outcome of this scenario? When for instance one employee leaves the company, it could harm to real damage, because this employee is taking all his knowledge with him. This is a need for process definition as a vehicle for process management.

The implementation (a) to define individual processes within a company, (b) to assess the processes against an excellent model and (c) to derive maturity and capability levels for each process as a quality statement for the whole company is dependent of the standard. ISO standards like ISO 9000 series for quality management systems and ISO/IEC 15504 (SPICE) framework for assessment of processes have a different focus on implementation of these approaches. CMMI is a maturity model similar to ISO 15504.

- **ISO 9000 series** sets up procedures to cover all key processes in companies business. The basis for ISO 9000 series is the old BS 5750 standard. It is known as a management standard because it does not specify what needs to be manufactured. ISO 9000 includes the following standards (ISO 9000:2000: Quality management systems – Fundamentals and vocabulary, ISO 9001:2000: Quality management system – Requirements, and ISO 9004:2000: Quality management system – Guidelines for performance improvements). Certification to an ISO 9000 standard does not guarantee the compliance of products and services. It certifies that consistent business processes exist.
- **ISO/IEC 15504** also known as SPICE is a framework for the assessment of processes, which was developed by the Joint Technical Subcommittee between ISO and IEC. ISO/IEC 15504 now includes six parts (the 7th part is currently in an advanced final draft standard

form and work has started on part 8 an ITIL based process reference model). Its basic idea develops of many maturity models like Bootstrap, Trillium and the CMMI. The main procedures are:

- The **reference model** defines a **Process Dimension** and a **Process Capability Dimension**.
- The **Process Dimension** in the reference model **refers** to an **external process lifecycle standard** including **ISO/IEC 12207** and ISO/IEC 15288. This standard verifies conformity of (any) reference models. The process dimension is categorised in process domains (primary, organisational and supporting) of the process reference model. It focuses on domain and scope, purpose and outcomes.
- The **Process Capability Dimension** has six capability levels, which are measured by nine process attributes.
- The **Capability Levels** are defined on the following scale (5: Optimizing process, 4: Predictable Process, 3: Established Process, 2: Managed Process, 1: Performed Process and 0: Incomplete Process).
- The **process attributes** in the international standard are 1.1: Process Performance, 2.1 Performance Management, 2.2: Work Product Management, 3.1: Process Definition, 3.3: Process Deployment, 4.1: Process Control, 5.1: Process Innovation and 5.2: Process Optimization. Each process attribute is assessed on a **four-point rating scale NPLF** (N: Not achieved 0% – 15%, P: Partially achieved >15% - 50%, L: Largely achieved >50% - 85%, F: Fully achieved >85% - 100%).
- **Process Capability** is based at level 1 (Performed Process) of **Base Practice** and **Work Product**. At level 2 (Managed Process) to level 5 (Optimizing Process) of **Generic practice**, **Generic Resources** and **Generic Work Product**.
- The **maturity model** is consisting of capability levels, which in turn consists of the process attributes and further consists of generic practices. Process dimension defines processes divided into five **Process Categories** (customer-supplier, engineering, support, management and organisation).
- ISO/IEC 15504 is the standard **reference model** for **maturity models**. It is executed through assessors, which collect the evidence during their assessment, with this evidence, the assessors can give an overall determination of the organisation's capabilities for delivering products like software, systems and IT services.

For some companies if they want to supply products they need a certain certificate, which assures their capability. For instance, a certificate or a defined maturity and/or capability level (based on CMMI or SPICE) is a precondition for a supplier in the automotive business area [3].

SPICE and its Capability Dimension supports checking quality compliance in selected Processes in Process Dimension in three Process Categories. These Process Categories are Primary Life Cycle Processes, Organizational Life Cycle Processes, and Supporting Live Cycle Processes. The Process Categories divide in a set of nine Process Groups [4]. In this Process Groups, we selected the whole Process Group (a) Engineering and the processes (b) Change Management, (c) Project Management, (d) Configuration Management and (e) Quality Assurance.

A measurable output can be generated in each Process Capability Dimension through an assessment of the evaluated categorised processes. Process Attributes assesses the process content and they are always the same for the maturity model, which is consisting of capability levels. These Capability levels are independent from the Process Reference Model (PRM). SPICE uses an exemplar Process Reference Model ISO/IEC 12207 (AMD1 and AMD2) which supplies relevant processes in the life cycle of software (Software Live Cycle Processes, SLCP) part 5 of ISO 15504 (SPICE). In SPICE there are six Capability Levels and the following levels are in focus of this paper. Level 4 is in our focus because of the measurement of processes in manufacturing and the ability to change this processes, when they are not mature enough.

- At **level three**, all processes reaching that level are established, planed and controlled.
- At **level four**, all processes reaching this level will be carried out constantly in between predefined borders. This includes implementation of metrics and constantly measurement of the required outcomes of defined software development processes.

The difference between level three and level four is, that at level three (Established Process) all efforts are put into amendment of product level. At level four (Predictable Process) onwards all additionally efforts are put into organisational level supported through a feedback loop.

How to precede an assessment is specified in Process Assessment Model (ISO/IEC 15504-3) in SPICE. ISO 15504-3 (SPICE part 3) gives guidance for performing an assessment with the following directives (details see ISO 15504) Measurement Framework, Role and function of process reference models, Requirements for selection of a model, Selection and use of assessment tools, Criteria for assessor’s competence and Verification and conformity.

When software development is determined by a pre-defined quality this very often leads to a well-used QMS ("heavy-weight"). For a development team this usually includes documentation overhead for definitions or recording of information and data. Common experience reports [5] show that the application of a "heavy-weight" QMS suffers from complexity and the amount of information and data, which leads to additionally administrative non-productive effort. If in a Software development company test process is organised, that for each requirement a test case is required otherwise the whole test will not proceed, than documentation for all test cases produces a lot of work when it is not clear that this test strategy produces the needed benefit for expected quality. In this case, it could make sense to start a prioritizing process to evaluate important, less important and unimportant requirements. Test only required and prioritized requirements before testing them all. Employees do not see any additional benefits. Furthermore, the implementation of a QMS can results form strategic decisions on upper management initiatives.

There is a need for a practical lightweight process approach (a) to enable a smooth introduction to a structured QMS without an enormous additional effort for implementation and maintenance and (b) to enable an easy starting point for an efficient software process including an improvement initiative.

3. Roadmap for Introducing a Lightweight Process Approach

In this paper, we focused in a meeting, which company processes we need to develop software in the Software Live Cycle Processes (SLCP). We looked into ISO 15504 and compared this company processes with the equal processes from SPICE. The following processes are the result of our comparison. The Processes described in details in ISO 15504 and self-speaking.

- Engineering process group describes
  - Requirements elicitation (ENG.1)
  - System requirements analysis (ENG.2)
  - System architectural design (ENG.3)
  - Software requirements analysis (ENG.4)
  - Software design (ENG.5)
  - Software construction (ENG.6)
  - Software integration (ENG.7)
  - Software testing (ENG.8)

  - System integration (ENG.9)
  - System testing (ENG.10)
  - Software installation (ENG.11)
  - Software and system maintenance (ENG.12)
- Supporting process group describes
  - Change request management (SUP.10)
  - Configuration management process (SUP.8).
- Management process group describes
  - Project management (MAN.3)
  - Quality assurance process (MAN.4).

The there are more than the selected processes in ISO 15504. There had been done a decision and the selection is the result evaluation of needed processes for manufacturing Software. In our research, we made the experience that there is also no implication when processes are added or removed. If there is, a process improvement planed, than it is no problem to extend the checklist with this new process.

Selection in five Steps

This section presents in a sequence of five steps development of a lightweight process approach at a large Austrian IT Service Provider. The five steps are mapping of a company process to Spice framework, series of interviews, informal SPICE assessment, project selection for evaluation purposes and Modification of the assessment levels.

Constructing a lightweight framework

1. *Mapping of company processes to SPICE framework*: We started exchanging the exemplar Process Reference Model (PRM) ISO/IEC 12207 against the company processes as specified in Roadmap for Introducing a Light–Weight Process Approach. Figure 1 is an example of company processes project management. The processes were put into a questionnaire – see table 1. With the questionnaire, process maturity was than measured against PRM at a large Austrian IT Service Provider. Details to the questionnaire are explained in step 2.

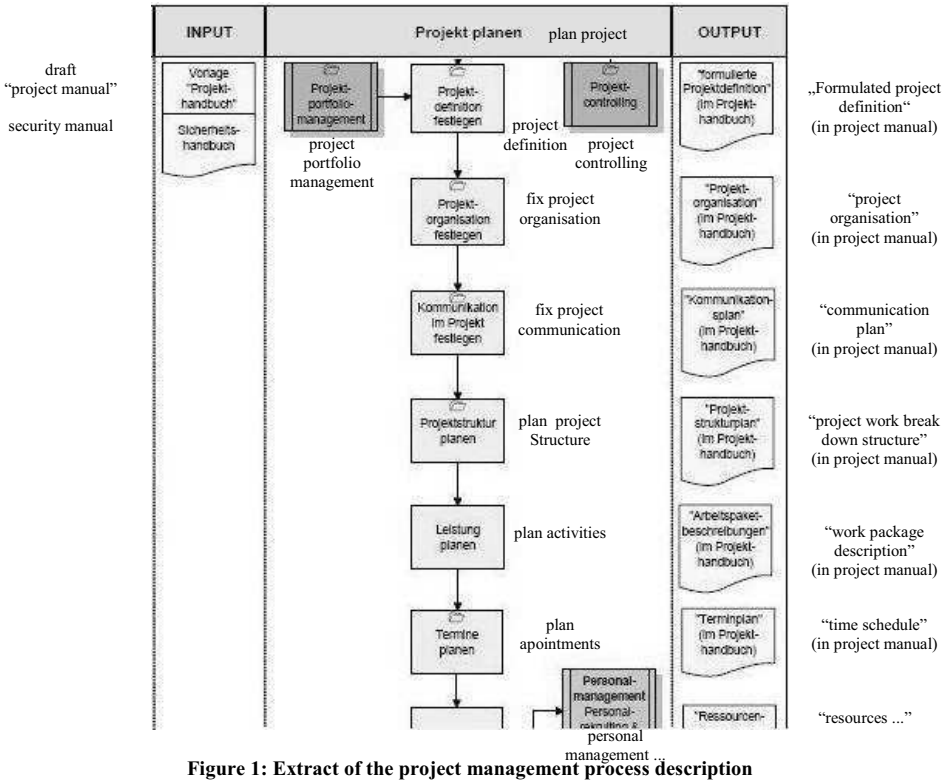

Figure 1: Extract of the project management process description

2. *Series of interviews:* Target in this step is to measure process maturity. We developed a questionnaire, where each company process of that PRM is a checkpoint. See example questions for Project Management (MAN.3). Than we made an appointment with each of the three project managers of the related projects (see step 4) for an interview.
    - Preparation of questionnaire by analysing all company processes of a SLCP including its input und output deliverables (outcomes) of each process step.
    - For process improvement, we expanded our questionnaire by new process checkpoints with the idea to get an early overview, how much effort it will be to implement these process improvements. It is a check up to get an overview, which process steps of the to-be invented are in use by our software developing teams – this is optional.

XX	SPICE	Questions PM - Baseline	Performed yes	no
X	X	1. Were the project objectives (goals, non goals) defined and recorded in the project manual?		
X	X	2. Was the project organization (tasks, responsibilities) defined and recorded in the project manual?		
X	X	3. Were communication mechanism (meetings, reports, escalation mechanism) defined and recorded in the project manual?		
X	X	4. Was a project schedule defined and recorded in the project manual?		
X	X	5. Were milestones defined and recorded in the project manual?		
		…		

Table 1: Extract of the questionnaire for determine the level of maturity

3. *"Informal SPICE assessment":* The process assessment still keeps SPICE Capability Levels (from 0: incomplete up to 5: optimizing) and their SPICE Process Attributes on. This includes evaluation values in percentage rates to match results. It is important, because a company PRM can be changed at any time to standard PRM ISO/IEC 12207 (AMD1 and AMD2) in SPICE.

4. *Project selection for evaluation purposes:* We were investigating actual process maturity at the following three projects at a large Austrian IT Service Provider. They have been chosen by their impact to users, selected process skills in developing software topic and project size.
   - *Project Digital Signature*. This project includes printing a profile block including a digital signature on any PDF-A document – the document receives a digital signature. The project was developed in several iteration cycles. Project size is medium.
   - *Company Deployment Calendar*. This calendar helps to plan deployment into production for any release. This project applies new technologies in middleware for software development. Project size is low.
   - *Cross-Border Goods Documentation System*. This project includes a high complexity due to comprehensive requirements from a various number of governmental requirements. Project size is medium.

5. *Modification of the assessment levels*: To have a more practical approach we were taking tailoring aspects of projects into consideration. We selected three project sizes but there is

no restriction to select more than three project sizes. For our investigation, three levels just suits.

- Low project size: This is the baseline for all projects (minimum deliverables).
- Medium project size: Projects that do not need all deliverables of PRM, but these projects need more than a baseline.
- High project size: These projects need virtually all deliverables form Process Reference Model (PRM).

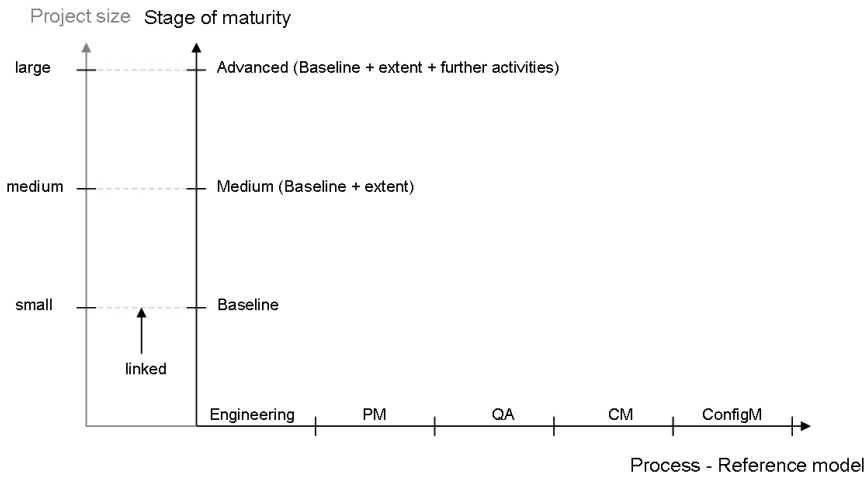

Figure 2: Project size coupled with stage of maturity

The transforming works as the following: Maturity level Baseline can be reached as largely (L) or fully (F). Maturity level Medium can be reached when level Baseline is fully (F) and level Medium is largely (L) or fully (F) fulfilled. Maturity level Advanced can be reached when level Baseline is fully (F), level Medium is fully (F) and level Advanced is largely (L) or fully (F) fulfilled. The rating its self needs to be the same as in the four-point rating scale NPLF (N: Not achieved 0% – 15%, P: Partially achieved >15% - 50%, L: Largely achieved >50% - 85%, F: Fully achieved >85% - 100%). If not, than transformation back to SPICE PRM ISO/IEC12207 from assessed company processes is left. To reach the next level maturity needs to be largely or fully.

	Activities and Work products
Project management process	Define goals and non-goals of the project
	Define the project organization (tasks, field of responsibility)
	Determine the communication (meetings, reports, escalation mechanism) within the project
	Create a product structure plan with work packages and outputs
	Plan of due dates (milestones plan), resources, and costs/revenues
	Summarize all cognitions in a project manual
	Register planned data for the project in SAP and the PM-DB
	Allocate work packages and tasks
	Collect actual effort, due dates, and used resources as well as actual costs
	Target/actual comparison of efforts
	Activate interim billings
	Evaluate project participation
	Acceptance of the project from the customer for grant discharge to the project team (acceptance protocol)
	Acceptance of the project from the operation including creation of a final project report
	Break up project team
	Activate project final invoice
	Freeze the project

Table 2: Baseline for the Project management process

Results

One very interesting result was that the quality and outcome of the individual process steps are higher than deliverables defined by process description (i.e. the teams seem to work on a higher level than expected, because they used reasonable methods and tools, which support their work significantly). All projects should meet at least level Baseline.

The results of the three selected projects delivered a knowledge about the actual situation how teams developed software. We did not aspect it in such a quality.

Project Calendar was classified with project size low and suits level Basline (see Figure 4: Level of maturity ratings in the project Calendar). The effort for engineering maybe was a little bit too high, because it should be a project at size Baseline.

	Baseline	Medium	Advanced
Engineering	100 %	74 %	86 %
Project management	85 %	67 %	83 %
Change management	80 %	90 %	57 %
Configuration management	83 %	80 %	40 %

Table 3: Reached percentages of the investigated processes for the project Calendar

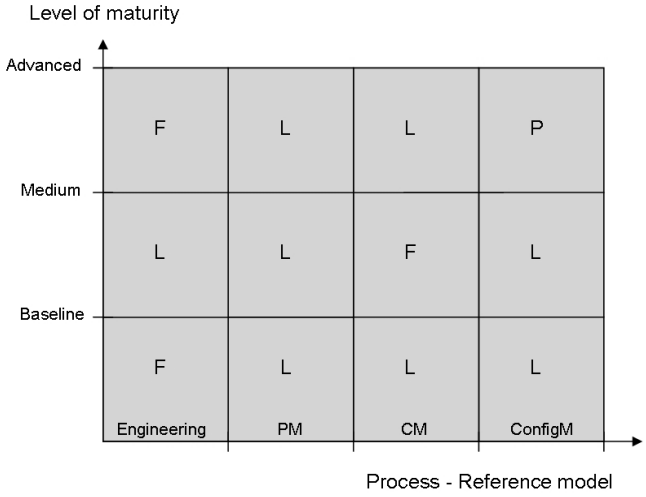

Figure 3: Level of maturity ratings in the project Calendar

4. Discussion and Conclusion

The lightweight approach enables the introduction of a QMS strategy quickly with less effort and enables the identification of improvement potential, based on the current state of the practice in various projects.

After analysing in a first step practical process usage in developing software, a company has the ability to shift from company PRM to PRM ISO/IEC 12207 (AMD1 and AMD2) SPICE, to measure process-gaps against ISO/IEC 12207. Instead of using SPICE, it is also possible to use CMMI maturity model.

The construction of the questionnaire must address the target QMS, e.g. SPIC, to enable comparability and compatibility of the lightweight approach.

There is a need to evaluate more projects, this should also happen in other companies, to get a broader overview in measuring user-acceptance of introducing a maturity model like SPICE, CMMI, etc. through of our introduced lightweight approach.

Based on the findings, the company can identify improvement candidates by sharing best practices across projects to increase the existing maturity level (see Table 4).

XX	SPICE	Questions ENG - medium	Performed yes	no
	X	1. Were functional and non functional requirements prioritized (for example must, should, could)?		
X	X	2. Were project-specific adjustments accomplished, i.e. adjustments of the procedure to the concrete situation?		
X	X	3. Was defined which activities in the project are performed and which not?		
		…		

Table 4: Concept for identifying possible process enhancements

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UNIFYING PERSPECTIVE BETWEEN HUMAN BEINGS AND TECHNOLOGY ALIAS CAN NARRATIVITY BE OF SOME USE?

Tomáš Sigmund[1]

Abstract

The paper summarises the development from BPR to BPM stressing the importance of human aspects. Then three theories for IS design considering the human aspect are introduced and their relevance shown. At the end some of their common features were identified and place for narrative aspect unifying objective and subjective perspective is found.

1. Introduction

On the last IDIMT conference I presented a paper with describing the differences between human and computer approach to world. This time I would like to present some alternatives how to connect both the human and computer approach in an information system. My paper is thus more practical than the previous one.

2. From BPR to BPM

Improving business processes is the necessity for every company which would today like to stay on the market. The competition is quite severe, the customers require product improvements and every company tries to improve its processes in response to that situation. New technologies developed at the end of the 20th and at the beginning of the 21st century bring stronger competition (e.g. though e-commerce) on one hand and new possibilities of process management on the other (BPR, BPM software, BI, SOA etc). The continuous improvement of processes wasn't enough as it didn't fulfil the requirements of the market and reengineering became in the nineties a common practice among

[1]Department of System Analysis, University of Economics, Prague; Sigmund@vse.cz

the companies. In their famous book from the late 1980s, *Reengineering the Corporation,* Michael Hammer and James Champy promote the idea that radical redesign and reorganization of an enterprise was necessary to lower costs and increase quality so businesses could become more competitive. The book also promoted the idea that IT was the key enabler for such radical change. For many organizations, then and now, this "wipe the slate clean" approach to business process re-engineering (BPR) is simply too difficult, too radical and too comprehensive. The impact on employees, on facilities, on existing investments in systems, and even on the organizational culture is too significant. Few CEOs have the fortitude to drive such comprehensive transformation. Even Michael Hammer in November 1996 confessed in the Wall Street Journal that he was not critical enough towards the human dimension. He realised that this dimension was critical as he met its resistance.

As a result of the reengineering crisis a new approach called BPM was developed. It is not radically different from reengineering, but tries to overcome its weak points. Like BPR, discussions of BPM often emphasize process thinking as a way to lower costs, increase the quality of services and products, and improve personnel productivity. Many BPM promoters also stress technology (again) as an enabler of business transformation. Although BPM today clearly draws on earlier process-oriented management theories, there are significant differences.

BPM advocates using an iterative methodology for making incremental process improvements. An iterative and incremental approach to process change enables more frequent adjustments and recognizes that business conditions change faster in globally connected markets.

The central feature of business process re-engineering theory was advocating the use of technology to replace manual efforts. The result, it was argued, would be increased efficiencies, lower costs and increased quality.

Like BPR, BPM starts with process modelling to understand workflows and identify manual and systems automated tasks. However, the objective of process analysis today is not simply to eliminate manual efforts. Rather, the objective is to understand the interactions and dependencies among the people, the systems they rely on, and the information they require to do their tasks best.

BPM treats people as equally important contributors to successful work process as systems and business documents.

However in reality many of the process modelling methods still originate from a computing perspective, their focal point is control-flow rather than interaction of social actors. They forget that

an enterprise is a complex socio-technical system that includes interaction of technical and social components. The interrelation between technology and BPM is quite obvious (there are computer supported methodologies, in most processes the flow and analysis of information is based on IT, there are computer supported standards for process modelling) which makes the coexistence of humans and technology one of the critical factors for process management. The problem is that while people connect in their experience both subjective (phenomenological) and objective (cosmological) world machines can operate in the objective world only. The problem is not only that people can understand machines and not vice versa but also how to achieve and support the complex and unified perspective human beings have. Because of this more complex perspective companies should give preference to their human resources. Many theories dealing with processes, their modelling and improvements don't appreciate the importance of the human factor and stress rather technologies. A thorough study of enterprises information systems (EIS) requires a broad grasp of the organizational and social context, in which the envisioned EIS will have to operate and enable business processes. "An EIS is not machinery alone or a collection of information technology (IT) components, but a complex socio-technical phenomenon, where business process and users are the other two main components. An accurate EIS design entails a significant deal of human communication and interaction study. [6]" The emphasis should be put on how to increase people communication, coordination, cognition and decision capabilities using computers. What we should do is to try to understand human beings and their world perspective and to introduce methods into BPM which would take it into consideration.

There are three socio-technical theories – the Language Action Perspective, Organizational Semiotics and the Theory of Organized Activity[2] which try to incorporate some ideas of the human approach to world and balance the prevalence of technical perspective on human-computer interaction. I will try to outline the main ideas of these three theories and then show that narrativity can be incorporated into them.

3. Theory of organized activity (TOA)

This theory was invented by Anatol Holt in his book Organized Activity and its Support by Computer [3]. He thinks that computers and IT just support human activities. He proposed two

[2] A good survey of all these three theories can be found in the José Cordeiro and Joaquim Filipe's paper Language Action Perspective, Organizational Semiotics and the Theory of Organized Activity – a Comparison, in Proceedings of the workshop DEMO. Tilburg, the Netherlands, 2003

computer programs (PULSAR and IGO) showing two possible approaches for group and individual coordination of activities.

Human activities occur in every organization and business system. Human action is the key element for the structuring and planning of all activities. TOA is based on a metatheory: The Theory of Units. A unit is something that the members of a group who have an activity in common identify as a common element. The common understanding of the unit is possible as there is a criterion within the group which can be used to identify realizations of the unit. Interpretation of the unit should produce a collective meaning. All activities in TOA are carried out in terms of the units which can be terms, actions or things. All actions have a performer who is always a person.

The main ideas of TOA are presented in the figure.

1. Every social group (or community) bound together by organized activities has its UNITS.
2. Associated with every UNIT of a community is a CRITERION which this community maintains – a CRITERION by which its members decide whether a given something is, or is not, a REALIZATION of the UNIT.
3. An ACTION is the UNIT of (human) effort.
4. Every ACTION is doubly performed – ORGANIZATIONALLY and PERSONALLY. Correspondingly, there are two types of ACTION PERFORMERS: ORGANIZATIONAL ENTITIES, and PERSONS.
5. A PERSON assumes a RESPONSIBILITY by becoming an ACTOR, (…) who plays a role in an ORGANIZATIONAL ENTITY.
6. ACTIONS are driven by the INTERESTS of their PERFORMERS. PERSONS have PERSONAL INTERESTS; ORGANIZATIONAL ENTITIES have ORGANIZATIONAL INTERESTS.
7. To make an organized activity efficient and effective requires bringing all INTERESTS involved – PERSONAL as well as ORGANIZATIONAL – into proper alignment with one another, in every imaginable combination.
8. BODIES are material UNITS
9. Every ACTION INVOLVES at least one BODY; every BODY is ENVOLVED in at least one ACTION.
10. BODIES extend in space; ACTIONS extend in time.
11. The BODIES which an ACTION INVOLVES are, together, called the THEATER of the ACTION; the ACTIONS which INVOLVE a particular BODY are, together, called the LIFE of the BODY.

Figure 1: OA basic statements (From [3])

4. Organizational Semiotics (OS)

R. Stamper presented in his work a theory where information and other IS key concepts were analysed using the sign notion originated in semiotics. This analysis should produce better understanding of IS and its ideas. According to Stamper "Business means getting things done by using information. All information is carried by signs. [4]"

Human Information Functions	**SOCIAL WORLD** – beliefs, expectations, commitments, contracts, law, culture, ... **PRAGMATICS** - intentions, communication, conversations, negotiations, … **SEMANTICS** - meanings, propositions, validity, truth, signification, denotations,…
The IT Platform	**SYNTACTICS** - formal structure, language, logic, data, records, deduction, software, files, … **EMPIRICS** - pattern, variety, noise, entropy,channel capacity, redundancy, efficiency, codes, … **PHYSICAL WORLD** - signals, traces, physical distinctions, hardware, component density, speed, economics, …

Figure 2: Stamper's Semiotic Ladder

We can identify in the table an already known idea that the real IS is a human system and the IT platform is below as a support to human activities. "Organizations should concentrate on the meaning of signs, the purpose for which they are used and the social consequences they produce. [5]"

The second important concept in OS are norms. Norms guide our behaviour, thinking and acting. There are four types of norms and attitudes corresponding to them:

- Behavioural – to govern the action of people (deontic attitude)
- Evaluative – to judge about something (axiologic attitude)
- Cognitive – to form beliefs about the world (epistemic attitude)
- Perceptual – to mold our perception (ontological attitude)

This classification can be used to define a general norm structure: IF condition THEN norm-subject ADOPTS attitude TOWARD something.

Norms don't need to be explicit, as written laws, rules, or regulations, can be broken and act as forces in our lives. Norms are shared by each group or community. The communities form information fields in which people live and belong and share a system of norms. Every field has

different meanings, intentions and semiotic signs. Individuals can belong simultaneously to different fields and obey different norms. Information fields and norm should be analysed in order to better understand and design an IS.

5. Language action perspective (LAP)

The Language-Action Perspective (LAP) challenges the conventional notion that communication is merely transmission of information or symbols and argues that people are linguistic beings and use language to perform actions (as in promises, orders, requests, and declarations etc).

LAP recognizes the importance of communication in an organizational context, therefore, emphasizes how people communicate with others; how language is used to create a common shared reality and how people use communication to coordinate their activities. The LAP approach is, thus, based on the premise that much of work in organizations is performed through language, i.e. communication is primarily action which, in turn, facilitates coordination and interaction.

The LAP approach has developed into a new foundation for designing effective information systems with two key principles. First, linguistic communication should be the basis for understanding and designing information systems. Second, people perform actions through communication; therefore, the main role of an information system is to support organization communication.

This approach proposes a design of computer systems based on the linguistic model of conversation for action. Linguistic action is considered to be the essential human activity. IT should play the role of mediators and facilitators of this activity. Three main approaches can be distinguished within the LAP:

- Action workflow
- Dynamic Essential Model of Organisation (DEMO)
- Business as Action Game Theory

In LAP utterance of a sentence is seen as an action. Illocutionary act is an act performed in saying something, as contrasted with a locutionary act, the act of saying something, and also contrasted with a perlocutionary act, an act performed by saying something. We can distinguish four illocutionary categories:

- Assertives – commit the speaker to the truth of the expressed proposition
- Directives – attempt to get the hearer to do something

- Commissives – commit the speaker to some future course of action
- Expressives – express a psychological state about a state of affairs
- Declarations – bring about the correspondence between the propositional content of the speech act and the reality

6. DEMO methodology

The DEMO methodology was developed by a the Dutch IT specialist J.L.G. Dietz. It is based on the Language-Action Perspective, Habermas' theory of communicative action, Austin's theory of speech acts, modal logic and Wittgenstein's theory of facts form the Tractatus [2] and stresses the importance of humans in the organization. This methodology is based on the process approach and considers an enterprise to be a system in the category of social systems the elements of which are social individuals – subjects.

In the DEMO theory the language theory is used to model organizations which are understood as networks of commitments and networks of communicating people. DEMO defines elements of the communicative act with illocutionary and propositional part as follows:

Locutor-illocution-addressee-fact-time for completion

To connect these elements means to form the business transaction as defined in DEMO. The business transaction is shown in the following figure (From [1]). It consists of an order phase, execution phase and a result phase. The first and last phases are performative conversations used to reach agreement. The middle phase is the necessary action associated with the request.

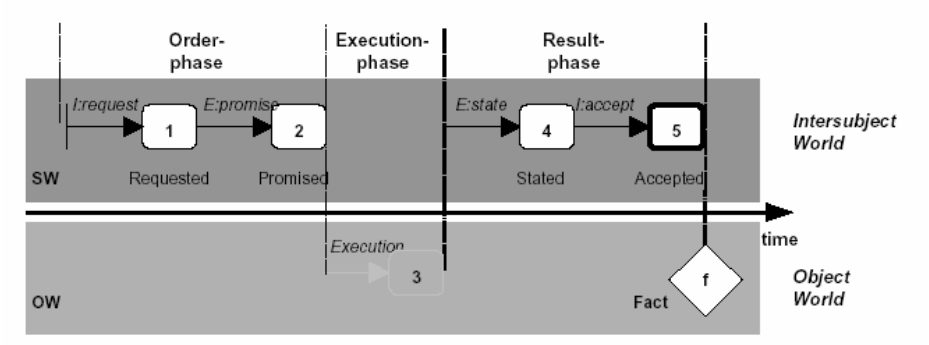

Figure 3: Connection as a business transaction according to DEMO [1]

The theory which belongs into the category of enterprise ontology consists of four axioms:

The operation axiom abstracts from subjects in order to concentrate on the different roles they fulfil. Actors perform production and coordination acts. By performing production acts they contribute to achieving the mission of the enterprise. By performing coordination acts they enter into and comply with mutual commitments about production acts.

The second axiom is the transaction axiom stating production and coordination acts occur in socioeconomic patterns called transactions.

The third axiom called the composition axiom states that every transaction is either enclosed in another transaction or it is a customer transaction or it is a self-activating transaction.

The fourth axiom – the distinction axiom – is about the integrating role human beings play in constitution of the enterprise. Three human abilities are distinguished – performa, informa and forma. The forma ability concerns the being able to handle data and documents, the informa ability regards the intellectual capacity of human beings, the performa ability concerns the ability to produce original new things, facts that cannot be derived from existing facts.

7. Common features of the three theories

The theory of organized activity stresses the social aspect of human activities and the common world people share. According to this theory computers do not perform activities as no interest and responsibility can be attached to them. In the theory of semiotics the norms and signs in their social perspective are analysed and concentrated on. In the Language action perspective and DEMO methodology the social aspect of our communication and the activities performed in language are the main point of interest. The theories have some common features: In all of them the human being plays the crucial role. Individuals and their relationships are central in every organization and activity. IS is a network of people with some relations. A social perspective on humans is always present. Human awareness and the importance of context is present in all these theories, too. TOA uses the activity and its members as a defining context for any performed action, OS defines an information field as the context to which everyone is subjected in a world of norms and social behaviours. LAP, on the other hand, relates to context by specifying an individual and social ‘background’ which takes into account each one’s preunderstanding and past experience together with the elements of a present situation. Meaning in TOA is shared, dynamic and socially created, being established by the TOA unit concept, in OS meaning is imported through the sign concept. A

TOA unit is a socially established sign, the meaning of which can be defined and socially validated through a criterion. In all these theories actors, actions, context play important roles even though they are called differently. Communication is important in all of them (either in the form of signs carrying information or criteria identifying units or language). All these theories try to unify humans with computers and stress the human perspective.

These methodologies are based on stressing the human beings and their role in the organization. They presuppose the dominance of humans over technology. As I have said earlier humans unify both objective and subjective worlds. One way how to do it is action. In it both our intentions, world experience, local structuring are incorporated and adjusted in the objective world. Action can be best described in narratives - they have four common traits: Both occur at some particular time (which implies they both have causal explanations), refer to persons who do something, both have some constitutive rules, both are dialogical and subjected to interpretations.

8. Narrativity

The socioperspective stressing language, coordination, socioeconomic environment, ontological aspects of the enterprise, relation of different transactions, unifying role of human beings who play their roles as actors, the composite, but homogenous structure of processes suggests that a human-friendly information system should be constructed as a good narrative. The ontologies underlying the above mentioned theories are not explicitly related to narrativity, but I consider they can go some steps in this direction. I think they can be supplemented with some narrativity features to be better suited for the human perspective they stress.

I hold the structuralist approach towards narratological texts as they offer some structures and forms universally valid which can be repeatedly used. Every work of art is unique, but some principles of its effects can be found and revealed.

Plots have many advantages against other types of information conveying: Aims, causes, chances, characters are put together and unified in one space and time in a plot. The most important in the narrative is the imitation of action – action is very important for process oriented methodologies, too. The information system should consider appropriate integrity (logic), extent and completeness of its information as is the case in narratives. Even disharmony has its place in the plot; in a good plot the disharmony must be integrated and resolved somehow (wrong end may be an integral part of the story, too). A disturbance is necessary for every plot to tell something and the trigger of the

action in enterprises is a disharmony, too. In the narrative disparate and discordant elements are unified into a concordant unity of a plot that has a temporal span; elements are accidental themselves, but in the plot they seem necessary; actions, characters are drawn together. Plots relate the development of characters and story together, too; characters and their actions are being evaluated by the auditory. A plot as well as an information system and organization model are based on the reality, but are not a mere copy of it. It always adds something to it and configures it according to its aims.

The role of narrator, i.e. from whose perspective the story is being told, is also very important for understanding the information conveyed through the IT. The information can be mediated either by an independent narrator (from the so called outer perspective), or by a system member who mediates the information or it can be just reflected by a system member without much mediation – here the immediacy is the strongest.

Other important narrative categories like focalization, rhythm, place, space, background, time, open and closed texts, motives (static and dynamic), possible worlds[3] with one or more subjects and their confrontation, events (transformation of the initial state into the final state in time), intentionality, theory of action, interaction, modalities (alethic, deontic, axiological, epistemic) etc can help EIS users understand the conveyed information and become a part of the company's cultural environment. Texts contain contexts which are necessary for information interpretation. The relation between primary text (information) and embedded text, sequential ordering, rhythm, repetition, actors and characters, focalization shouldn't be forgotten, too.

The distinction between text, story and fabula[4] can be used as well. Text is a finite whole composed of (usually language) signs. In a text an agent relates a story in a particular medium. (We can find different versions-texts of the same story.) A story is a fabula that is presented in a certain manner. A fabula is a series of a logically and chronologically related events caused or experienced by actors. The difference is between a sequence of events and the way these events are presented (in order to favor on character etc.) Event is a transition from one state to another. To act means to cause or experience an event. Events, actors, time and location constitute material for the fabula. Their arrangement produces the desired effect in the story. In a text the story is transformed into signs. Even in the IS these three levels can be used to identify the information content and its effect

[3] See the book by L. Doležel, Heterocosmica, Fikce a možné světy, UK 2003, ISBN 80-246-0735-2
[4] The level of the fabula corresponds a little bit to the syntactic aspect which is the most important in it. On the second level of story the meaning of the text, i.e. its semantics is the main focus and on the level of the text the interpretation, context and the practical implications of the information is the main point of interest.

on information receivers even though the signs variety is limited and the goal of the business "text" is quite simple – to convey something. Human aspect adds more features which should considered in information conveying. I do not want to stress the importance of narrative texts but the relevance of narrative structures and their meaning. Of course all the nuances of narrative texts cannot be translated into IS narratives, but some of them have relevance.

The narrative aspects are important not only for the communication with the IT, but for the process modeling of organizations, too.

I don't want to set only some guidelines for the case studies or use cases. My perspective can be useful for the IT design and process modeling, too.

I think information systems conveying information and modeling business processes (both these functions are necessary interrelated) use these categories implicitly. Our task as researchers is to help to discover the hidden presuppositions and show their horizons and possible utility.

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Systems Thinking in Project Management and Business Excellence

INFORMAL SYSTEMS THINKING IN THE FORM OF OPERATIONS RESEARCH

Vesna Čančer, Matjaž Mulej[1]

Abstract

Systems thinking is about getting away from oversights resulting from the over-specialization of most current professionals, especially scientists. It can be formally based on systems theory of a selected type; there are many around, or informal. The concept of informal systems thinking is important because there is a lack of education in systems thinking / systems theory, there is a lot of unavoidable narrow specializations, and hence a lack of consideration of holism. Successful decision makers in business and government concluded that their decision analysis training together with practical experience help their informal decision-making. The keynote paper deals with the prescriptive orientation to decision-making: instead of regarding people as perfect rational individuals, we developed a frame procedure for multi-criteria decision-making to complement intuition and to master interdisciplinary cooperation on formal and informal principles. We discuss how decision makers can integrate analytic results into their informal requisitely holistic thinking, without disrupting it, and how training in formal decision analysis can support informal decisions. This paper introduces how informal systems thinking was incorporated in solving several real-life complex problems with contemporary operations research methods, presented by practical applications on the micro level (information system's development, creditworthiness assessment, environmentally oriented business decision-making, process benchmarking, choice of investments) and on the macro level (measuring the globalization of national economies), as well.

Key words: Decision Analysis, Dialectical Systems Theory, Informal Decision-Making, Informal Systems Thinking, Operations Research, Requisite Holism

[1] University of Maribor, Faculty of Economics and Business, Razlagova 14, SI-2000 Maribor, E-mails: {vesna.cancer; mulej}@uni-mb.si

1. Introduction: The Critical Questions Addressed

Systems thinking is about getting away from oversights resulting from the over-specialization of most current professionals, especially scientists [2]. It can be formally based on systems theory of a selected type; there are many around [17] and their authors differ critically in their perception of the essence of systems theory and of holism, or informal [28]. Basically, most scientific disciplines, reaching beyond the scope of the traditional description of a part of nature from a selected viewpoint, have their roots in systems thinking and cybernetics, implicitly, at least (not unavoidably in systems theory, though; systems thinking is a much older practice of holism than systems theory!) [15]. It has already been proved by the case of the visionary companies that informal systems thinking can be very powerful and suggested that systems theories should work more on informal systems thinking [28]. Informal systems thinking takes place when the concepts of requisite holism, interdependence, emergence, synergy, complexity, depth of investigation, perception, thinking, emotional and spiritual life, decision-making, and action, networking, interdisciplinarity, transdisciplinarity by interdisciplinary co-operation, openness, hierarchy of complexity, etc., rather then single-disciplinary, one-sided reductionism etc. are used, but no formal language of systems theory shows up.

Experiences reports that it would be beneficial and useful if every professional was skilled both in [26]:

1. his or her own special profession; and
2. methods of interdisciplinary creative co-operation, e.g. Dialectical Systems Theory [23] and its applied method USOMID, or Total Systems Intervention, derived from Critical Systems Thinking etc.; and
3. the version(s) of systems theory, which is or are the closest to his or her profession [15].

Education and training for this triple capacity would mean that the skill of person 1 be completed up by skills of persons 2 and 3 in two ways, partly a formal and partly an informal one. The formal direct way means that there is a course offered presenting systems theories, cybernetics, and their applications in the professional field of person 1. The informal indirect way means that in the time of teaching a course the instructor asserts transdisciplinary and interdisciplinary views, helps students experience networking, emerging synergies, democratic team work etc. [26].

Decision makers in enterprises 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. develop inventions into innovations, leading to improvements in e.g. quality and quantity of output, its cost, quality, range offered, uniqueness, and environment friendliness, including their synergies (in a best-case scenario). They can do so by several methods, among which we emphasize the decision-making ones supported with appropriate computer programs [12, 13, 14]. It has already been demonstrated that the modern Operations Research (OR) methods can help managers much more than the traditional ones [20, 22, 31]. 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. Among several neglected topics of behavioral or descriptive research [3], the most important ones for this article's theme are how can people integrate analytic results into their informal requisitely holistic thinking, without disrupting it, and how can training in formal analysis educate intuitive and informal decisions. This paper introduces a frame procedure for multi-criteria decision-making (MCDM) by using the group of methods, based on assigning weights. We have developed it by utilizing the conclusions of several authors regarding the absence of decision makers' perfect rationality and the need to support decision-making by systematic procedures (See, e.g. [3, 18, 19, 30, 32]), and the conclusions of experts in practice regarding the suitability of different multi-criteria methods. The described procedures for decision analysis were taken into consideration, as well. This paper introduces how informal systems thinking is incorporated in solving several real-life complex problems.

This paper is supposed to open the arena for new proceedings of the summarized type. We wish to contribute to the issue of requisitely holistic informal systems thinking concerning not only *operations research / management science* but also *business excellence, business ethics, project management and organizational science.*

2. Making Operations Research Useful

Decision aiding, and prescriptive decision analysis in particular, can help people master interdisciplinary co-operation on formal and informal principles. Brown [3] concluded that the root problem is not technique, but motivation, which is notoriously difficult to correct. The question is how to make decision aiding more successful, by making usefulness a top priority among decision makers and researchers.

For half a century sound tools of rational choice have been widely available and used, notably prescriptive decision analysis[2], involving the quantification of personal judgments of uncertainty and preference. *Decision aiding* is often used to mean explicit use of a quantitative decision model to help someone make a better decision. However, the interpretation of decision aiding can be broadened to include any use of quantitative models. For example, training in decision modeling often enhances a decider's informal decision-making. Brown [3] reports that highly successful deciders in business and government[3] found their *decision analysis training* help their *informal decision-making*.

The types for specialty research include logical and behavioral research. One of the most important neglected topics of logical or normative research is how viable is the construct of the 'ideal' judgment that would result form perfect analysis of a person's available knowledge. For informal systems thinking in decision aiding, practice-driven research is of great importance. According to Brown [3], it often leads to specialty research or aid development.

Considering generic aid development, which addresses a single aspect of decision methodology, we have already compared several decision tools (e.g. traditional OR, AHP and behavioral techniques) [13, 14]. Decision researchers (See: [3]) are wondering which of them produce closest-to-the-most-appropriate action, when cognitive accessibility, logical soundness and implementation are traded off. Mulej and Kajzer [25] have already answered his question: "How complex, or structure-intensive, should decision models be, as opposed to judgment-intensive?" with their law of requisite holism.

Operations Research and other specialists often discuss the question why so many models are designed and so few used. As David [16] pointed out, the question of model implementation is a link between organizational theory whereby organizations are studied as isolated objects and traditional OR theory whereby organizations are seen as a context. Failures in model implementation can be (wrongly) put down to the low cognitive capacity of the actors[4]. Studying several pieces of advice how to successfully implement OR models [21] it can be concluded that OR advisers found it necessary to link systemic view with OR models:

- Close co-operation with the strategic stakeholders;

[2] It was the Raiffa-Schlaifer team that developed prescriptive decision analysis at Harvard Business School in the 1960s [3].
[3] E.g. CEO, Treasury, ICF-Kaiser Inc.
[4] David [16] defined the implementation process of a model in an organization as a process of formalization/contextualization of knowledge and new relations.

- A balance between the level of model sophistication / complexity and the competence level of stakeholders;
- The model must be adapted to the cognitive capacity of the stakeholders;
- The strategic stakeholders of the decision-making process must be quite knowledgeable about and comfortable with the contents and the working of the model.

3. Systematic Approaches to Complex Problems as a Basis for Informal Systems Thinking

A number of important decisions in practice are often made without methodological decision support. Namely, even the use of well defined traditional quantitative procedures can oppress effective decision-making, for example because it is hard to evaluate the probabilities, because the assumptions do not hold in the given situation or they can not be verified. Besides, decision theories, particular the game theory, are based on the assumption that a decision maker is always perfectly rational. Therefore, Raiffa (See, e.g. [32]) suggested a new, so-called prescriptive approach to decision-making: instead of regarding people as perfect rational individuals, we develop systematic[5] decision-making procedures supportive of decision-making, completed with intuition. These should be based on the combination of normative theories, cognitive aspects and behavioral aspects – the structural parts of decision-making in practice.

The authors who put forward suggestions for the improvement of decision-making in practical problem situations rather than focusing on descriptions of decision processes of the past (i.e. the authors that are concerned with prescriptive decision theory) [9, 18] contribute to informal decision-making and to systems thinking, as well. Practice-oriented OR researchers report that the study of systematic approaches to decision-making helps their informal systems thinking [3]. Therefore, systematic approaches to complex problem solving are intended for decision makers in companies, non-profit organizations and government agencies as practical working tools to help them resolve complex problems. They enable studying complex decision problems, which leads to successful

[5] We distinguish between systems/systemic and systematic: Systems/systemic focuses on attributes of the entity under consideration as a whole, making it different from its parts due to synergies resulting from the parts' interactions, while systematic focuses on attributes of the parts with no consideration of synergies between parts. Both viewpoints are necessary for requisite holism, and so does the viewpoint of interdependence between parts and realism of the observers and authors. Holism is not about features considered, but about way of consideration. Systematic may also be a concept taking care of all steps of a process in a hierarchy of succession [27].

informal solving of complex problems, which we deem necessary for survival and long-term success.

Following Grünig and Kühn [18], a decision-making procedure can be defined as a system (i.e. network rather than a mental picture of the feature under consideration from a selected viewpoint) of rules for obtaining and analyzing information, which can be applied to the resolution of a certain type of decision problem. Some advantages of a systematic procedure over an intuitive one are as follow: it can be used for more decision problems; it improves the quality of decisions by differentiating between factual knowledge and subjective assessment and by improved use of the knowledge base. However, the limitations of a general (heuristic) decision-making procedure are: less effective and efficient for special types of decision problem than special procedures, where these are available and practicable; cannot guarantee that a wrong decision will not be made; cannot compensate for lack of knowledge or for limited skills of an actor in assessing factual knowledge.

When building prescriptive models – usable decision-making procedures, decision logic is required along with heuristic principles and practical experience of problem solving processes[6]. The methodological suggestions are based on the authors' conviction that the solution of decision problems must in practice incorporate sensible use of intuition and experience (See, e.g. [18]). Namely, rational action on the one hand and intuitive experience-supported action on the other complement each other when problem solutions are developed in real life. Evaluating and forecasting methods, as well as creative thinking methods can enlarge capacities of decision-making procedures, as well. Such approaches are welcome contributions to Management Science (in the context of Operations Research / Management Science) in the practically normative way.

4. A Frame Procedure for Multi-criteria Decision-making

On the basis of systematic rational thought supported by relevant information, the alternatives' values can be measured with respect to a single criterion or with respect to multiple criteria.

[6] For example, the so-called general heuristic decision-making procedure of Grünig and Kühn [18] is partly based on contributions from the relevant literature (existing general heuristic decision-making processes from other authors, heuristic principles, decision maxims) and partly on the experience of the authors (experience as advisors in complex decision situations, experience in the teaching of decision methodology, experience in the development of specific heuristic decision-making). Some of the quantitative methods of decision analysis, especially multi-criteria decision-making and decision theory as a part of game theory in broader sense, are included in this general heuristic procedure. In our opinion, the term "general" decision-making procedure is too enthusiastic; the "framework" procedure offers developers and users in real life practice much more opportunities to adjust it to particularities of the actual problems and to develop it following the contemporary scientific (formal) findings.

Considering the prescriptive approach to decision-making[7], we present the frame procedure for multi-criteria decision-making[8]. When applying MCDM methods to several decision-making problems, we concluded that they should be approached step-by-step. On the basis of our implementing this process in real-life applications at the micro and at the macro level we concluded that it should include the following steps (See Figure 1):

- *Problem definition.* When the problem arises, we should describe it accurately. We should define relevant criteria and alternatives. Creative thinking methods (e.g. morphological analysis and brainstorming) can be applied when developing alternatives; however, in the process of generating and developing innovations [14] they are used before the decision procedure.
- *Elimination of unacceptable alternatives.* We should define requirements for the alternatives. We assess all possible alternatives; when the alternative does not fulfill the requirements, it is defined as unacceptable and should therefore be eliminated.
- *Problem structuring.* We structure a complex situation in a hierarchical model. Each problem consists of a goal, criteria, very often some levels of sub-criteria, and alternatives. In a hierarchy, criteria can be structured in more levels so that lower levels specify sets of sub-criteria related to the criterion of a higher level. When structuring a problem, the law of requisite holism should be considered [25].
- *Measuring local alternatives' values.* This step involves judgments about the alternative preferences and the calculation of the values of alternatives with respect to each criterion on the lowest level. We can measure the local alternatives' values by making pair-wise comparisons or by using value functions [4]. 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.
- *Criteria's weighting.* We have to establish the criteria's importance in order to define the weights of the criteria: by using the methods based on the ordinal (e.g. SMARTER), interval (e.g. SWING and SMART) and ratio scale (e.g. AHP), or by direct weighting. Again, professionals of several fields that are capable of interdisciplinary co-operation should be involved in this step. They can respond the questionnaires and then coordinate their judgments with other respondents. Their co-operation may lead from systematic to systemic approach, if making synergies, or better: add systemic to systemic viewpoints. Group priorities' establishing is well supported by the group-decision making upgrades of computer programs that have been

[7] Namely, we put forward suggestions for the improvement of decision-making in practical problem situations.
[8] For theoretical bases of MCDM, see e.g. [1].

most preferred for individual MCDM in the last two decades [14]. 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.

- *Synthesis and Ranging*. In synthesis, the additive model is used where the reciprocal preferential independence of criteria is assumed [4, 33]. By alternatives' ranging, we can select the most appropriate alternative(s), eliminate the alternative(s) with the lowest final value, or compare the alternatives with respect to their final values. Such synthesis may hide synergies.
- *Sensitivity analysis*. Sensitivity analysis is used to investigate the sensitivity of the goal fulfillment to changes in the criteria weights (priorities). It enables decision makers to detect the key success or failure factors for the goal fulfillment.

It has already been demonstrated that 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 problems step-by-step, as well as DST's guidelines concerning implementation of starting points [15].

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. The limitations of systematic procedures can be overcome by informal systems thinking, emphasizing interdisciplinary creative co-operation of mutually different specialists: it includes synergies more probably.

The presented frame-procedure for multi-criteria decision-making fulfills all criteria of the proactive approach[9]: a decision maker is focused on "important" (read: most relevant); it helps him or her to be consistent, to consider objective and subjective factors and to combine analytical thinking with the intuitive one; it requires only so much information and analyses that are necessary for solving of a particular problem (the law of requisite holism); it is oriented to information and professional opinions; it is simple, reliable, easy to use and adjustable. Therefore, its use can encourage decision makers to seek new opportunities.

[9] The proactive approach to decision-making [19] encourages a decision maker to seek the decision opportunities. It does not tell us which decision we should make, but how the decision should be made. It helps us to realize visible and invisible viewpoints of the decision situation and that important facts, feelings, opinions, beliefs, suggestions, etc. transform to the best choice.

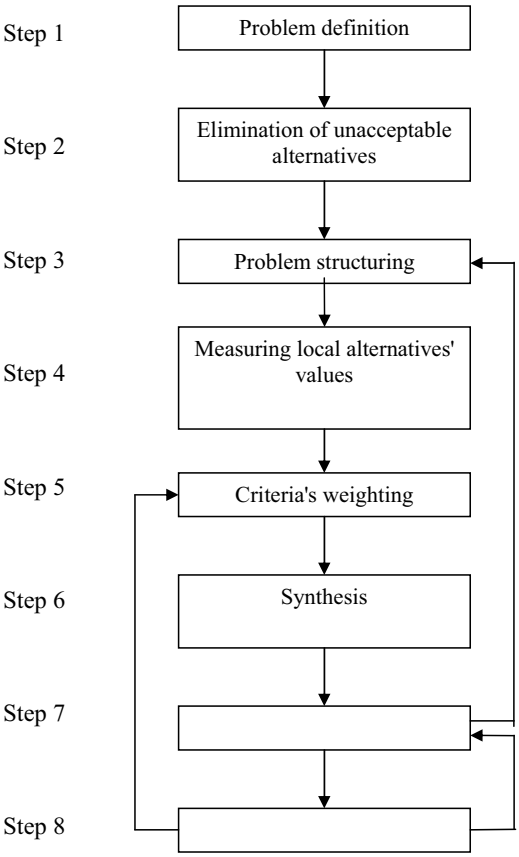

Figure 1: Steps of the frame procedure for multi-criteria decision-making by using the group of methods, based on assigning weights.

5. Informal Systems Thinking in Solving Real-life Complex Problems

Let us briefly introduce *how informal systems thinking was incorporated in solving several real-life complex problems* with contemporary operations research methods, presented by practical applications on the micro level (choice of investments, information system's development, creditworthiness assessment, environmentally oriented business decision-making, process benchmarking,) and on the macro level (measuring the globalization of national economies), as well.

5.1. Investments in new production technology

The methods for determination of criteria‘s weights which base on ordinal (SMARTER), interval (SWING, SMART) and ratio scale (AHP), as well as the ways of measurement of local alternatives’ values (direct input, use of value functions and pair-wise comparisons) were used in a real-life problem of estimation of the alternatives for the acquisition of pattern sets in a Slovenian foundry [9]. Participants in this application were an outside expert (a tutor), experts in the foundry and an employee with the appropriate knowledge about the used methods (coordinator). The experts in this foundry were involved in the steps 1 – 5 of the frame procedure for MCDM: they defined the problem, eliminated one unacceptable alternative (on the basis of their professional opinion and experience), and structured the problem; when measuring the local alternatives’ values, they preferred making pair-wise comparisons much more than direct measuring and using value functions; in interviews and questionnaires, created by the coordinator, they established their judgments about the criteria’s importance directly and by making pair-wise comparisons. The coordinator performed synthesis and sensitivity analysis. The experts selected the alternative with the highest final value as the most appropriate alternative for the acquisition of pattern sets.

5.2. Selection of information systems

The frame procedure for MCDM was followed in selection of suitable approach to further information system development of multi-project business processes in a Slovenian building company [8]. Participants in this application were an outside expert (a tutor), experts in the company and the head of computer department with the appropriate knowledge about the used methods. In the steps 1-3 of the frame procedure for MCDM, experts determined possible software solutions as alternatives: renovation, internal development, external development, purchase – Add-On and purchase of the standardized program solution; they determined relevant criteria and structured the problem. In step 4, they measured the alternatives’ values with respect to each attribute by pair-wise comparisons, direct input and value functions. To measure alternatives with respect to criteria by value functions, experts should know the characteristics of each criterion. Value functions enable decision makers to understand the problem (as a whole and in details) better and provide insight into the structure of values for the decision. In step 5, the method based on an ordinal scale SMARTER was evaluated as convenient in decision situations, in which it is possible to evaluate only the rank of the criteria’s importance. They evaluated the methods based on interval scale SWING and SMART as more convenient because a sufficient information basis enables the

assessment of criteria's importance and preferences to alternatives. Further, they are convenient for both the quantitative (in this case investments, rate of return, automation, savings, information needs, risk, compatibility, complexity) and the qualitative (in this case functionality, robustness, support, further development, upgrade) criteria. In this practical case, the AHP method based on a ratio scale was found applicable when expressing judgments about the criteria's importance, mainly on the basis of their experience. Pair-wise comparisons enabled decision makers better understanding of the criteria's meaning and importance; they gave decision makers the opportunity to confront other participants' judgments. The enterprise's experts that evaluated information systems found multi-criteria decision methods and appropriate software as excellent tools in solving complex problems. However, the head of the computer department emphasized that the quality of the decisions made on the basis of their results depends on the responsibility in establishing priorities about the criteria's importance and preferences to alternatives.

5.2.1. Creditworthiness assessment

When building several models for creditworthiness assessment, we delineated the process of the assessment of an enterprise's business partners' creditworthiness that is made by a firm itself (so-called internal ratings) where the problem is approached step-by-step [6, 11]. Since qualitative factors come into play in the creditworthiness evaluation, we found the AHP methodology (and its main advantage – pair-wise comparisons) appropriate in this application. Further, since decision makers were often inconsistent in making pair-wise comparisons in steps 4 and 5 (which means that the importance allocated to the considered criterion or the value allocated to the considered alternative is over- or undervalued), we developed and presented the procedure for the improvement of the decision makers' consistency. Studying the corrected intensity levels, they improved their understanding of the relationships among the criteria, and of the criteria meaning and importance as well.

5.3. Environmentally oriented business decision-making / Process benchmarking

We developed the method for selecting among environmentally oriented business processes with respect to multiple criteria [5], applied for MCDM in a medium-sized enterprise producing packaging for diary products. The AHP methodology in connection with other decision-making tools (linear mixed integer optimization and simulations) was used when evaluating business processes. Pair-wise comparisons, made by top managers, were successfully applied in the criteria determination, the assessment of the criteria's importance and even in the data calculation for

different business processes. In our case the method helps a medium-sized enterprise in short-term business decision-making regarding the evaluation of business processes. To use this approach in long-term or strategic decision-making process, the information basis should be improved by more criteria (e.g. knowledge related factors, the assessment of strategy, business moral and organizational culture), compared by industry related information, and benchmarks. Therefore we completed up this method to obtain the multi-criteria method for benchmarking of environmentally oriented business processes [7]. We considered not only ecologically most acceptable manufacturing, but also other, different and conflicting criteria that are relevant to this complex goal.

5.4. Measuring and analyzing the globalization of national economies

We developed the method with the intention to establish and study thoroughly a country's position and potential for international integration [10]. When applying this methodology to measuring the globalization of national economies, we concluded that the frame procedure for MCDM should be adapted and completed as follows: problem definition, model structuring, data collecting and measuring, establishing priorities for importance of criteria, hierarchy restructuring and weights (re)calculation, synthesis, ranging, sensitivity analysis. Following the theoretical framework, the international trade's experts structured relevant direct and indirect indicators into a hierarchy. We employed conventional and unconventional secondary statistical data bases. Experts from economic, business and social sciences took part in obtaining the indicators' weights. They were given a questionnaire for establishing priorities by pair-wise comparisons. Although they followed traditional trade theory, new trade theory, the theory of international production and relevant empirical analyses, the established judgments include their personal understanding of the criteria's importance, as well. The sequential coordination method was used to obtain the final intensity levels. To consider the available data about the direct indicators on the first, and the indirect indicators on the second level, the hierarchy of the model was transformed so that both the direct and the indirect indicators became the first-level indicators. We found the solutions for restructuring the model, preferred by evaluators of the indicators' importance, to the final model that allows considering all available data. For the considered national economy, we can define the key success and failure spheres of its performance in the period of contemporary globalization.

6. Some Conclusions

Since traditional OR methods cannot satisfactorily support many complex decision-making processes, the entrepreneurs' effort to master interdisciplinary co-operation as a means of systems / systemic / requisitely holistic thinking (See: [29]) can be supported with contemporary multi-criteria decision-making methods on formal and informal principles. The described frame procedure, which is well supportive of requisite holism, can be adapted to the decision problem's particularities. A systematic step-by-step approach has already been successfully used in complex problem-solving in real-life practice. It supports decision-making on the bases of not only theoretical findings and empirical research, but also (and first of all) requisite holism, interdisciplinary co-operation, hierarchy of complexity, creative thinking and openness, by following intuition and experience - without talking the systems theory language; therefore, it supports informal systems thinking. Procedures under application (Figure 1) can also be called close to project management procedures because they are innovation-oriented and individually adapted.

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INFORMAL SYSTEMS THINKING IN PROJECT MANAGEMENT AND COMPANIES LONG TERM SUCCESS

Igor Vrečko, Matjaž Mulej[1]

Abstract

Persons with informal systems thinking use systems theory's principles without mentioning them. They may still attain the requisite holism and hence success in their activity. Project management is a well-proven methodology supportive of informal systems thinking, but it succeeds more often, when its user apply the requisite holism. The case of strategic crises proves this situation: project management applied to these problems can support the requisite holism, and may receive support from it as a good quality of thinking.

Key words: informal systems thinking, project management, requisite holism, strategic crises

1. Introduction

There are people around who are capable of success that proves to be based on their rather holistic behavior, which is supposed to be based on systems theory, but they have never learned the latter. These people may be called cases of informal systems thinking. In our experience, their practice may both provide and receive support in project management.

2. Informal systems thinking and requisite holism

Informal systems thinking was originally presented at IDIMT ten years ago (Mulej et al, 1998). It proved to be helpful. It matches the expectation of European Union as we can see in the quote EU definition of the link between innovation and systems thinking (Figure 1):

[1] University of Maribor, Faculty of Economics and Business (EPF), Slovenia; {igor.vrecko | mulej}@uni-mb.si

> 'The Action Plan [First Action Plan for Innovation in Europe, 1996, based on Green Paper on Innovation, 1995] was firmly based on the 'systemic' view, in which innovation is seen as arising from complex interactions between many individuals, organizations and environmental factors, rather than as a linear trajectory from new knowledge to new product. Support for this view has deepened in recent years.'

Figure 1: Systemic thinking about innovation as defined by EU (2000, p. 6).

Systemic thinking, hence, tends to reach the requisite holism. It does so in an informal way, when it does not use the formal language of any of the many existing systems theories (François, 2004), but attains requisite holism anyway. See Figure 2 for our definition of holistic thinking (Mulej, in Mulej et al, 1992, reworked in Mulej, 2006).

Inside an authors' (usually tacitly!) *selected viewpoint*, one tends to consider the object dealt with on the basis of *limitation* to one part of the really existing attributes only. When specialists of any profession use the word system to call something a system inside their own selected viewpoint – it makes a system *fictitiously holistic*. It does not include all existing attributes that could be seen from all viewpoints and all their synergies. See Figure 3.

A brief summary of the *law of requisite holism* may thus read:

The law of requisite holism says that one needs always to try and do, what many, but not all, have the habit to do in their thinking, decisions, and actions – do one's best toward avoiding the exaggeration *of both types: 1)* the fictitious holism*, which observers cause by limiting themselves to one single viewpoint in consideration of complex features and processes; 2)* the total holism*, which observers cause by no limitation to any selection of a system of viewpoints in consideration of complex features and processes. Instead,* the middle ground *between both exaggerations should be covered, which can be achieved by using a "dialectical system", made by the author/s as a system / entity / network of all essential and only essential viewpoints.*

3. Practice of informal systems thinking and requisite holism in project management concerned with strategic crises

Requisite holism is obviously, as practice shows all the time, difficult to attain. Every organization or individual as a (business) system, either we speak about small or big company, virtual or net organization, nation or region, profit or nonprofit system, etc. pass over periods of arise and decline during their life cycle. Business systems always did and always will face problems and obstacles. They can learn lessons from them (and become more experienced, reorganized, renovated, with new and better concepts, etc.) or they can get into decline or even decay because of them. Reasons for such phenomena are different and they have occupied many researchers over the last few decades (Argenti 1976, Winz 1993, Stratemann 1994, Heath 1998, Caponigro 2000, Slatter 2004, Collins

and Porras 1994, 1997). Many different forms and types of crises arise from those researches. The paper will focus on strategic crisis, which as a rule precedes the business crisis.

Interdependent actual general groups of real features' attributes	***Interdependent attributes of the requisitely holistic consideration of real features***	***Considered attributes of thinking about real features***	***Attributes of participants of consideration at stake***	***Surfacing of all these attributes in a given case***
Complexity	Systemic	Consideration of whole's attributes that parts do not have	Interdisciplinary team	The final shared model resulting from research as a dialectical system of partial models
Complicatedness	Systematic	Consideration of the parts' attributes that the whole does not have	One-discipline group or individual	Partial models resulting from one-viewpoint based investigation
Relations - basis for complexity	Dialectical	Consideration of interdependences of parts that make parts unite into the new whole – emerging (in process) and synergy (in its outcome)	Ethics and practice of interdependence – path from one-discipline approach to the interdisciplinary teamwork	Shared attributes and complementary different attributes, which interact to make new synergetic attributes, i.e. from systematic to systemic ones
Essence - basis for requisite realism and holism of consideration	All essential	Consideration that selection of the systems of viewpoints must consider reality in line with the law of requisite holism for results of consideration to be applicable – by reduction of reductionism	Capability of researchers to deviate from reality as little as possible in order to understand reality, including systemic, systematic and dialectical attributes of it	Findings applicable in practice, although resulting from theoretical considerations

Figure 2: Dialectical system[2] of basic attributes of requisite holism/realism of thinking, decision making, and action

[2] A dialectical system comprises in a network all crucial viewpoints in order to help the observer attain a requisite holism, once a total, i.e. real holism with all viewpoints, synergies and attributes reaches beyond the human capacity. See Figure 4 for definition of requisite holism.

←----------		----------→
One-sidedness as **fictitious holism** due to limitation to a single selected viewpoint – mental picture	**Dialectical system** (= synergetic network), which links all essential and only essential viewpoints in one mental/emotional picture of the phenomenon under consideration matching the law of requisite holism and thus reducing reductionism in order to enable a requisitely holistic consideration	**Total holism** by (= system) synergetic network of absolutely all viewpoints – mental/emotional pictures
Dangerous due to – often unperceived – oversights	Can be achievable and sufficient in real life, provided active and realistic selection of essential viewpoints and their creative co-operation occur	Impossible to attain individually and in too small teams

Figure 3: Selection of the level of holism and resulting realism of approach to the selected topic varying between fictitious, requisite and total holism and realism (Mulej, 2007, and earlier)

APPROACH TO DEALING WITH AN OBJECT AS A TOPIC OF THINKING ETC.	One-sidedness by a single viewpoint	Requisite holism by co-operation of all essential professionals and only them	Total holism by consideration of totally all viewpoints, insights from them and synergies of them
TYPE OF APPROACH	(Too) simple	Requisitely simple	Very entangled
TYPE OF SYSTEM	Single-viewpoint based system	Dialectical system	Total system
ATTRIBUTES OF OBJECT INCLUDED IN SYSTEM	(Very) few	All essential	All
RESULT OF APPROACH	Fictitious holism (in most cases)	Requisite holism (good in most cases)	Total holism
FOCUS MADE POSSIBLE	(Too) Narrow focus (in most cases)	Requisitely holistic focus	Lack of focus
NUMBER OF PROFESSIONS	One single	Requisitely many	Literally all
TYPE OF WORK	Individual	Mixed team of requisite and different experts	All humankind in co-operation
CONSEQUENCES	Complex due to crucial oversights, dangerous	No problem due to no crucial oversights	Simple due to no oversights
AVAILABILITY	(Too) Frequent in real life	Possible in real life	Not possible in real life

Figure 4: Law of requisite holism in some details

It is hard to perceive and especially to assess the strategic crisis, because it can not be measured with common business system success indexes. This leads to problems in choosing the adequate measures, which could be late and/or not requisitely holistic and innovative.

Strategic crisis appears more frequently in increasing complexity of the business system's environment, both social and natural. Contemporary business environment is very dynamic, marked with the globalization, intensive information and technology development, rising competitiveness, shortening developing times and products/services economic life cycles etc. All mentioned elements cause changes and demand requisitely holistic responses and adapted business operations.

Neglected or ignored changes may provoke potential appearance of strategic crisis and later business crisis.

Strategic crisis appearance, their timely and requisitely holistic recognition, influence of business environment dynamic changes etc., demands management's central attention for assuring business systems long-term success. Management needs appropriate knowledge and (new) business models for recognizing and solving strategic crisis. Those request creative instead of routine way of thinking and therefore creation of new inventions and whole processes to the new success solutions – innovations. Processes should match the "law of requisite holism" (Figure 3, and Mulej, Kajzer, 1998).

Project management, along these lines, is becoming a more and more frequent way of mastering various activities in business systems. It also proved to be a very important way for solving business crisis (Vrecko, 2002). It could also be applicable as a method for solving strategic crisis. In that case we have to comprehend project management requisitely holistically.

As project management becomes an increasingly popular means of managing the activities within organizations, the variety of project types being managed is expanding. By their very nature, projects tend to deal with innovation processes of one type or another, and a portfolio of projects within an organization is likely to include a mixture of organizational change, information technology (both entirely new IT and upgrading of existing IT), product development and business process re-engineering. (Aitken, Crawford 2007).

But as the practice-world of project management continues to develop across different industries and sectors, the theory-world of project management continues to attract criticism from academics and practitioners around the world. Statements such as "project management theory remains stuck in a 1960s" and "the underlying theory of project management is obsolete" might seem harsh criticisms. But the new emerging pattern is that of increasing concern about conventional project management theory and how it relates to the growing practice of managing projects across different industry sectors. Against this background, academics and practitioners do their best to identify new directions for how the discipline might be extended and enriched for the 21st century (The International Research Network on Organizing by Projects, http://www.mace.manchester.ac.uk/project/research/).

Project management has to move beyond the classical "process" and "competence" bodies of knowledge (BoKs) and standards proposed by the well established professional bodies. Industries and Professional bodies strive to create an integrated framework, which translates strategic aims

into operational processes thereby improving performance and creating sustained value. But these BoKs and standards are still mostly based on a positivist paradigm, using linear process views and classical operational research tools, when they address 'complex project management'. This view is reflected in the developing research and standards which attempt to link strategy, portfolio, program, and project management (see e.g. PMI: 2004 research project Translating Corporate Strategy into Project Strategy: Realizing Corporate Strategy Through Project Management, by Morris and Jamieson (2004), A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Third Edition (PMI, 2004), Organizational Project Management Maturity Model (OPM3) and Standards for Program (PMI, 2006) and Portfolio Management (PMI, 2006); the U.K. APMG on behalf of the Office of Government Commerce (OGC): PRINCE2™ (OGC, 2005), Managing Successful Programmes (OGC, 2003); the ongoing development of a new AACEI integrated standard and certification scheme dealing with Portfolio, Programme and Project levels (C3PM); the launch of the College of Complex Project Managers in November 2006 (the Australia DMO, the UK MoD, the US DAU) and related guide (DMO, 2006); the official launch of the Global Alliance for Project Performance Standards (GAPPS) in November 2006 (GAPPS, 2006).) (Bredillet, 2007). In accordance with above starting points, the new framework for Project and Programme Management, called P2M – »Project & Programme Management for Enterprise Innovation« was developed in Japan in 2000-2001. It was based on the so called KPM paradigm.[3]

Moving beyond the positivist or analytical paradigm of classical project management, P2M proposes a framework based on a *mission driven approach* and insightful thinking – based on a constructivist perspective. This enables solving complex ambiguous problems in uncertainty by translating strategic intent (and resulting mission) into value creation operations and capital recovery through a lifecycle which integrates the scheme, system, and service models.

Project management as a complex integrative field, provided by P2M and similar solutions, has to be considered when dealing with strategic crisis in companies and when establishing a system for ensuring companies long term success.

[3] In the 1990s, Japanese companies experienced a deflationary depression called the 'lost ten years.' To survive, and to regain their global competitiveness, they looked for solutions in the 'kaikaku' (reforms) of business management, organizations and technology. The companies which utilized the intellectual property of the entire organization were more successful than those, which focused only on technological abilities. These successful companies made efforts in the planning and execution of strategic businesses that would change the framework of value creation for the next generation. All these companies applied a new project management paradigm and related framework called 'Kaikaku Project Management' (KPM).

4. Conclusions

Thus, project management can support the requisite holism by supporting the informal systems thinking, and vice versa, in solving many practical issues, all way to strategic business crises. Foresight about them is the least possible of all business situations, and they still must be solved for life to go on well.

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THE BENEFIT OF IT-INVESTMENTS: TECHNOLOGICAL AND COST-RETURN-BENEFIT APPROACH

Ferenc Erdős[1], Mária Raffai[2], Ágnes Varga[3]

Abstract

Focusing on the benefit and profitability of IT-investments we have to take numerous considerations and factors into account. In the last decade the enterprises, let it be large multinational organizations or small and medium businesses (SME), invested huge amount of their capital to purchase and deploy IT-technology in order to support different business functions and processes. In most cases no investments were/are analyzed from the point of view of profitability, and the economical calculations failed. The entrepreneurs had and even have today the feeling that the money expended for IT-projects (developing, modernizing and/or buying applications and supporting systems, purchasing and deploying technology, integrating the independently running applications, operating the existing systems and managing changes) does not return, their investments into IT do not produce any profit, the competitiveness of the enterprise does not improve. The SMEs are especially in trouble with IT-investments because of the high prices of supporting systems e.g. ERPs. The entrepreneurs planning to start an IT-project expect to see benefit before making their decision, the measurement and the time period of the return, and also the advantages of using up-to-date and even very expensive IT.

In our paper we intend to analyze the possibilities of completing calculations before starting IT-projects, the methods and tools giving unbiased evidence to the decision makers that the capital expended to IT (applications, infrastructure and operation) will not only return, but it will add value to the business and result in many advantages in running the business.

Keywords: IT-investment, benefit, return, IT-controlling, return of investment, cost analysis, added value, calculation methods (TCO, NPV, IRR, ROI, PBP, PBT, ROV etc.)

[1] Assistant at the Széchenyi István University, erdos@sze.hu, home page: http://www.sze.hu/~erdosf
[2] Professor at the Széchenyi István University, raffai@sze.hu, home page: http://rs1.sze.hu/~raffai/raffai.htm
[3] Assistant at the Széchenyi István University, vagaa@sze.hu;

1. Introduction

Presently enterprises have to face the challenge of increasing system complexity and strong competition in a software-intensive business environment, and after all they are under the challenge to exploit new technologies parallel with the forcing demand for reducing costs, improving quality and responding faster and faster to the continuously renewing facilities. [22]

The efficiency of investments is getting more and more a question of IT development, although this need has been coming into focus only during the last decade. It can be observed that at the beginning of the '90s even the most of developed countries did not put sufficient emphasis on examining the efficiency of IT investments, because at that time the investments were mainly managed in an obligatory way and without reviewing any results and/or consequences. [1]

The role of the investment efficiency receives emphasis especially in connection with enterprises that are in lack of resources. In such companies the management has to make a deliberate decision about what they spend their poorly available resources on. After the turn of the millennium the importance of efficiency calculations of ICT investments came to front instead of the reducing resources, which have been deriving from the deflation of the "dot-com balloon" and the recession in world economy.

Dealing with IT efficiency it is important to explain the term and also to give an unambiguous definition of it. We have to answer the question: What does efficiency mean in the case of IT investments? First and foremost it is necessary to distinguish between the *soft* and *hard factors* and the *business impact of IT*. Let these be financially definable or qualitative results. This categorization helps us to separate and also to manage the powerful technological solutions and the efficient, cost oriented financial calculations together. Striving to acquire benefit from IT investments it is necessary to see the influencing factors clearly also from technological approach, namely

- the development philosophy, paradigm and concept,
- the applied technological standards and frameworks,
- the automatic model transformation processes and tools, and
- the tools and suites that support the whole ICT development project

have to be defined.

From the investment costs' and revenues' point of view it is worth to examine the following questions:

- What individual expenses occur during the IT projects?
- How much is the total cost of the IT investment? (development, operation and other costs)
- How do the costs of business processes and the revenues change following the investment?
- How can the risks of the IT investments be managed?
- How does the investment meet the strategic goals of the company? Etc.

In our paper we present that there are many existing methods and procedures that have the efficiency of IT investment in sight, and also there are good practices that are useful to follow but whose results are mostly summarized only in business case studies. [2] Nevertheless, these procedures can only be applied by companies that possess their own expertise or capital enough for involving a properly prepared, independent consulting company that is expert in the field of the decision process. In the next chapters we discuss some efficiency-increasing solutions namely effective technological methodologies and financial analysis such as methods of efficiency calculation, cost and profit analysis.

2. Efficiency of IT Systems

The basic aim of the rational economy is to maximize the organizational result, and to gain more and more profit. In other words, the purpose is to reach greater and greater benefit with the smallest possible expenditure. If we have a purpose to increase the effectiveness of a system, then it is needed to determine the critical points of it. The focus of the calculations and the analysis is the value and the state of the developed system. The value of the variables is influenced by several factors that can be classified into two groups: *qualified* (it is also called soft factor) and *quantifiable* (numerically expressible, called also hard factor) factors. The level of service can be regarded as a qualified parameter; the financial data such as costs, expenditures, results are the quantifiable characteristics of an investment. The diagram in Figure 1. focuses on the ROI based (Return on Investments) decision factors and their relations in an IT-project.

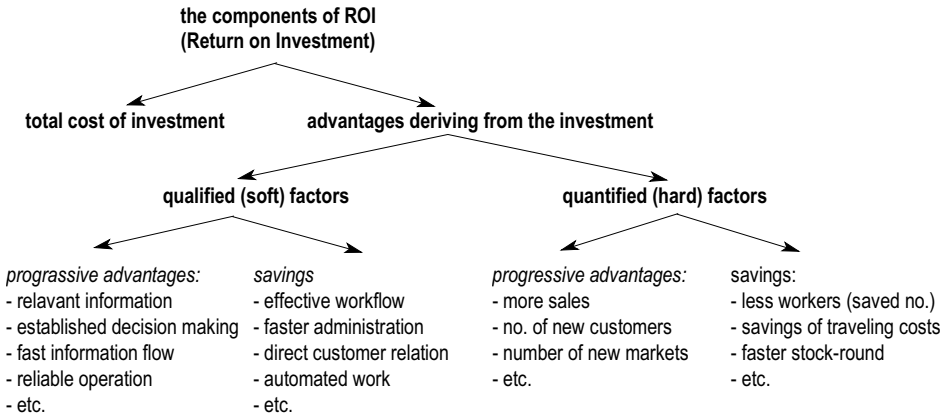

Figure 1. The role of indices and factors in return-calculations [18]

The main purpose of the IT projects is to develop applications that satisfy the qualification requirements and also provide the expected level of the efficiency by supporting or automatically executing the business tasks. Measuring the value and the level of the IT systems' efficiency, defining the profit that derives from using applications, we do not have to take only the expenditures and the numerically expressible profit into consideration, but also those parameters that influence the *result/outgoings* ratio. But unfortunately the impact of the technological and organizational changes, the results and the impact of a development and even the savings usually cannot be expressed in direct figures. Consequently we also need indices that are calculated by both numerical and not numerical parameters.

The very high level of costs spent on IT investments forces the managers to make decisions aware of knowing the figures of the precalculations, the expectable results and the sizing up the alternatives. The base of decision has to be the VOI index (the whole Value of Investment) instead of defining only the numerically calculated indices. Taking the possibilities into consideration the managers will choose that alternative where the VOI index and the ratio of return is the highest. [18] Although the VOI is a very useful index, see in the next chapters of our paper, there are difficulties in defining it. While earlier the organizations took only the value of tools and the directly proved profit as the basis of return calculations, nowadays they emphasize also the importance of the *total business value based on soft factors*. The three dimensional diagram in Figure 2. represents the dynamic impact of the soft factors.

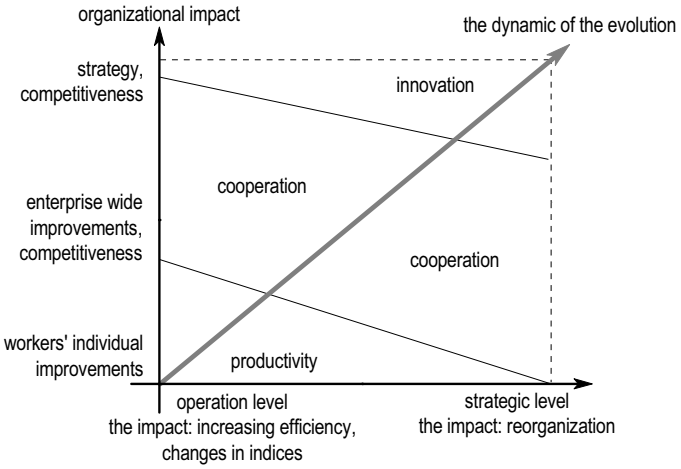

Figure 2. The dynamism of the soft factors [19]

3. The Importance of the Powerful Technology

As the basic mission of the application developers is to satisfy entirely and effectively the business requirements aiming to make more and more profit by using IT systems, they are forced to use the newest and the most appropriate solutions. In this sense it is desirable to take into account

- the concepts, e.g. model driven approach (MDA, MOF,), abstraction, visualizing, component based design (CBD), object-orientation, reusability,
- the potentially applicable methods and development methodologies, e.g. object oriented methodologies and beyond the RUP,
- the modeling languages, such as UML and novelties in UML 2.0, OCL,
- the different technological and transformation tools for supporting design phase, for transforming models, for generating codes, e.g. UEML, iUML, XUML,
- the libraries for reusing model elements and components, for creating and publishing design patterns and
- the standards that are to develop interoperable and platform independent systems, such as CWM, middleware standards: CORBA, COM, .NET, XMI/XML.

Why do we have to talk about the IT development technology while the main focus of our research is to study the methods of evaluation and IT investment? The answer lies in the efficiency expressed in soft factors and in the special nature of IT systems! In the most cases it is quite easy to calculate

the benefit of different investment types and to give the figures related to the direct results. But the situation of the IT projects is very much different, as it does not have benefit on their own, and even more, its impact on the organizational effectiveness can be expressed mainly in qualitative parameters, and proved only indirectly.

Discussing the most important efficiency-increasing role of the technology first and foremost we have to talk about the enterprise wide integration (EI) that can relate to different components of the organization. That means, it is possible and in most cases desirable to integrate

- the business units of the interorganizational enterprises,
- the functions and the processes enterprise-wide or partial,
- the requirements of the entrepreneurs, managers and/or employees,
- the investments and the costs expended by different business units,
- the business components, such as resources, infrastructure, technology, products,
- IT systems: infrastructure, applications, data, corporate knowledge etc.

Consequently the *enterprise integration* is a complex flow *from* discovering and analyzing a problem *through* designing the system *to* implementing it on the appropriate platform. In order to specify the main target of integration correctly it is necessary to see, that the organizations require interacting solutions for cooperation of

- the new and old (traditional or legacy),
- the custom and off-the-shelf and even
- the internal and external systems.

This also means that the enterprises need to define the exact goals of integration otherwise it cannot meet the business requirements. Without specifying the scopes clearly and utilizing IT technologies the integration process can not be effective. [22]

The concept of Model Driven Architecture (MDA) brings a real revolution into the software development process, in other words: the paradigm, the methods and the tools of the application development are radically changing. The MDA approach gives possibility for realizing a fast enterprise-wide integration *(Rapid Enterprise Integration)* [20] and in the possession of the IT environment and the implementation technologies for transforming the conceptual design models to platform specific model [21]. Comparing the MDA with the traditional development process it is apparent that the answer to the challenges of today's highly networked, constantly changing system environment is to provide an architecture that assures:

- portability, increasing the application re-use and reducing the cost and complexity of application development now and in the future;
- cross-platform interoperability, using rigorous methods in order to guarantee the standards, based on multiple implementation technologies, implement identical business functions;
- platform independence, reducing the time, outlays and complexity associated with re-targeting applications for different platforms;
- domain specificity, through domain-specific models that enable rapid implementation of new, industry-specific applications over diverse platforms; and last but not least
- productivity, allowing developers, designers, software engineers and system administrators to use languages and concepts they are comfortable with, while making possible seamless communication and integration across the project members.

But the most important advantage of the MDA is that it makes possible for the experts of business domain and also for the professional IT developers to focus especially on results and efficiency instead of losing in the details that are unimportant from the point of view of the final result. Several vendors already provide tools that support integration, including substantial code generation capability. In the last years the tool vendors and service providers have extended their support also to MDA. Codagen Technologies, IBM, InferData, Iona, Hewlett-Packard are only some examples of these companies, and ArcStyler, ARI, iUML, iCCG, ModelMethods are examples of the offered products. Following the leading development concepts, using the most up-to-date technologies and tools, the duration time of the IT projects will be shorter, the costs and the risks can be reduced, the users' requirements will be satisfied in the expected way, and also the managements' and stakeholders' expectations concerning the results, returns, revenues and efficiency will also be fulfilled.

4. Calculate Efficiency

In economics the efficiency is calculated as the quotient of the profits and the costs, whose relationship is tried to be maintained through the possibly exact cost and profit analysis process. Knowing the figures of costs and profits of the investment several factors of the efficiency can be made up, as it is written and explained in the publications dealing with corporate finance. If the costs and profits of the IT-investment projects can be properly determined, the generally used financial analysis factors and methods are also applicable in connection with such investments.

Using the general efficiency calculations we can distinguish static and dynamic methodological approaches, depending on the fact whether the method takes time dimension as an economic factor into account. As IT-investments are accomplished usually in a more complex way, the costs and the profit often come up only indirectly and in the long term, so the static methods alone are not suitable for the adequate evaluation of such investments. Table 1. summarizes the indices that are widespread in business practice. The NPV, the IRR and the ROI are the most frequently used measures for evaluating so that the leaders and stakeholders of the companies can adopt to make sound decisions.

Table 1. Relevant indices of efficiency calculations

A	Annuity
BCR	Benefit Cost Ratio
IRR	Internal Rate of Return
NPV	Net Present Value
PBP	Payback Period
PBT	Payback Time
ROI	Return on Investment

4.1. Analysis Methods

The different cost and return analysis methods are worked out to calculate the costs/results ratio, the period of investment's return, the efficiency and the impact and the benefit, and to evaluate an investment project. The analysis methods are based mainly on the numerical data, but there are already proposals in increasing number that take the soft factors also into account. The most frequently used analysis evaluations are the cost and the profit analysis.

4.2. Cost analysis

The first cost analysis model, which was developed in 1987 by Gartner Group[4], the American market research company is the Total Cost of Ownership analysis (TCO). The TCO index shows the total expenses incurred during an IT-investment's whole life cycle. The model had been originally created for procurement of PCs, but later it was overdeveloped for local networks and also for making decisions to purchase notebooks. [3], [4]

[4] www.gartner.com

The advantage of TCO calculation is behind the logical structure of defining the direct and indirect costs occurring during the whole IT-investment life cycle [5], and also behind the suitability for comparing the plans and facts and for unambiguously distinguishing them. But there is a serious disadvantage as well, that it calculates only the costs, and it does not take the business value, the impacts on the different business processes or the profit of a certain investment into consideration. Consequently it is useful to combine TCO with other methods in order to help the investment decisions.

Apart from Gartner Group other competing IT market research companies worked out models based on TCO which differ from several approaches and which can be interpreted as sophisticated and overdeveloped versions, becoming known on different names. These are for instance the META Group's[5] own TCO models, the RCO (Real Cost of Ownership) and PCM (Predictive Cost Modeling), the TCAO (Total Cost of Application Ownership) model of the Tolly Group[6], the CENTS (Comparative Economic Normalization Technology Study) method of the Standish Group[7], but the Forrester Research[8], the IDC (International Data Corporation)[9], the RFG (Robert Frances Group)[10] and the Yankee Group[11] have also developed some other models. These models are aimed the IT-project evaluation from point of view of the costs in order to support the promotion of decision making in investment. From the numerable TCO-models available on the IT-consulting market, those of the Forrester Research and the META Group are the most widely used in international business environment. [6]

4.3. Profit analysis

In most cases the profit of investments can be determined with more difficulties than their costs. Certain quantitative kinds of profits can be easily converted into numerical values (hard return), but there are qualitative kinds of profit as well, which can only be measured with extreme difficulties or they cannot be measured numerically at all (soft return). As the IT-investment cannot only be judged by its various costs, the profit analysis, besides cost analysis, is also an essential component of the economic calculations.

[5] META Group was purchased by the Garnter Group in December 2004.
[6] www.tolly.com
[7] www.standishgroup.com
[8] www.forrester.com
[9] www.idc.com; www.idchungary.hu
[10] www.rfgonline.com
[11] www.yankeegroup.com

It can also be observed that due to complicated profit calculations and estimation methods, the benefit of IT-projects can be less often numerically forecasted than their costs [7], moreover, knowing their complicated and complex mode of action the ex-post definition is extremely difficult. Nevertheless, there are also IT-investments whose profit can be relative easily measured.[12]

As the needs and so the aims of the different companies and even the IT projects very much vary, there cannot be an only profit model that is adaptable for all companies, as we have already seen in the case of TCO models in cost analysis. Therefore there is not a generally applicable TBO (Total Benefit of Ownership) model for evaluating the efficiency of the various IT-projects in a structured way. Instead of using a unique method there are special procedures (e.g. TSTS-procedure, HWM, increase of information value, effect chain-based procedure, ROV), and also complex methodologies (e.g. TEI, REJ, BEIS, TVO) that can help to partly monetarize the profit yielded by IT-investments.

From the facts written above we deal only with the real option approach of IT-investments. The valuation of real options (ROV – Real Option Valuation) is a quite new method for calculating the efficiency of investments, which supports the management in decision making process.

The often applied DCF-based capital value procedure regards the investment projects as an indivisible whole without any possibility for operating flexible. As opposed to these methods, the application of real options provides this possibility. [8] "A real option is the investment in physical assets, human competence, and organizational capabilities that provide the opportunity to respond to future contingent events." [9] Although the sequential investment strategy presumes a sequential process of predetermined decisions the basic idea of the method is to give a flexible possibility to make decisions. The management of the company, being in possession of the new information related to the market changes, can review and over-define their previous decisions. This reaction creates new chances to increase the investment capital value. [10]

The expansion of financial options to real options regarding investments was used first in the '80s. [12] The approach and technique applied for converting real options into numerical values is the same as the options pricing procedures used in financial fields, from which the binomial and the Black-Scholes models are primarily used.[13] According to these methods an investment can be viewed as a sequence of options. There are several applicable option categories such as: exit option, waiting option, growth option, staging option and various modifying options. [13] As long as the

[12] Such can be for example the creation of a web store.
[13] The option pricing methods are detailed among others in [14][15][16] and [17]

real options dealing with management decision flexibility are not built into the efficiency calculation, the distribution function of the expectable project's net present value will be completely symmetrical, as it is shown with a dashed line on Figure 3. below.

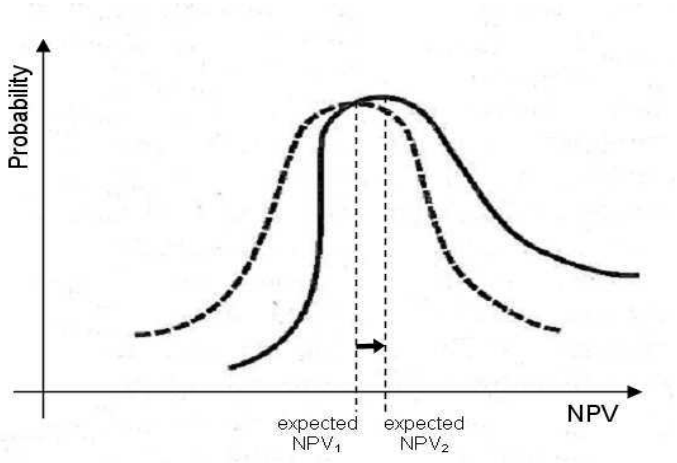

Figure 3. The decision flexibility's impact on the expected NPV

As an effect of the decision flexibility the function representing the expected value of the NPV turns slightly right and upwards. The higher net value corrected this way is called active, while the value based on the traditional method is called passive NPV [13]. The flexibility provided by the real options embedded in the model can be determined as the result of subtracting NPV1 from NPV2.

4.4. Business Case

Dealing with the hard and soft factors and indices of the IT investments it is good to give an overview of the implementation possibilities. Let us see some option types from the field of IT! Taking first the *value option* into consideration, we have to see, that the IT-investments can be considered irreversible, because a tailored IT system cannot be sold to another company. Therefore this option is invaluable in our case. As the *growth option* means the possibility of a later scalability, it is practical to use if the investment provides a possibility of later growth. This is generally significant in the case of an IT system investment, and it is worth to apply in the calculations of efficiency by any means.

In the running investment projects the procedures are divided into structured phases. At the end of all phases there is a milestone where the management in possession of the project and environmental information has the chance to make decision about the next step, namely postpone,

modify the next stages or to give the project up. A clear example for such an IT-investment is the introduction of an ERP system. As it is a long and complex development process, the different modules can be installed at different times. As in such projects every step can be considered as an option referring to the value of the next steps, so they can be evaluated as a *complex option* made up of growth, waiting and exit options.

Taking the market and environmental changes such as the managements' decisions making during the project life cycle into consideration the *modifying options* can be used. While with the help of these modifying options we can relatively good appreciate the uncertainties around the production investments, in the case of an IT system the management has a tighter space to manipulate the project. The operations of a production system can be temporarily shot down because of the market circumstances getting less favourable (option to shoot down), and it can later be restarted (option to restart), these options are invaluable for IT systems. Nevertheless, there are only few modifying options that are worth to be taken into account in the case of IT-investments. The extension of the project's life cycle (option to extend) can be for example such an option, where the uncertainty of the hypothetic life cycle is taking account to determine the NPV used in DCF-based, e.g. generally used methods.

5. Conclusions

There are several existing technologies and tools to increase and evaluate the impact and results of an IT-investment varying from the relatively simple methods to complex methodologies. In our paper we only touched upon the efficiency increasing, the impact analysis and also the financial evaluation methods, that aim to give more benefit to the IT investments. Naturally there are effective technologies, such as standards, EI/EAI, MDA, UML, executable tools to enhance the competitiveness and the profit of an organization, and there are also quantitative and qualitative methods suitable to evaluate IT-investments without giving immediate financial figures related to the profit. The quantitative methods (e.g. balanced scorecard) give a numerical – but not financial – result, while the qualitative methods (e.g. critical success factors, portfolio analysis) may give further help in understanding the problem and in examining the strategic matching. There are also multifactor and complex methods, which evaluate the IT-investment projects according to a multidimensional system of parameters, by determining the value of investment (VOI).

The choice for a method can be influenced by several factors:

- company characteristics, such as size of the company (number of employees, income, branch of industry, company strategy, role of IT at the company, etc.
- investment parameters, such as type of investment, size of investment (expansion), importance of investment, etc.,
- parameters of the evaluation, such as decision situation (aim of evaluation), complexity of the evaluation process, resources needed for the evaluation process (cost), type of the expected output, etc.

Choosing the most appropriate method is extremely difficult because the application assumes expertise knowledge and good practice, moreover it needs an exceeding amount of resources. Most of the multidimensional, complex evaluation methods are developed by companies at the IT-consulting market, and for our greatest regret the exact, detailed content and information are under business secret. If a company does not have a suitable team of experts to calculate expenditures and evaluate investments, it is by all means expedient to involve an independent, external consulting company into the decision and evaluation process. But there is another problem as well! It is known, that the IT-investments can be evaluated both in formal and informal way, The formal evaluation guarantees a quite large extent of objectivity as these methods and criteria are standardized and better defined, but the informal evaluations are more often based on political or personal interests or intentions instead of enforcing the company's interest.

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DESIGING AN IS/IT SERVICE PORTFOLIO

Josef Charvát

Abstract

The paper focuses on IS/IT service provider and current market trends in IS/IT services. It categorizes IS/IT services and the most common pricing model. The second section introduces an approach to the design of IT service portfolio. The approach is represented by the process model with set of processes and the analytical tool for a simulation of various scenarios of IS/IT service portfolios.

Keywords: IS/IS/IT Services, IS/IT Service Provider, IS/IT Service Pricing Models, SLA, Theory of Constrains, Throughput Accounting

1. Introduction

The paper focuses on IS/IT services from an IS/IT service provider's perspective. There are IS/IT providers with established portfolio of IS/IT services. There are also IS/IT service providers, which were formerly parts of the main business organization. They were separated from their parent business organizations, forced to set up service level agreements and define their service from a zero point. Both of these groups face a problem how to define their services, respective if the current service portfolio is the best from their financial result perspective or if there is another model which would improve their performance.

The question which arises is if there are any rules which can be applied when defining an IS/IT service portfolio and if some of the generally accepted theories can be used for this problem.

The author of this paper has faced many different approaches and questions raised, such as: Why did we define ninety five services instead of ten? Will customers understand our services? Would you have any definition of a billing product? Why we do pay to wireless providers per message but we do not pay per email?

There appears to be an overall lack of rules and methods which would help IS/IT service providers to approach the problem of IS/IT service portfolio design.

The aim of this paper is to briefly introduce the perspective from which the IS/IT services can be seen and to present the process model and the modelling tool for simulation of various scenarios of IS/IT service portfolios, as developed by the author of this paper.

2. IS/IT as a Service

There are different ways of how look at IS/IT Services. IS/IT service can be described as a sequence of processes, but also as hardware, software and labour or as a set of qualitative and quantitative characteristics and price, as stated in an SLA.

If we look around at the market of IS/IT Services, we come across to different definitions of IS/IT services. The same name of a service may mean different level of a service. Many customers get confused as some providers tend to benefit from the popular topics, such as ASP and offer their services as ASP, even if the real service delivered is fundamentally different.

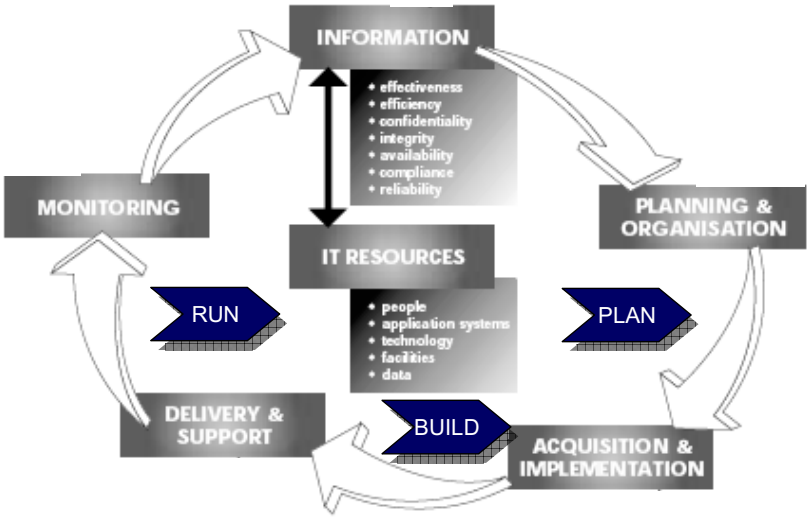

Figure 1: IS/IT Value Chain – Vertical categorization of IS/IT services
Source: [ITG2000], [Dück2000], Author

For the purpose of this contribution the author uses two perspectives of how to look at the IS/IT Services. They can be called a “Horizontal” and a “Vertical” perspective.

"Horizontal" perspective represents the process view; the sequence of phases/processes which aim to deliver IT service. It can be also called an "IS/IT service value chain". Figure one combines the Plan, Build, Run definition, eg. as defined in [04] with the processes as defined in methodology COBIT [10].

"Vertical" perspective can be also called as a "resource" perspective as it is represented by different levels of resources needed to provide IS/IT services.

Resource/ Process	IT Service
Business Process	Full Outsourcing, BPO
Application	Hosting/ASP
Middleware	Hosting
Operating SW	Hosting
Hardware	Hosting
Network, Telecomms	Housing/ Colocation
Facilities, energy	Housing/ Colocation

Table 1 „Horizontal" categorization of IS/IT Services, Source: Author

These perspectives are important for the further analysis and underlying assumptions for the process model and the tool introduced in the next sections of the paper.

2.1. Trends in IS/IT Services

Recent market researches show that service providers are trying to lower their cost of operations by investing in process standardization and utility offering. The transition to more-standardized services will change the way providers deliver services. Customers that want to take advantage of these cost-effective services will need to accept standardized services and one-to-many models. A highly customized solution will still be possible, but for a premium paid to the providers. For example as pointed out in [06]: "In the long term, utility offerings should lead to simpler and more-standard contractual and service base catalogue arrangements."

Few years ago Nicholas Carr opened a discussion on the strategic advantage of IS/IT. The main message was that IS/IT looses its strategic function and changes to a cost of doing business. He also explains how the future of the infrastructure services may look like. "Individual hardware components will disappear, and companies will just connect directly to the IS/IT infrastructure as they do now for electricity. This sets the stage for grid computing, where computers don't just exchange files; they blend together into essentially one machine."[15]

The discussion about standardization and "commodization" has a significant impact on IS/IT service providers when defining and managing their services. Some IS/IT services may bring a

strategic advantage to customers while others are more or less a must which businesses have to buy. It has consequences on how the IS/IT Services should be offered and managed.

Lets put together the two perspectives of IS/IT Services described above - the "horizontal" which follows the value chain of IS/IT Services and the "vertical" which describes the perspective of resources. Lets mark the areas where we can assume the IS/IT Services tend towards "commodization". In the Figure 2 below these services are related mainly to HW, networks facilities and operating SW. From the value chain perspective it covers mainly the processes of Delivery & Support and Monitoring. All together this are can be described as "running the infrastructure".

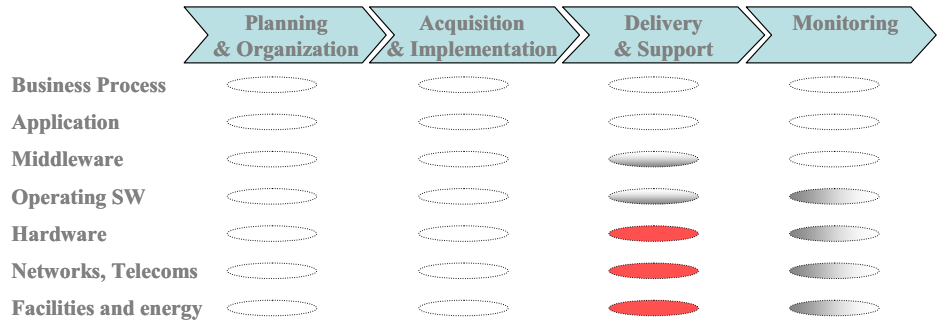

Figure 2: Areas of IS/IT Commodization; Source: Author

On the other hand there are areas of IS/IT services, where the discussion about commodization is irrelevant. Processes of Planning and Organizing will be always areas where unique decisions are made and where the strategic advantage can be reached. Also within a "Build" phase or an "Acquisition & Implementation" a significant strategic advantage can be gained.

2.2. IT Service Pricing Models

IT Service providers use a wide scale of pricing models. Most commonly used pricing models are Time and Materials (T&M), Fixed Price, Cost Plus, Open-Book Pricing, Unit-Based/Usage-Based, Incentive-Based or Shared Risk/Shared Reward.

Service / Pricing Model	Collocation	Application Hosting	Collab. Services	ASP	Full Outs.	Planning, Design & Implement.
Fixed price						✓
Time & Material						✓
Unit Based Pricing	✓✓✓	✓✓✓	✓		✓	
Transaction Based Pricing			✓	✓✓✓		
User based			✓✓	✓✓✓		
Cost plus	✓	✓				
Open-Book Pricing	✓	✓			✓	✓
Shared risks/Shared rewards					✓	✓✓✓
Incentive-Based Pricing					✓	✓✓✓

Figure 3:Types of IS/IT Services and suggested pricing models; Source: Author

The figure 3 suggests combinations of the pricing models and IS/IT services. Not all the pricing models are suitable for all the service types. For example Transaction Based Pricing is a pricing model which can be successfully applied to ASP services. But it cannot be used for the design of IS/IT solution and it can be hardly used for hosting services, as the IS/IT provider is not an owner of the application, which performs the transactions.

Many organizations allow their IS/IT service provider propose the pricing model. But the IS/IT service provider will select a pricing model with the least risk on its financial performance, which may not be the most appropriate model from the customer perspective. As the markets with IS/IT services became more mature, there will be a increased pressure on IS/IT service providers to deliver the service with the pricing model selected by customers.

2.3. Goals of IS/IT Service provider

In most cases, a primary goal of an IS/IT Service provider is to increase owners' wealth—to maximize profits, shareholder value and return on investments. Logically the financial results of an IS/IT service provider are a function of the income from IS/IT services and associated costs.

The income from IS/IT services provisioning is based on the pricing models used, type of services provided and on the demand for the IS/IT services. IS/IT service providers face the pressure from customers to decrease prices. Especially the competition on infrastructure markets increases continuously. The reason is that these services are more understandable for the customers and the service delivered can be clearly defined and measured.

It also supports the "commodization" theory. In microeconomics the commodity markets are presented as the markets very close to "perfect competition". The products are homogenous, market deviations are very low. Prices can be easily compared and products substituted.

	Commodity	IT Service
Output	Electricity	CPU power/output
Source	Nuclear plant	Server
Costs in relation to the output	Fixed	Fixed
Storability of the output	No	No
Lifetime	Defined, known in advance	Defined, known in advance
Therefore maximal output delivered for the lifetime	Known in advance, when resource utilized maximally	Known in advance, when resource utilized maximally
Therefore minimal costs per unit of output	Known in advance, when resource utilized maximally	Known in advance, when resource utilized maximally

Figure 4: Comparison of the IS/IT Service and the commodity; Source: Author

The figure 4 compares one of IS/IT services with a commodity. The results of such a comparison are not applicable to all IS/IT services and all commodities. But such a comparison may help to understand the nature of resources needed for IS/IT service provision and the nature of associated costs.

The majority of the costs of an IS/IT service provider consists of HW and SW depreciation, leasings energy, building rental payments, staff costs, maintenance costs and costs of third party services. Most of the costs mentioned are fixed costs with low short term variability. The real variable costs per "service unit" delivered to the customer are minimal.

The investments to technologies are enormous and technologies get obsolete quickly. There is a minimal relation between useful life of a resource and a level of usage. Used and unused resources become obsolete after the same period. That means that any unutilized time of the resource represents a loss.

In summary, an IS/IT provider generates income by providing portfolio of IS/IT services and applying various pricing models and, on the other side, incurring a significant amount of fixed costs. How should IS/IT service providers allocate their resources and define their services to recover costs and increase the profits?

The Theory of Constraints uses a version of variable costing called throughput accounting. In throughput accounting, the contribution margin is called throughput and fixed costs are called operating expenses. The contribution margin per unit of the constrained resource plays a major role in Theory of Constrains. This measure is used to prioritize the use of the constraint, to estimate the benefits of increase the constraint, to assess profitability, and to set prices.

The unit contribution margin equals the selling price minus the costs of direct materials and other totally variable costs. The main formulas of throughput accounting are [20]:

$$Net\ Profit = Throughput - Operating\ Expense,$$

where:

$$Throughput = Sales - Totally\ Variable\ Costs$$

and

$$Return\ on\ Investment = \frac{Throughput - Operating\ Expense}{Investment}$$

Let's adjust the formula to reflect the situation of an IS/IT service provider. What are the "Totally Variable Costs" for an IS/IT Service provider? As we discussed above, the majority of the costs of IS/IT service provided are fixed. So let's assume that:

$$Totally\ Variable\ Costs\ per\ IS/IT\ Service\ unit\ delivered = 0$$

then:

$$Throughput\ of\ IS/IT\ Service\ provider = IS/IT\ Service\ Revenue$$

and

$$Net\ Profit = IS/IT\ Services\ Revenue - Fixed\ Costs\ of\ IS/IT\ Service\ Provider$$

Return of Investment of IS/IT Service Provider:

$$Return\ on\ Investment = \frac{IT\ Services\ Revenue - Fixed\ costs\ of\ IS/IT\ Service\ provider}{Investment}$$

Based on the formula above, the throughput of an IS/IT Service provider can be improved by:

- increasing the revenue from services provided or
- decreasing the fixed costs of the service, while retaining the same amount of the revenue

The return on investment can be improved by:

- decreasing the investment needed to provide the same level of IS/IT Services or
- increasing the throughput from the IS/IT services provisioning as mentioned above.

3. Consequences for IS/IT service providers

What are the consequences for an IS/IT service provider? When defining or redefining the services IS/IT service provider should come up with such an IS/IT service portfolio which would maximize the throughput and which would bring maximal return on investment. This may mean different actions for different types of services.

For "plan" and "build" type of services the potentials may be found on the revenue side. Accepting higher risk and sharing risk with customers (by using eg. shared risk-shared revenue pricing model) may bring higher revenue and increased throughput.

For run or infrastructure type of services the focus may be aimed to the cost side. The question which may arise for infrastructure services can be: “We buy the same HW as our competitors; we have the same consumption of energies, we pay competitive salaries to our employees. How can we come to a lower price?” For infrastructure services the key may be in utilization of technologies, as mentioned above. KPIs focused on utilization would lead management decisions to the investments e.g. to unified platform or to server virtualization.

The performance measures must follow the main goal of an IS/IT Service provider. This means development of a set of KPIs which would support the maximization of the throughput and of the return of investment. This can vary based on the type of a service. On the top level, the KPIs would follow the quantitative and qualitative measures from SLAs. The internal KPIs should cover the internal steering function and support the internal goals defined for each service. These may be the KPIs focused on utilization of infrastructure for “run” services and for example maximizing revenue or profitability of a project for plan and build services.

The optimal portfolio of IS/IT services can be totally different from the one, which simply follows the technology view (we own servers so we provide hosting services). The approach mentioned above allows think about the IS/IT services from a wider perspective. The service portfolio can be rethinked and redesigned.

For example the current “service portfolio” of wireless communication providers consists of phone calls charged per minute and messages charged per message. What would happen if the portfolio of services would be changed to one standardized product with no exceptions - unlimited calls and messages for a fixed monthly fee?

The throughput accounting formula as defined for an IS/IT service provider may change for example in the following way:

$$Return\ on\ Investment(\uparrow) = \frac{IT\ Services\ Revenue(\uparrow) - Fixed\ costs\ of\ IS/IT\ Service\ provider(\downarrow)}{Investment(\downarrow)}$$

The change of the IS/IT service portfolio can bring:

- Higher revenue because customers are willing to pay more for unlimited services,
- Savings in investments to SW and HW for the marketing, mediator and billing systems,
- Savings in staff costs related to billing and mediation systems, as all the internal processing of the standardized product is simplified,
- Increased utilization of the network.

In reality the result of such a change are doubtful, but it is a good example of how the whole IS/IT service portfolio can be seen from a totally different perspective.

4. An Overall Approach to the IS/IT Service portfolio Design

All the conclusions above can be now reflected in the set of tool and methods, which would help IS/IT services providers design their IS/IT service portfolio. The outputs developed by the author consist of two components:

- The Process Model defining phases and processes of IS/IT Service portfolio design and
- The Modeling Tool for development of various scenarios of IS/IT service portfolios.

The main assumption is that the services shouldn't be designed in isolation. IS/IT Service portfolio should be designed as an aggregate scenario giving a global picture of resources and performance of an IS/IT service provider.

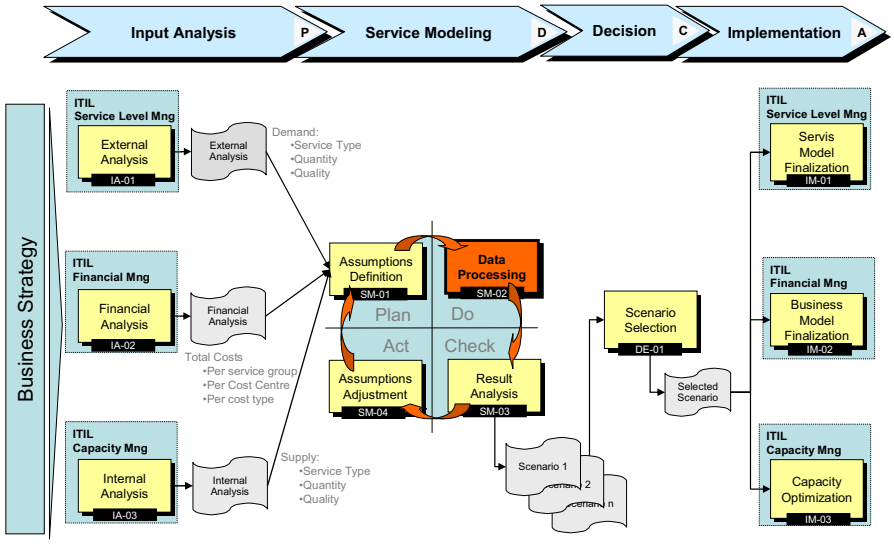

Figure 5: Process model for IS/IT service portfolio design, Source: Author

The process model is designed as a flow of processes following the main principles of the Deming's Cycle. Each process has its inputs, main activities, outputs and the links to other processes. One of the main assumptions of the model is that there is not a one correct solution. To come to an optimal result, an IS/IT service provider follows a cycle of defining and redefining the assumptions and creates various scenarios.

The best scenario is selected from a set of scenarios and is finally implemented to the main processes of IS/IT service provider. The phases are Input Analysis, Service Modeling, Decision and Implementation. The intention of the process model is to keep the link to the generally accepted standards. There are links created in the Input Analysis and Implementation phases to the ITIL processes. The main processes involved are ITIL Service Level Management, ITIL Capacity Management and ITIL Financial Management. The phase Service Modeling is designed as a cycle and contains a link to the IS/IT service portfolio modelling tool.

5. Modelling tool

IT service modelling tool is an integrated part of the process model. It allows IS/IT service provided gather all the data from capacity management, financial management and service management, and analyse them all together.

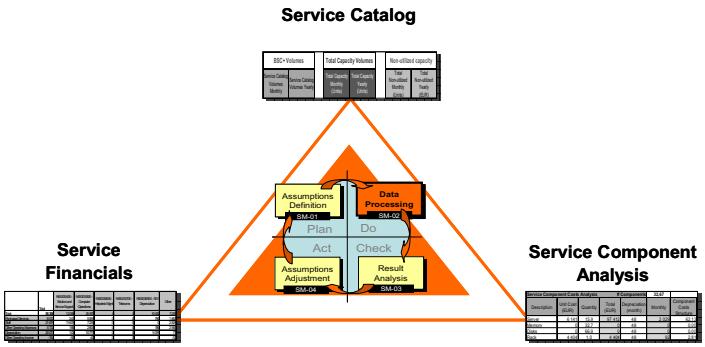

Figure 6: Main structure of the IS/IT service modelling tool, Source: Author

The tool allows consolidate the information on the costs, demand, capacity of main resources and other relevant assumptions and inputs. The outputs of the simulations are scenarios containing various reports on utilization, cost recovery or Break-Even Point. All the outputs are designed to give a complex view on the IS/IT Service portfolio, cost recovery and financial performance.

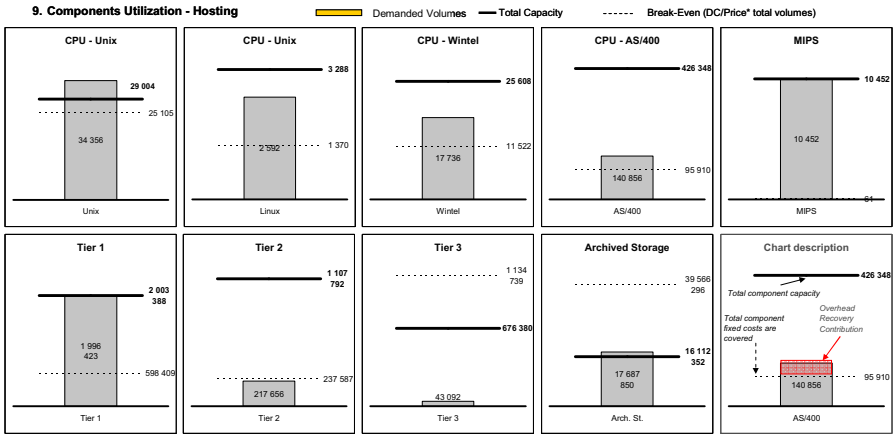

Figure 7: Selected output of IS/IT service portfolio modelling tool – Break-Even Point analysis

The figure 7 shows one of the output charts showing the performance of the service components from the utilization and Break-Even Point perspective. Unfortunately the scope of the essay doesn't allow present more of the outputs of IS/IT service modelling tool.

6. Conclusion

IT service providers face a difficult task when designing their portfolio of services. In reality there will be many limitations, such as existing agreements with current customers, the customer resistance to accept a new service model or a parent organization requiring exact service structure. But still IS/IT service provider may think of redesigning his current service portfolio within a longer term and improving its financial performance.

The author explains his understanding the problem and within the limited scope of the essay introduces the key outputs of his work – the process model and the modelling tool. These outputs set an overall framework to the problem of IS/IT service portfolio design and they support IS/IT providers with methodological guidelines and a practical tool.

The aim of this work is to help providers to move forward from the current situation, when the IS/IT services are defined spontaneously and "per partes", to the clear process of defining assumptions, collecting data, understanding the resources and constrains and designing an optimal portfolio of services.

With the toolkit introduced by the author, the IS/IT service portfolio is designed step by step following the processes as defined in the process model, the relevant input data are consolidated in the portfolio modelling tool and the outputs of the simulations are presented in a form of comparable scenarios. This allows the IS/IT service provider keep the transparency of the design process from the very start to the end, identify constrains and select such a portfolio of IS/IT services, which will contribute the most to the overall strategic goals of an IS/IT service provider.

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ACHIEVING BUSINESS EXCELLENCE THROUGH QUALITY OF LOGISTICS MANAGEMENT AND MEASURING IT

Matjaž Knez, Bojan Rosi, Marjan Sternad[1]

Abstract

In the age of global expansion of business operations and contemporary way of life rapid growth of material and information flows in various companies and between them is being achieved, and is thus becoming more and more difficult to manage. Have business functions in companies been dealt with separately until now (purchase, production, finances, sale etc.), today, the emphasis is put on their integration or correlation. By studying supply chains in a company and between business partners, companies can gain competitive advantage and can become more adjustable, taking into account the increasingly changing market circumstances. This creates a mechanism that aims to meet consumer demands and expectations as holistically as possible. Taking all activities into account, it is logistics management that plays a key role as an answer and strategy of companies that are facing the challenges of the new millennium.

Based on the numerous mega-trends[2] which influence many a business subject, this article aims to explain how the strategic importance of logistics management is increasing. The latter is not to be dealt with one-sidedly as a cost. Moreover, the key aspects such as competitiveness as well as long-term existence of a company are also to be taken into consideration.

Key words: Logistics, logistics management, logistics strategy, globalization, supply chains, mega-trends, logistics costs, competitiveness.

1 University of Maribor, Faculty of Logistics Celje-Krsko, Slovenia;
{matjaz.knez1, bojan.rosi, marjan.sternad}@uni-mb.si

[2] Mega-trend means a big and clearly defined direction of a particular development (Knez, Cedilnik, Semolic, 2008).

1. Introduction

Today, it is becoming more and more difficult to meet customers' demands[3], as many are expecting to receive an enhanced level of customer service. Therefore, a company may quickly lose its market share if it fails to maintain a high level of customer service. The trend of logistics development mainly depends on globalisation of the world economy, which has facilitated a number of factors that influence production growth, equalisation of products and consumer needs. Greater competition between companies, shorter life cycle of products and new circumstances are forcing all participants in a supply chain to adjust to such changes. In the future, the logistics management will play a key role in adjusting and continuing existence of companies, as it will influence the business success of the company or lack of it. Therefore, logistics costs[4] will also play an important role in competitiveness and success of the company on the global market.

2. Logistics as added value and not as a cost

Logistics is usually referred to as a service, dealing with material flow management, from resources to end-users in a company and between them. Furthermore, logistics encompasses the physical flow of material from the supplier, manufacturer and seller to the end customer and includes all relevant flows of information and know-how. It supports the physical or material part of the entire life cycle of a product including its reverse route[5].

Logistics is a crucial part of the value chain, as it defines business processes in the line of other activities and processes from suppliers, manufacturers to the store shelves, i.e. the entire industrial supply chain. Moreover, it must provide an optimal flow of goods in the logistics or supply chain. In this chain, companies can either be suppliers, manufacturers or distributors. They all have to provide the right goods and services at the right place, at the right time and in the right quantity and quality, creating lowest the possible costs and environmental influences.

[3] In the 1970's the buyer may have been the “king”, but in the 21st century a buyer is a dictator, dictating demands that supply chains must follow in terms of success and price competitiveness and when customers' demands are to be met (Knez, 2008).

[4] This especially concerns products and services with extremely low profit margins (Knez, 2007).

[5] Reverse logistics deals with the management of the remains of products and residual waste that are created at all levels of supply, production and distribution. The material flow has the opposite direction of the aforementioned parts of logistics. Its task is to follow economic and ecologic goals. Whereas the main tasks of reverse logistics are: planning and dismantling of used equipment of customers and in production, collecting, sorting of waste, temporary storage, manipulations and waste transport, recycling, collecting, deposition and discharge of waste. Taking into account the shorter life cycle of products and complex ecological regulations and standards, the importance of reverse logistics is drastically gaining significance.

Logistics is thus the main support process in a company and in a supply chain that encompasses all processes, from forecasting, demand, supply, demand and production planning to material business, warehousing, handling of goods and services, packaging, commissioning, distribution, transport, sale and after-sale activities, as well as the process of waste management.

The notion that logistics activities and processes as such incur costs is too vague. It results from a single-minded belief that warehousing, transport and handling of goods and services incur costs and fail to bring added value. If added value is viewed as an increase or improvement of value, price, functionality or usability, then the latter is not true. What is the value of a product that is placed in suppliers' warehouse instead of the production line of a user or on supermarkets' shelf? What is a cutting tool worth in a warehouse or during its processing on the cutting machine? If logistics really incurs costs then: why are we building modern warehouses for the incoming goods and components and warehouses for outgoing goods, transport routes and systems, distribution centres and automatic management of goods and products etc.? The fact that the flow of materials and components depends on transportation, warehousing or handling of materials and products, further proves the complexity of logistics management.

3. Objectives of logistics management

Despite the fact that logistics management is an interdisciplinary and universal combination of activities, the main topic of this paper in terms of specific goals, behaviour, structure and special adjustment skills is still diverse.

Business logistics is a social process; hence the content of this universal process is changing in line with social development trends. Expanding globalisation markets and at the same time individualisation of customers' wishes, information technology, environmentally friendly implementation of logistics services and increasing terrorism and criminality concerns are the five mega-trends (Knez, Cedilnik, Semolič, 2007, p. 98) that create a demand for the alteration of business contents. That is why they present a real challenge to logistics management. The combination of five mega-trends has been shaping business logistics for the past few years.

Logistics system management will shape and integrate objectives, decision makers' behaviour, structure and the ability to be flexible regarding various combinations of mega-trends. Social mega-trends help companies gain competitive advantage and excellence using a particular logistics strategy.

Greater competition on international markets calls for constant innovation. Companies continuously have to prove that they are worthy of their customers and at the same time expand to new markets. This can only be done if companies are market-oriented. However, all business functions of a company, including logistics, must also be market-oriented. Logistics is effective and successful when the following activities can be fully implemented:

- Market opportunities are identified;
- A concept of effective service (meeting demands) of customers is introduced;
- The right quantities of goods (and services) at the right price, at the right place and at the right time are provided;
- A system of prices that can maximize the sales is established and
- After-sale services are introduced.

To that end, logistics system (with all the participants) must set a goal, i.e. its directives of operation that will meet customers' demands and contribute to the entire effectiveness and success of the company[6]. Here, a systemic approach (for example dialectic network thinking) may be applied. Dialectic network thinking foresees extensive and more complex tasks of holistic logistics management to be tackled systematically, i.e. already in the starting phase of the target orientation logistics. Then, the definitions of goals, tasks and procedures are adjusted to them. By defining tasks and implementing them, the set goals can be achieved, on which the tasks also depend. This means that in the face of the entire problem, each task is its own piece in the jigsaw. Whether setting tasks is appropriate or not, cannot be justified without further context. The context of a task or more tasks is the system, the problem of a comprehensive operation of logistics, its goals and tasks[7] (Mulej, 2000; Rosi, 2004, 2008).

Knowing or being aware of the complexity of logistics and its goals, logistics can be managed much easier and holistically. The fundamental objective of logistics systems is an optimal supply of production with materials and energy as well as an optimal supply of consumers with products in the right quantity, quality and in the right moment. The aim is thus to achieve an optimal level of supply service (Ogorelc, 1996, p. 23).

[6] *Efficiency* means doing things the right way, whereas *success/effectiveness* means doing the right things. Therefore, efficiency is an inner characteristic of companies, and success is their outer feature (see: Rosi, 2004, 2008)

[7] Until something starts bothering us we do not see a problem and therefore do not need to define our goals and hence to define or implement tasks. Man is different from other creatures: tension makes him or her active. Solving one problem initiates the solving of the next one or several of them, for which goals as well as ways of dealing with them are defined. Then, tasks are set that must be carried out. It is a continuous circle (Mulej 2000).

However, when goals of logistics quality management are being planned and achieved, it is important to measure the success of reaching the set goals and business success of a company.

4. Measuring business success

In order for a company to be successful, logistics organisation must be developed and updated in line with the global mega-trends. This calls for information-technical modernisation, standardisation as well as adjusting functions such as informatics and accounting to logistics' needs.

Some principles of modern logistics may be linked to Taylor. Although his ideas are connected to improving efficiency in a factory, organising workers' tasks on assembly line, temporal dimensions that he had introduced, such as sequence, duration, rhythm, synchronisation and temporal perspective are also very useful for logistics management. What Taylor's principles of management have done for a factory through the improvement of efficiency is what logistics has done for logistics flows[8] in companies and between them. If parallels of Taylor's principle of management can be drawn to logistics, then question arises as to how business efficiency of companies is measured today, almost 200 years (!) later.

Can you imagine managing a modern supersonic aircraft solely by using the airspeed indicator and at the same time not be interested in various other parameters concerning a safe and successful flight such as altitude, fuel usage, direction of flight, weather conditions? This is a rhetorical question. However, some leading managers, "pilots", and their accountants, "co-pilots", are similarly leading their organisations into the future and are frequently using a single measure – profits. Measuring competitiveness using solely financial quotients, sometimes combined with process quality measures, productivity and costs per product, does not suffice for long-term competitiveness of a company. For there is only evidence of previous successes of an organisation, however, due to (too) few financial data no practical forecasts can be made. Data referring to the degree of customer loyalty, satisfaction and trust of employees or the pace of learning along with the organisation's ability to introduce changes are usually not measured so that they would enable a transfer of data into effective business strategies and actions ("what is measured can also be managed or what is measured can be implemented"). Companies are often struggling when they are trying to connect business strategies, processes and necessary measures.

[8] Logistics flows are flow of goods, flow of information and know-how and financial flows.

These important gaps in measuring competitiveness and efficient implementation of business strategies have partly been abolished by contemporary managerial tools, such as balanced business indicators (i.e. EFQM – European Excellence Model).

The need for a thorough renovation of tools that are used by the managers and entrepreneurs for their strategic change management was first addressed in The Wall Street Journal by the famous management guru Peter Drucker: "current organisation concepts and tools are not appropriate for management and control of business operations. We need entirely new ways for measuring competitiveness of organisations – instead let's call them business audits!"

"The father of contemporary management", as Peter Drucker is referred to, unambiguously warned with the above statement that the new ways for measuring and managing competitiveness and excellence are not just a flash in the pan, but the actual need that will facilitate much needed changes for organisations that still measure their success based on previous business success, i.e. profit. According to Drucker, profit as well as some other traditional financial measures of competitiveness should include a warning! A warning claiming that trust, satisfaction and loyalty of consumers, satisfaction, enthusiasm and motivation of employees, intellectual capital and potential of a company, reputation, competences of the leading team or lost opportunities are not being measured! Without such measures, we will have problems to adequately manage and control third century companies due to constant turbulent and rapid changes[9].

5. Objectives of measuring competitiveness

An answer to the question as to what organisations want to achieve by measuring competitiveness is not as simple as it may look like, for organisations wish to control their business operations, so they can react, but "what cannot be measured, cannot be managed". This answer does not reveal the fact that current methods for measuring competitiveness do not "forecast" the future very well! As today the future is not a simple extrapolation of the past, one needs to strive for such measures that will tell a company in time, if it does not react in a specific strategic area, which might have fatal consequences.

[9] Drawbacks of traditional (financial) systems of measuring competitiveness are not new. First and foremost they are narrowly focused only on previous business operations. This facilitates the worst of diseases in contemporary management, short-term focus of organisations. It is therefore not surprising that in the past few years the advanced economies have rapidly started integrating various new measures and models for managing and studying competitiveness: EVA (*Economic Value Added),* MVA (*Market Value Added),* SV (*shareholders value*), *balanced scorecards*, EFQM (Excellence Model), Malcolm Baldridge Award, 20 keys system, etc. (Gruban 2002).

Measuring competitiveness must thus be a quantification of previous business actions of an organisation in a way that it enables the forecasting of future results, for which we need additional, appropriately collected, defined, analysed, interpreted and communicated information and data.

Profit as a measure for competitiveness is slowly but surely becoming history. Several studies have proven that even investors, financial, stock-market and business analysts, who are unsusceptible to new trends, are becoming increasingly open to additional, usually non-financial measures for competitiveness. According to different sources, financial measures today present only one third of appraisal of competitiveness of companies. This sends out a clear and unambiguous message to the management of companies: "start presenting competitiveness of organisations integrally!"[10]

Supporters of the "school" of the Nobel Prize winner Milton Friedman concerning management responsibility towards capital owners, expressed in monetary, profitable form will not disappear over night. However, an alternative viewpoint is coming to the fore and with it another Nobel Prize winner, Kenneth Galbraight, who claims that leaders are not to be held responsible to the shareholders but also to numerous other people who are in any other way associated with the organisation by interest, and on which its success or failure depends. These are firstly consumers (buyers, customers, commissioners, clients etc.), as well as employees, suppliers, and the local and wider social environment etc. The actual measuring of business excellence and competitiveness cannot occur without relevant public opinion.

Profit is thus, as the aforementioned scholars claim, the only and the most central measure of competitiveness. This does not answer the question: if something is a measure, what is then the goal? *Profit cannot simultaneously be a measure or a goal or a means for goal achievement and the goal at the same time?!* Therefore, this enigmatic riddle of post capitalist regulation remains unsolved for now. However, along with (or even instead of!) the profit as a central measure, there are also other financial and non-financial measures for competitiveness.

6. Conclusion

The fundamental aim of each company is business excellence, i.e. on the one hand company's solid and stable ability to be competitive and profitable and on the other hand satisfied stakeholders of the

[10] For now this is not the case in practice, as 90 percent of managers still use traditional financial accounting. Charles Handy, a renowned management expert, made a cynical comment regarding this: "what cannot be counted, does not count. Money (profit?) can easily be counted, that is why money has become a universal measure for everything, including competitiveness!" (Gruban, 2002).

company. The changing production conditions and demands of a changing environment are forcing companies to adjust to such changes through various combinations of production factors. Companies can achieve business efficiency by focusing all their potentials or "key competences" of the company onto the main business areas (Quinn, Hilmer, 1994, p. 43–53). Here, the management of logistics or business functions of logistics—which is a network of interwoven activities that serve for transporting raw materials, semi-finished products, other materials and finished products from suppliers to the company—will play an increasingly important role for transportation within a company and from the company to consumers or buyers and all related activities. The so called "composed activity" features many sub-functions of an economic system of which each activity could be dealt with as an individual management activity." Important here is the fact that a bundle of interwoven activities is important for a safe, ecologically appropriate, fast and cheap flow of raw materials, semi-finished products and products from manufacturers to end consumers. If the companies can manage that, then we can talk about successful logistics management and hence, a satisfied consumer or buyer.

Aims for measuring business efficiency are thus (i) on the one hand by using radar accuracy of signal detection that indicate a weak immune system of an organisation and at the same time prevent the development of illness symptoms on the vital parts of the organism. On the other hand (ii) the role of measuring is aimed at controlling the parameters linked with consumer satisfaction and loyalty, commitment, trust as well as satisfaction of employees, of shareholders, management of business processes and organisation's ability to be innovative and constantly create added value. The third (iii) part is connected to the choice of information that creates new challenges for organisation and deliberately exceeds the current "cohort" logic for measuring business excellence.

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INNOVATION THROUGH IT INVESTMENTS AT SMES IN HUNGARY

Ferenc Erdős[1]

Abstract

Innovation is the engine of economic growth. Without it business enterprises would not be able to remain competitive in today's markets. While large firms historically played a defining role in the innovation landscape, SMEs have also contributed to a growing extent to the shaping trends of innovation.

More recently, IT development has become strongly connected with innovation in the normal course of business.

This presentation provides partial results and conclusions based on a survey carried out in summer 2007, aiming to explore the relationship and between innovation and information technology.

Keywords: IT-investment, innovation, SME

1. Various forms of innovation

Innovation at companies can take various forms, however firms often apply a combination of these. Schumpeter, who was the first economist to study innovation, differentiated between the following types: new product introduction, new production methods, opening of new markets, new sources of purchasing, and restructuring of the existing organisation to better fit work processes. [8]
According to the latest classification in international literature, innovation can take the following forms: [7]

- Product innovation is the creation of a new product or service, but also includes the substantial development of an existing product

[1] Szechenyi Istvan University, Hungary; erdosf@sze.hu

- Process innovation involves the application of new technologies or processes to produce goods or services that require solutions which did not exist earlier. This type also incorporates all kinds of innovation related to processes from procurement to retailing, such as purchasing, logistics and distribution with regards to raw materials, finished goods of services.
- Applying organisational-institutional innovation means new or materially improved ways in organising work processes, managing these processes, new organisational structures, decision making processes or maintaining external relationships.
- Marketing innovation is the application of new or materially improved marketing methods in order to increase sales focusing on consumer needs, opening of new markets or placing goods with a different objective on the market.

Above classification can obviously be narrowed or broadened. Most corporate innovation studies using the narrower classification only distinguish between product and technology innovation.

Measuring the innovativeness of a firm is the core question in both Hungarian and international studies. According to the definition in the 1997 edition of the Oslo handbook [6], a corporation is innovative if it achieved at least one product or technology innovation during the examined period. Another source [4] defines a company innovative if more than 20% of its revenue is generated by some form of innovation deployed over the preceding three years. Other approaches define innovativeness based on the existence of at least one of the four innovations types (product, process, organisational, marketing) over the past few years. [2]

2. The relationship between innovations and IT-investments

The key factors of extensive capital investment, including IT investments, stem from the demands for goods and services, as well as the basic tenets of economic growth—these are the key necessities for innovation. It must be emphasized that innovation is the most important out of all of these factors.

From a corporation's perspective, the integration of new information technology is most commonly understood as innovation. From another perspective, most of today's production-service innovation demands support from information technology. [3] However, information technology cannot independently claim greater economic competitiveness. The German example of successful

innovative companies illustrates that the companies which are capable of changing both their products and corporate processes are those which can utilize the potential in IT. [5] In addition necessarily there is a natural learning curve which is undertaken for information technology integration and it actual use [5], which in part explains the typically delayed impact and resulting consequences of capital expenditure in IT. [1]

In the following, we try to explore the relationships between innovation and information technology support in Hungary-based SMEs. Along this vein, the factors of innovation were examined according to the classification of the most modern, internationally accepted Oslo handbook's latest edition. [7] This meant the distinction of four different groups of innovation: product, process, organizational-institutional and marketing innovation. The sample involves 381 Hungarian SMEs and it is representative of the number of employees and the industries. The data acquisition happened in summer of 2007.

We provide several examples to determine the proportion of IT support in each individual type of innovation, amongst which for instance product innovation can be best explained in the following way (Figure 1):

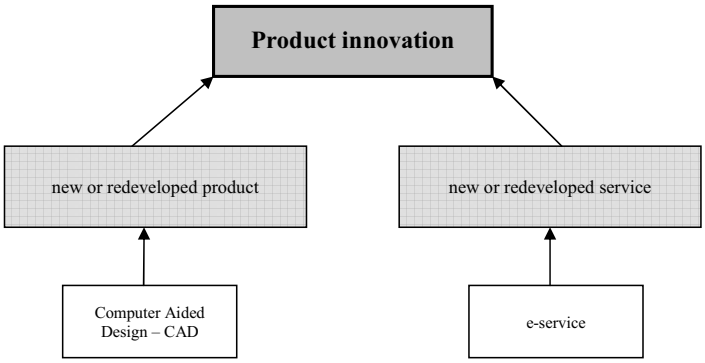


Figure 1: The several possibilities of actualization or support of product innovation with IT instruments

Out of all SMEs applying product innovation (n=73), on average about half utilized IT-support, which typically came into force involving product design aided by computers (*Computer Aided Design – CAD*). The smaller enterprises generally found this adaptation more difficult as well as recruiting the expert pool of professionals. Despite the apparent differences in enterprise sizes, after the Chi-square test's completion it can be deduced that the relationship amongst the size of the company, the degree of IT support and this type of innovation is statistically insignificant (χ^2=1.98;

df=2; p=0.371). Dividing the sample universe of SMEs' into three categories by 2006 net sales (<100 million HUF; >=100 million HUF and <300 million HUF; >=300 million HUF) instead of the number of employees, the examination of the crosstab of the relationships between revenue categories and IT-supported innovation yield a statistically significant result (χ^2=7.56; df=2; p=0.023). Amongst the variables the moderately weaker relationship can be deduced with Cramér's V Test and the calculation of contingency coefficient (V=0.33; C=0.31).

Today process innovation IT support is wide ranging and more sophisticated opportunities exist at a firm's disposal. (Figure 2)

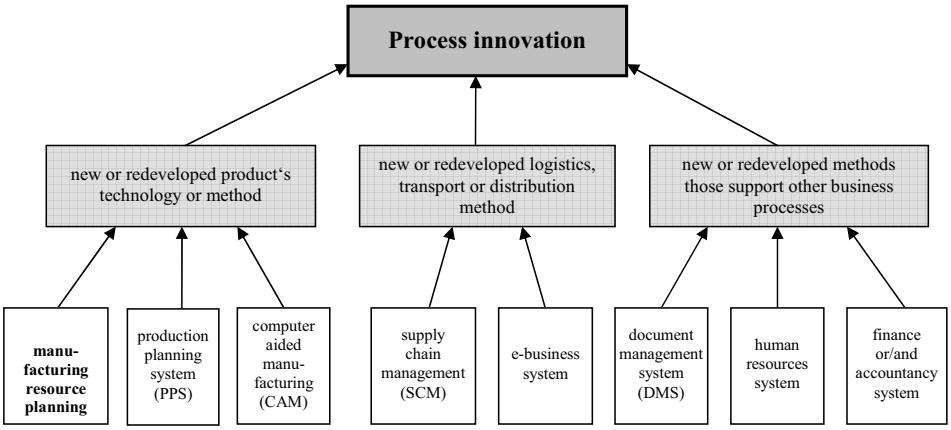


Figure 2. The several possibilities of actualization or support of process innovation with IT applications

Within process innovation the new or developed production methods exhibit significant correlation between the size of the company and IT support of such innovations (χ^2=7,24; df=2; p=0,027). The strength of the relationship can be described somewhat weaker than medium (V=0,33; C=0,31). The significance and strength of the relationship according to sales categories is also similar (χ^2=6,42; df=2; p=0,04, V=0,31; C=0,3). More then half (56%) of all SMEs using this type of innovation (n=68) have applied various IT developments in production. It seems logical that firms with more employees and generating more sales are more prone to achieve production innovation by applying expensive IT or computer aided manufacturing (CAM). Taking IT-support as a dependant variable, it can be stated that the forecasting ability of independent variables (number of employees and net sales revenue) are rather low (λ=13,3%; τ=10,7%; UC=8,2% és λ=29,3%; τ=10,8%; UC=8%), consequently other factors play significantly larger role in this form of innovation.

Similarly, IT support in logistics, transportation or distribution innovation is a feature at more than half of the companies (59%), however the sample size (n=27) is rather low and no relationship can be established with the size of the SME.

Almost 80% of SMEs (n=44) have applied IT support in new or developed processes. The high ratio is most probably due to the fact that this field encompasses a wide spectrum of potential methods of innovation, which are widely supported by modern IT applications. Despite the differences in size categories in cross-tab analysis, the Chi-square test does not support significant relationship between the existence of IT support and the number of employees (χ^2=3,4; df=2; p=0,182) or the net sales of the firms (χ^2=5,53; df=2; p=0,063).

There are increasingly modern tools available in order to trigger structural-organizational innovation with IT applications. These are illustrated with a few examples in Figure 3.:

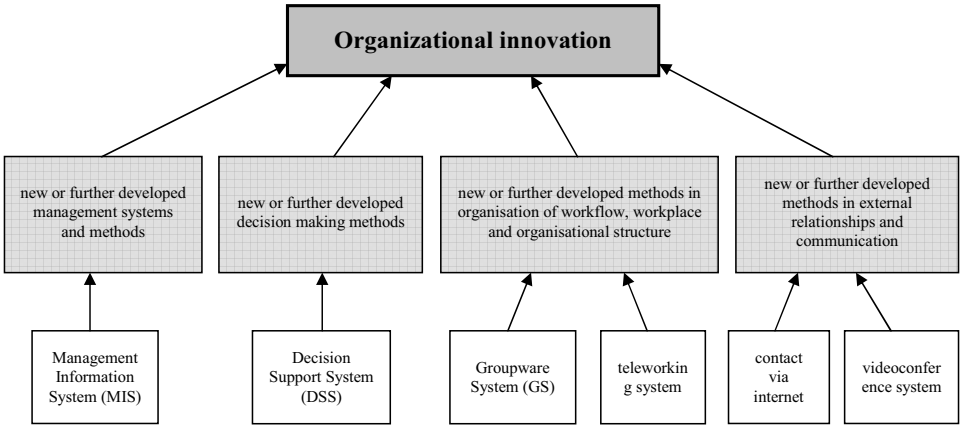
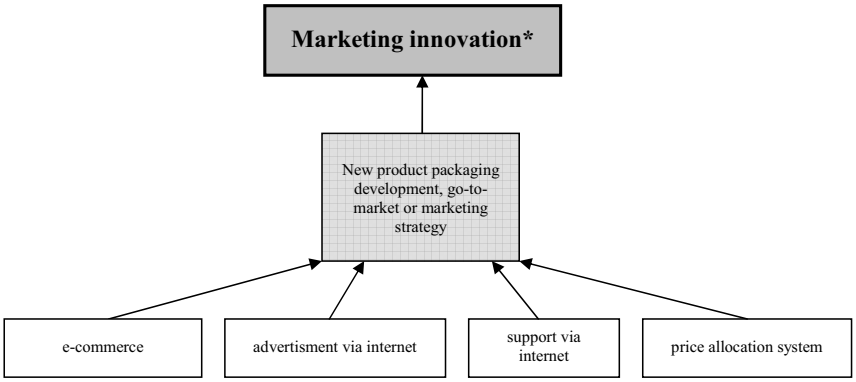


Figure 3. The several possibilities of actualization or support of organizational innovation with IT applications

Examining the structural-organizational innovations, no correlation was found between the size of the company and the innovation by IT tools. Innovation of this type carried out by IT tools is extremely high: in 83% of cases relating to leadership methods, in 63% of the cases relating to workplace organization and structure, and in 75% of the cases relating to external communication. These high ratios are primarily due to the modern integrated IT systems, which generally incorporates a Management Information System module supporting management decisions efficiently, and becoming more and more affordable to SMEs, too.

IT solutions in the field of marketing innovation are in most cases related to e-marketing activities (refer to Figure 4).

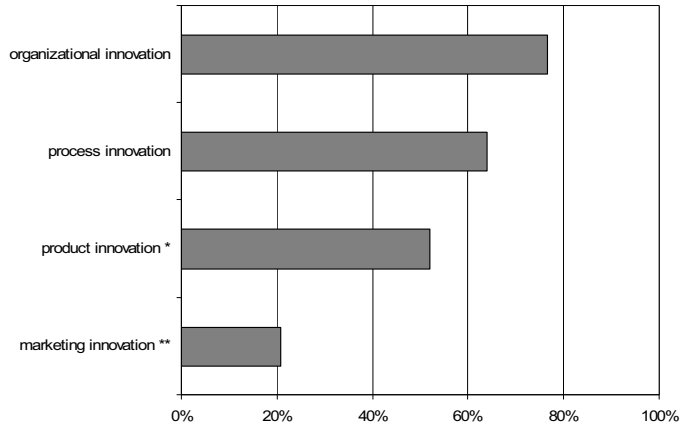


* innovation relating to product design are classified as product innovation

Figure 4. The several possibilities of actualization or support of marketing innovation with IT applications

Consequently, the analyisis emphasizes more on the examination of e-marketing driven innovations in the SMEs universe. On average only 21% of the innovating companies applied some form of IT application, however this form of innovation exhibits different patterns: SMEs with more then 5 employees are more prone to use electronic tools (such as e-marketing) in this type of innovation. This is certainly due to the fact that e-marketing solutions offer cost effective solutions also to SMEs, hence the ratio of application is far higher than for larger enterprises. In contrast, big corporations often stick to traditional and more expensive media due to those being more ominpraesent. However, statistical methods have not resulted in any meaningful significant correlation between the size of the company and IT-supported marketing innovation.

Figure 5 displays a comparison of the likelihoods for the various types of innovation utilized by SMEs in the region. The two displaying the greatest probabilities are organizational innovation (77%) and process innovation (64%).



* amongst the types of product innovation, service innovation has been ignored
** amongst types of marketing innovation, the data only includes the product placement, advertisement and price allocation

Figure 5. Different types of IT innovation utilized by SMEs in the West Transdanube Region, 2004-2006

Table 1 shows the IT innovation development profiles of Hungarian SMEs in the West Transdanube Region. The statistical significance test reveals that 381 SMEs of the 420 that I analysed were significant for utilizing these types of IT innovation. The average percentage of IT-support amongst these firms was 55%.

Table 1. A profile of support of IT innovation for West Transdanube SMEs, 2004-2006

	+	–
type of innovation	organizational innovation (77%)	marketing innovation (21%)
number of employees (2006)	50-249 (67%)	-
total revenue (2006)	>300 million HUF (65%)	-
type of ownership	majority international ownership (69%)	majority national ownership (51%)
sales relationship	majority international sales (67%)	majority national sales (52%)
year of establishment	after 1998 (58%)	before 1992 (47%)
consortium relationship	part of a consortium (72%)	not part of a consortium (50%)

From the table one can deduce that in the sample period, the SMEs in the region utilized more than half (55%) of the various types of innovation with the help of IT investment. Among these companies a greater proportion innovated through IT which had a higher revenue, more employees,

were founded after 1998, had a higher likelihood international ownership, produce primarily for the international market, are part of a consortium and actuate some type of organizational-institutional or product innovation.

Looking ahead, future research can expect that this proportion will grow continually, given that these types of innovation are increasingly interwoven with IT. The companies that are developing IT systems are increasingly targeting SMEs with their products, this way more small companies will be able to have new IT capacity, with a wider scope and in more integrated fashion. In the Hungarian region which was examined, 54% of the SMEs in the survey sample plan some type of IT development in the short term, which represents an eminent proportion.

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Security and Safety as a Systemic Challenge

A HOLISTIC VIEW AT DEPENDABLE EMBEDDED SOFTWARE-INTENSIVE SYSTEMS

Erwin Schoitsch[1]

Abstract

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. 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 as a complex "umbrella"-property is key to massive, ubiquitous deployment and use of embedded smart systems, including sub-properties such as safety, reliability, availability, security, maintainability, survivability. These properties are, depending on the application, not independent: they can be complimentary or even contradictory. 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. They consist of control units, sensors, actuators, "intelligence" ("smart systems") – to serve our needs and fulfil their tasks in a safe and reliable manner. Applications include critical systems such as sea, ground and air transport, medical devices, industrial and power plant control, surveillance and monitoring, emergency systems, other working environments, and less critical ones for communication, info-/edutainment and entertainment.

The paper will demonstrate that mass deployment of networked, dependable systems implies a new, holistic system view on critical systems, and how the challenges should be addressed by proper system assessment and evaluation, architecture, design, development, validation and maintenance.

[1] Austrian Research Centers – ARC (Vienna); erwin.schoitsch@arcs.ac.at

1. Introduction

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), 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 have 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.

2. Dependability – a holistic umbrella term

As already outlined in [1], used in [16], [22], 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 (*Fig. 1*) (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 [8],

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 [20], [24].

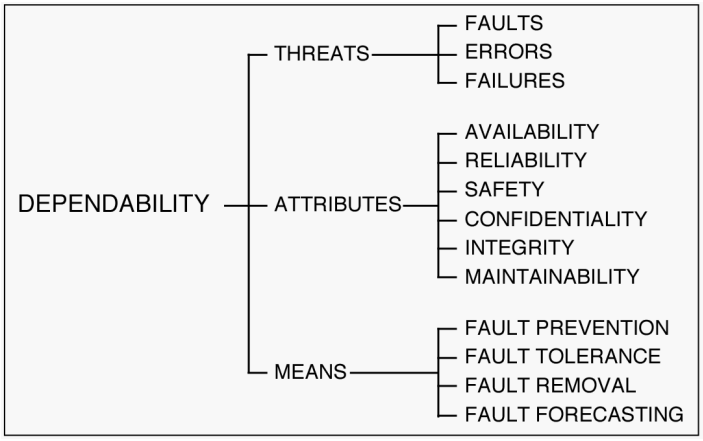


Fig. 1: Dependability - Basic Concepts and Terminology

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).

The situation drastically worsens when considering large, networked, evolving, mobile/wireless systems with demanding requirements driven by their domain of application, so called *ubiquitous systems*, 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.

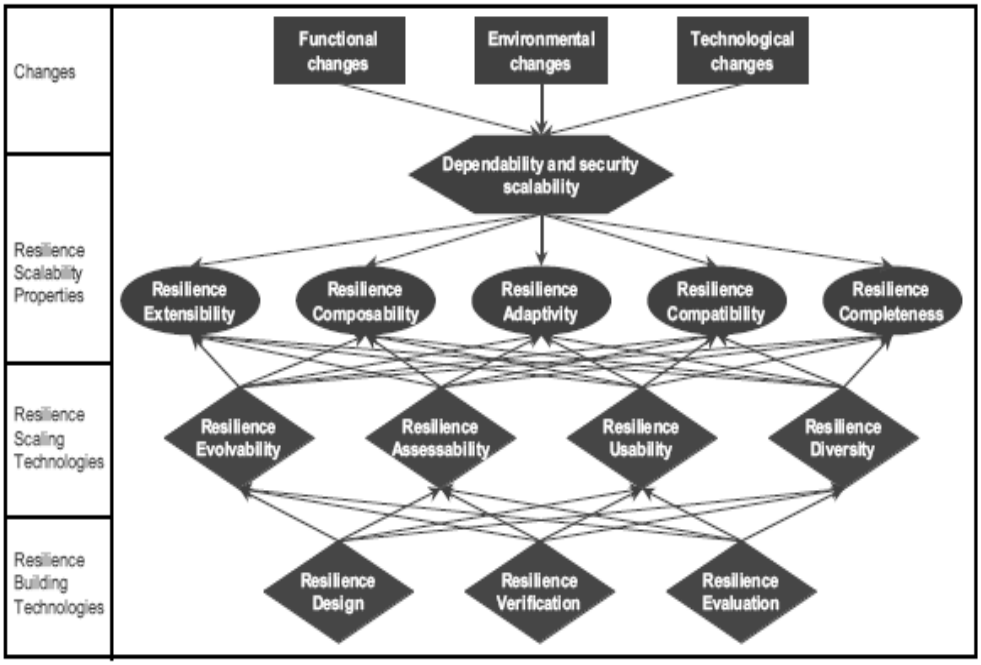


Fig. 2: Scalable resilience (from [28])

ReSIST [28] views resilience as involving four major properties:

a) 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,

b) 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
c) usability, and
d) diversity.

The concept of "resilient computing" *(Fig. 2)* 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 [28], 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.

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) = …….)

3. Characteristics of Embedded (software-intensive) Systems

There are many definitions of Embedded Systems around. Generally speaking [6], 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)…" [6]. To be able to develop dependable systems from components with these characteristics, foundational system infrastructures and methods ([14], [15]) 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) [11].

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) (*Fig. 4*).

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 (*Fig. 3*). 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.

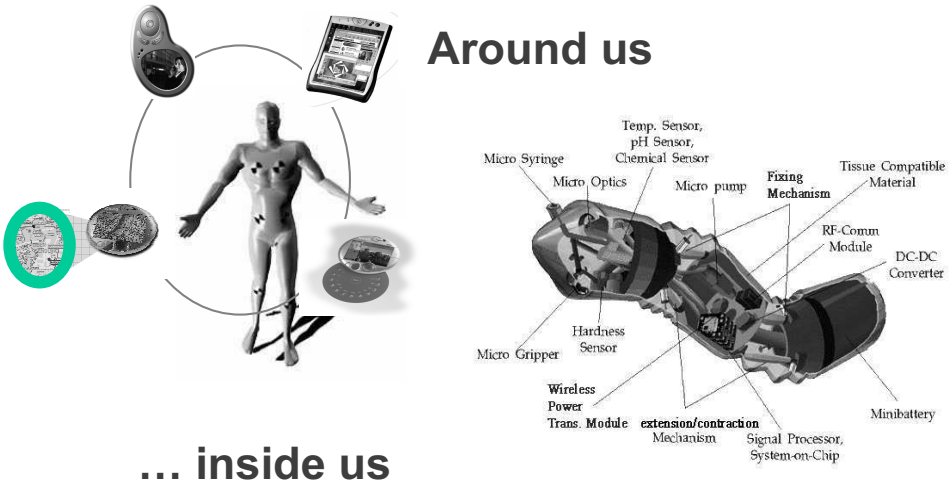


Fig. 3: Health Care Systems becoming pervasive / ubiquitous

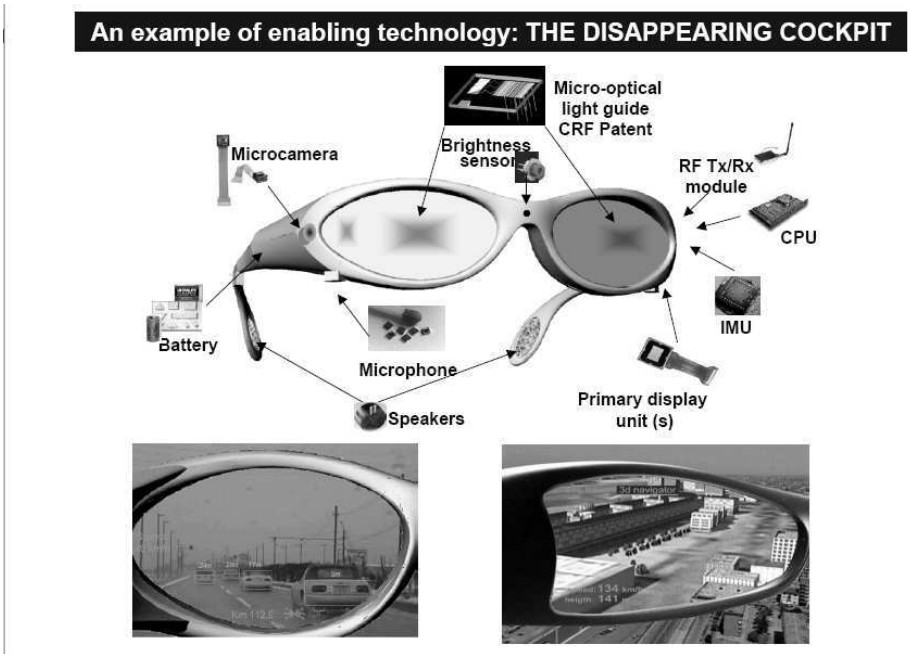


Fig. 4: Hidden Computing – embedded vision and driver support systems (Fiat (CRF) patent)

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 – this is called “ubiquitous computing”. The failure of these systems can have and often has considerable financial, social and health consequences. In these cases we speak of software-intensive systems [27].

We have to be aware, that Systems are NOT always safety-critical by definition – often the actual criticality and dependability levels rise based on our desire for enhanced reliance on them!! (Human Factors – 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, sometimes system evaluation was not done properly, and severe impacts have been overlooked – one example is 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. by inserting 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. After 9-11, we have to take into account malicious actions by intrusion into communications or computer control systems and consider this type of security risks in our safety analysis.

4. Applications and Trends

The AMSD Roadmap for Dependable Embedded Systems [22] has taken into account several application areas, where mass deployment of embedded systems will become critical:

- Automotive
- Aerospace/Avionics
- Railways
- Medical Devices/Systems
- Industrial Automation and Control

Typical for all of these applications, there are certain trends:

- a shift from electro-mechanical to programmable electronics in the systems
- connectivity between systems on a local and global basis (no longer isolated), integration of systems on several levels

- a shift from purely human responsibility and activity to more automation with goals such as more safety, more efficiency, more comfort and services, new functionality and devices (vision driven).

Initially, safety was the only critical issue to be looked at (safety-driven visions), but increased connectivity and interaction with higher layers of overall "systems of systems" (e.g. traffic/transport) and more access points (e.g. for diagnosis and maintenance, error correction and upgrading) enforce a more security-driven approach: Security has severe safety impact!

Since automotive industry is the driver for safety-critical, advanced application of embedded systems with extremely high impact on the public and economy (mass deployment, cost driven), this sector is chosen as an example.

Already now, in cars of the upper class, there are about 80 ECUs (Embedded Computing Units) and five or more bus systems, controlling comfort as well as safety critical functions. Most of the innovations (80-90%) in cars are ICT-driven, especially product individualization and differentiation are based on ICT. The cost of electronics and software in such a car will rise from 25% to more than 40%. On the other hand, according to reports at the 2003 informatics conference in Germany, 55% of car failures are caused by electronics and software, and the "X-by-wire" implementation plans had to be delayed by major players in the field by years. Diagnosis and maintenance in the field are again a challenge – because of complex electronic systems.

Automotive is clearly the "driver" in this area:

- cost-driven (clear goal: "from supply chain to design chain", to build consistent dependable systems from components of many different suppliers) and
- requiring mass-deployment capabilities for critical (sub-) systems composition ("aerospace safety at automotive cost"), and
- with a clear overall vision: "accident-free driving", and as
- ultimate goal: "Autonomous Driving" (at least on specialized highways and lanes)

Automotive is an exquisite example for a long term vision in the area of critical applications, because the potential for networking to build adaptive systems on several levels of connectivity, which requires the full set of dependability attributes to be fulfilled (safety, security, reliability, availability, maintainability) in a holistic manner, is already there, although the gaps are at the moment bridged by human interaction only:

- on-board embedded systems, vehicle-bound connectivity
  - advanced comfort functions (car body electronics, noise suppression, configurable cockpit, navigation, communication, information)
  - Safety Enhancement
    - Vehicle dynamics (ABS, ASR, ABC, ESP (Electronic stability program), AAS (Active additional steering), adaptive cruise control road tire friction control),
    - Advanced Warning and Control (pedestrian protection, crash avoidance, lane support, track control)
    - Driver Monitoring, predictive driver assistance, emergency call system
- extending autonomous on-board functions with interactive and co-operative systems [8]
  - roadside embedded systems and interaction (e.g. intersection control, speed control, automatic advanced emergency call systems)
  - Vehicle-to-vehicle communication (advanced adaptive cruise control, traffic throughput optimization)
- Global connectivity: Integration into regional traffic navigation and control, satellite bound global connectivity

A simple example will highlight the security issue (from a presentation of DaimlerChrysler at SAFECOMP 2004 in Potsdam, [10], *Fig. 5*): 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.

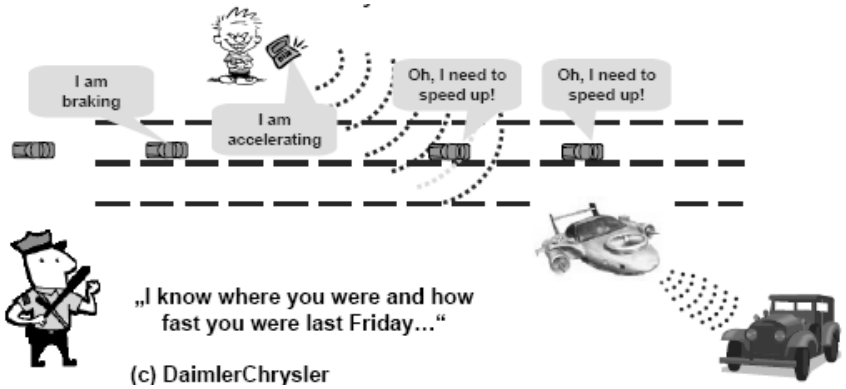


Fig. 5: Security breaches endanger safety and privacy (from [10])

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 [10]).

- 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, [11]), 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!).

5. Safety and Security: Two sides of a coin?

As already stated, security very often has safety impact, and vice versa. But there exist two separated communities at the moment, with different traditions, standards, methods, almost ignoring each other.

The generic standard of the safety community is IEC 61508, 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 in progress). But this standard takes only the safety view, security is not even mentioned!

IEC 61508 is already in the maintenance phase, working groups MT12 (software) and MT13 (systems) are working closely together. In MT12, a task group JTT4, Remote Access and Security [12], tried to integrate the security issue into IEC 61508, giving advice on how to include security issues into the IEC 61508 life cycle, especially on the analysis and functional allocation level. IEC 61508 defines so-called SILs (Safety Integrity Levels), for complex systems "Criticality Levels". On the other hand, the relevant Security Standard ISO 15508 (Common Criteria) uses so-called EALs (Evaluation Assurance Levels). The task group did not succeed to define a consolidated view on these different approaches to define system dependability.

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.

Unfortunately, the committee decided not to take into account in-depth considerations on security in the new standard draft. The security issue was delegated to another committee of SC65, to SC65C, WG 13, Digital Communications, Cyber Security [13], and the chairman of JTT4 became member of this committee. Unfortunately, this committee was not at all interested in safety, only in communications and cyber security. Here again, both "worlds" kept themselves separated!

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). From the dependability point of view, requirements could be derived for security features and profiles depending on the SILs required for safety. Allocations could be done not only between HW, SW and components on functional level with respect to safety but with respect to security also. But interaction and discussion would be necessary! (Note: The aspects of "multilateral security" could be correlated to SILs according to [8]).

In industry, independent work was started in the meantime to define "Security Profiles" for Avionics by CAA (Civil Aviation Authority) [3] and the US Industrial Automation Group PCSRF – Process Control Security Requirements Forum ([4], [9], [18], [19]), 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 [26].

Unfortunately, the gap has not been spanned by these approaches. As far as I know, only JRC Ispra has once financed a project of EWICS TC7 (European Workshop on Industrial Computer Systems, TC7, Safety, Reliability and Security, an expert group in this area), on "Study of the Applicability of ISO/IEC 17799 and the German Baseline Protection Manual to the needs of safety critical systems (March 2003)(www.ewics.org)" [23], where the gaps between the security standards and the safety-related system evaluation requirements have been analyzed for several sectors (medical, railways, nuclear, electric power networks) and in general.

The author was member of JTT4, and has similar experiences from research projects in the area of dependable systems, where it was either very difficult, under cost-pressure and funding priorities, to

include certain security aspects besides the safety related issues, or, after reduction of funds, the work package was deleted where the security modelling aspect should have been added to the safety-related part. Nevertheless, at the end an annex explaining the need for assessing safety risks which could be caused by security breaches was added, with adequate reference in the main part on risk and hazard analysis which provide the basis for safety functions allocations. In the mean time, triggered by homeland security and fear of cyber-terrorism, several industrial standardization groups (IEC 62443, originally IEC TC 65 WG 10, now managed by ISA99 WG 4, and security profiles for bus communications, SC 65C WG 13, IEC 61784-4), have become active and proposed standards in their domain covering security issues in industrial control systems.

6. Merging Views: an example for a holistic approach

6.1. The Approach of IEC 61508 – the Safety view

To understand the underlying principles of IEC 61508, *Fig. 6* 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

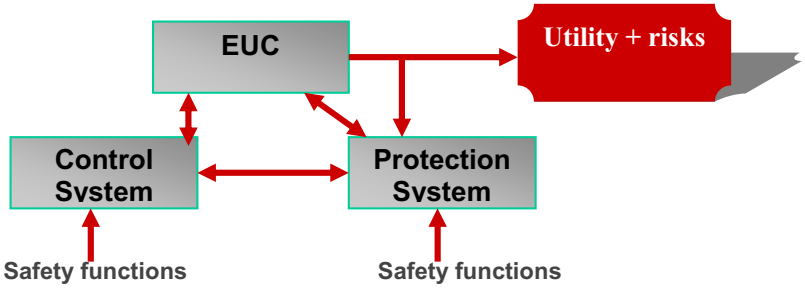


Fig. 6*:* IEC 61508 – Equipment under Control

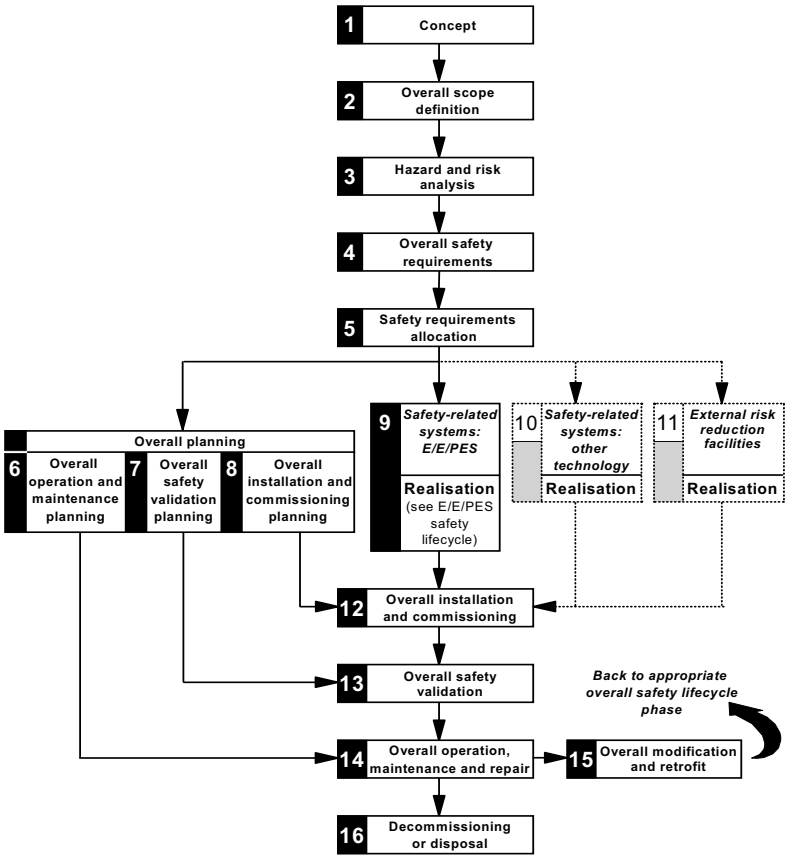
To fulfil these goals, the standard requires:

- 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.



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.

Fig. 7*:* IEC 61508 – the IT/DES Safety Life Cycle (from the IEC 61508 Standard)

To structure guidance, IEC 61508 proposes a well defined safety life cycle (*Fig. 7*).

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 (Security: EAL-Evaluation Assurance Level? Correlation to SIL?)
- The safety requirements specification defines the safety requirements necessary for risk education
- Carrying out safety planning ensures a methodical and auditable approach

Is this a safety view only? The following chapter will provide some insight in the proposed unified approach to dependability of safety – critical systems, taking security into account.

6.2. The Unified Approach to IEC 61508–the Security view

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 [25].

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.)

⇨ What hazards does the system pose?
⇨ What are their possible causes and consequences?
⇨ What is the likelihood of their occurrence?
⇨ What are the risks associated with each of the hazards?
⇨ By how much do we need to reduce the risks

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 is proposed (*Fig. 8*):

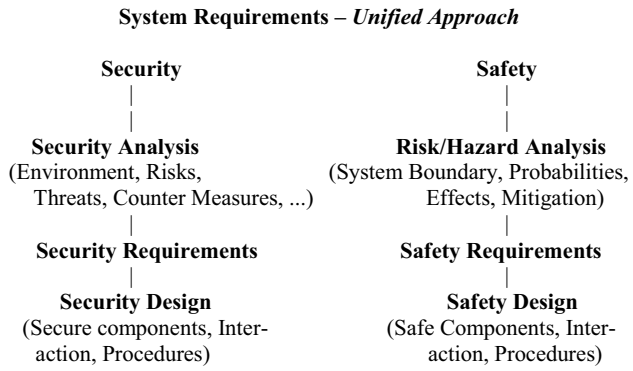


Fig. 8: System Safety & Security Life Cycle - Unified Approach

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, which could be a proposal for a new version of IEC 61508 (with focus still on safety), 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. IT – 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>, Fig. 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>)

7. System Analysis and Evaluation: Integrating humans and environment

A typical example for complex systems integrating sensors, actors, communication on different levels and humans as active part are traffic management systems (as provided and operated by road infrastructure operators, like ASFINAG in Austria) coupled with advanced driver assistance systems as provided by car manufacturers. Here we have a similar situation as in case of safety vs. security: Both communities have their suppliers and supply chains, each of the communities works almost independent: Road operators and traffic management are interested mainly in vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle communication, thus providing a more global view of the situation. On the other hand, car manufacturers work either on their single-car only systems (in car sensors and actors) or on car-to-car (C2C) communications (see *Fig. 5*), organized in a separate consortium.

A holistic view is required to get the best of all for an efficient and sustainable road traffic system: in-car only systems will help avoid or reduce consequences of local impact, and in-car data on a

regional scale will help to optimize traffic flow – that this is not common understanding was evident in a panel discussion of a DECOS/ERCIM/COOPERS workshop at SAFECOMP 2007, where representatives (technicians) of car manufacturers doubted the usefulness of a more regional traffic management approach – "Couldn't this be done by C2C communication only?".

The project COOPERS ("Co-operative Systems for Intelligent Road Safety", www.coopers-ip.eu) is one of the European Research Projects trying to close this gap [21] (see *Fig. 9, Fig. 10*).

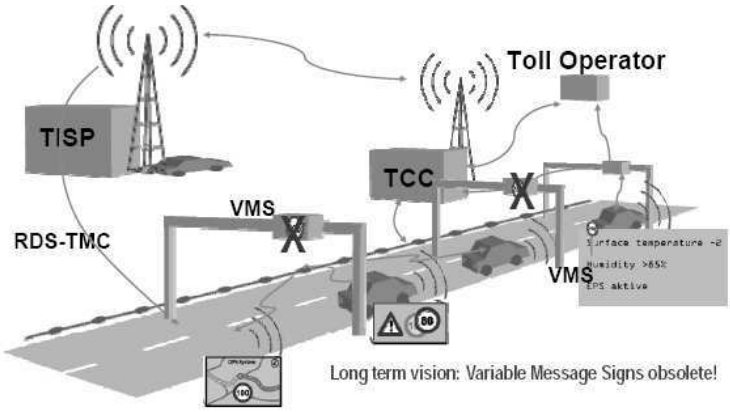


Fig. 9: COOPERS Vision: Intelligent traffic management via V2I and I2V communication, On-Board Unit as Human Interface

As described in [21], the Integrated Project COOPERS (Co-operative Networks for Intelligent Road Safety), co-funded by the European Commission under contract IST-4-026814, aims at developing co-operative systems' based innovative telematics applications to increase road traffic safety. The long-term objective is enabling co-operative traffic management by implementing intelligent services interfacing vehicles, drivers, road infrastructure and highway operators. These services have different levels of criticality and safety impact, and involve different types of smart systems and wireless communications. For safety-critical electronic systems in general, the generic international standard IEC 61508 or an equivalent has to be applied. Therefore, in the initial phase of the COOPERS project a RAMSS analysis has been carried out on road traffic scenarios, services and communications. One of the major problems faced during the analysis was in this early phase the lack of knowledge regarding the implementation of the system. To cope with this problem, a holistic approach has been chosen to investigate the complete co-operative system and identify the potentially most critical parts of COOPERS. Analysis included all objects and subjects in the signal

path. Two bottlenecks were identified: The radio link and the driver interaction (via OBU, On-Board Unit). The recommendations were:

- COOPERS Services have to be tolerant against communication failures
- Special care has to be taken concerning user interaction and the HMI

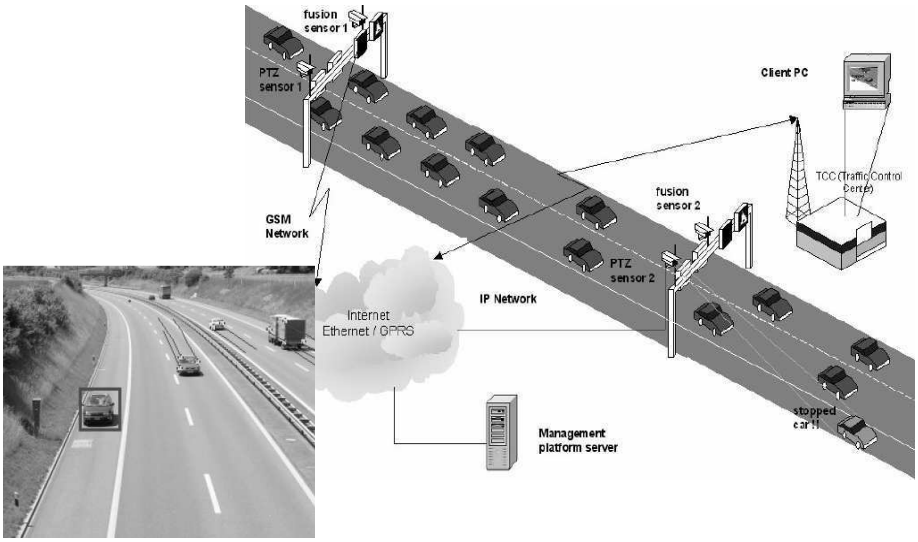


Fig. 10: COOPERS Vision: each car is a sensor and information/communication platform, the TCC a sensor management platform

The analysis concerned communications on the one hand, which is a critical factor for a system based on wireless information transfer, analyzing all available communication infrastructure in central Europe (from DAB to GSM, micro wave and infra red as used for tolling systems), taking into account different scenarios (flat country side vs. mountain highways and tunnels in the Alps or city highway traffic with frequent entries and exits). On the other hand, the HMI via the OBU (On-Board Unit) was analyzed as the other critical element in the system according the 4-stage model of human information processing [29]. The risks of the HMI, resulting in wrong driver reaction, are:

- Information delayed
- Confusion through information overload
- Visibility issues (direct sunlight, glare)
- Misunderstanding displayed information (language, symbols, ...)

- Lack of clarity, ambiguity (slow understanding process)
- Non-intuitive interface (difficult handling)
- Driver distraction (e,g, video playing)
- …….

Additional, the EC recommendations of 22 Dec. 2006 on safe and efficient in-vehicle information and communication systems had to be observed, as well as some existing national regulations. A working group was established, with representatives from different stakeholders, to agree on recommendations.

Some of the important recommendations are:

- Size of display: 5 – 7 " maximum (larger ones may hamper sight)
- Graphic colour display (8 bit sufficient)
- Touch screens better for more complex decisions than hard buttons
- No remote control: may be misplaced
- Human field of view and text recognition capabilities to be considered
- Location of display: it takes more time for accommodation to look down than to look aside. So a location *on top of the dashboard* is to be *preferred* to a lower location.
- Symbols better than text; Vienna convention on traffic signs allows some variability – to be configured
- Static symbols preferred – moving or animated symbols only if meaningful or in emergency
- Reduce driver distraction – minimize information flow, critical messages different from non-critical ones (audio, animation – not haptic, source difficult to identify!)
- Audio: mute function, simple warning tones or simple speech.
- Visibility and contrast – special screens for automotive use recommended (not PC flat screens)
- Software requirements (to be validated by simulation):
    - The number of symbols on the display in the car shall never exceed five
    - Symbols for hazards shall be displayed twice as big as speed limit w.r.t. area of the bounding rectangle (1.41. times length and width). Acute hazards are: weather condition warning, accident warning, ...etc.
    - Symbols on the display in the car shall never obscure one another
    - The symbols on the display in the car shall be equal to the Vienna Convention 1968 traffic signs.

- The speed limit symbol shall always appear at the same fixed position, which must not be occupied by hazard warnings, and the space for hazard warnings shall not be occupied by a speed limit sign.
- The driver shall be able to control the loudness at least by switching the acoustic warning off. He should be able to adjust the level.
- Information should be presented to the driver about current status, and any malfunction within the system that is likely to have an impact on safety must be reported to the driver by a visual and an acoustic message.
- Etc.

This analysis was done before the design of the OBU and the communication so that the results can be implemented and be validated, respectively requirements changed according to validation results. The overall goal was to avoid any impairment of safety by COOPERS equipment and handling, so that the full potential of the planned services can be utilized. The intended services are:

- S1. Accident/incident warning
- S2. Weather condition warning
- S3. Road works information
- S4. Lane utilization information
- S5. In-vehicle variable speed limit information
- S6. Traffic congestion warning
- S7. ISA (Intelligent Speed Adaptation) with links to infrastructure
- S8. International service handover
- S9. Road charging to influence demand
- S10. Route navigation – estimated journey time
- S11. Route navigation – recommended next link
- S12. Route navigation – automatic road map update

8. 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. Two examples, from the security area as well as from the co-operative systems area, have been selected to describe the issues how different communities

of different economic and technical interest have to co-operate to achieve the best solution in the long term. In each example, at least two communities have to interact, communicate and find an integrated solution at the end. 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, and an example of assessment of a co-operative system, including the human, is described. These examples demonstrate the need for systems engineering approaches, complementing software or hardware IT-related engineering, being only part of the game.

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DEPENDABILITY OF THE INFORMATION SOURCES

Jan Čapek[1]

Abstract

The contribution deals with problem of obtaining trustworthy data from information sources for next processing in numerous systems. For example decision making systems, warehouses, control systems, etc. Generally we differentiate operating and failure states in a status space of an information sources system. The status space of failure states is divided into safe and, dangerous failure states. It is used in a majority system of information sources.

Key words: dependability, reliability, confidentiality, information sources system, safe failure state, dangerous failure state, trustworthy information.

1. Introduction

The contemporary world is without any doubts based on using information's from plenty of information sources. It focuses on information activities – like Information Needs, Seeking and Use (INSU) – on various professional and other everyday life settings.

There are very few INSU studies that are based on individual tasks. Most studies, and especially those which relate INSU to task complexity, have considered the phenomenon studied on the basis of jobs (i.e., as a host of certain tasks) (e.g., Tiamiyu, 1992; Culnan, 1983, Hart & Rice, 1991; Van de Ven & Ferry, 1980). In this respect, the present study covers an area that has not previously been addressed within INSU research. Since no conceptual model concentrates sufficiently clearly on the aspects of tasks and INSU, one was created to serve the present work (Byström & Järvelin, 1995; Byström, 1996; Byström, 1997, Byström, 1999).

An illustrative pyramid diagram according Byström, 1999 for the information activities is presented in Figure 1. Each corner of the pyramid represents one of the four main dimensions emphasised in information activities. One corner of the pyramid is occupied by the *means* of information seeking

[1] Institut of System Engineering and Informatics, Faculty of Economics and Administration, University of Pardubice, e-mail: capek@upce.cz

(e.g., information systems, information services, information seeking channels and information sources), another by *information* (e.g., type of information, content of information, usability of information), a third by *individuals* (e.g., cognitive styles, information seeking styles, information profiles, and demographic factors), and a fourth by *contexts* (e.g., aspects of work organizations, jobs, individual tasks, and everyday life situations).

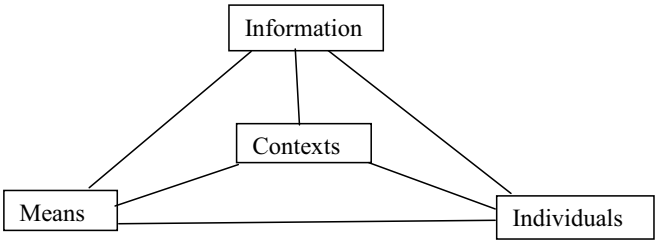

Fig. 1 Information activities

In the following sections we focus our attention on one corner of this pyramid, only. The selected corner is *means* of information seeking and from this problem point of view it is information sources.

Nowadays the information sources are usually access able through the computing systems which serve from this point of view for both, the acquisition and storage information.

2. System - Dependability and Reliability

A system is a set of members (systems elements), which are bound by some relations between these elements. Each system is defined by its behaviour and structure. The inputs boundary elements of system are for example information sources. The safety system is as safe as is each element of this system. The technological leaps of the past decades in computers, electronics, optics, and advanced, high-performance, complex control systems have created the need for extra reliability and safety. An underlying feature of all "safety critical" systems entails a reliable fault-detection (and of then isolation and reconfiguration) system." Both, the conventional methods of fault detection, such as use of regular limits, trend checks, signal analysis and so on and nowadays applications of the control theory algorithms on modern digital computers and microcomputers supposed using the errorless or trustworthy information's from information sources. (Smutny 1996). For the reason, we focus our future steps into these boundary elements of system – information sources. First of all is need to notice that the term reliability according the IEEE (Wikipeida 2008) defines the *Reliability*

as ". . . the ability of a system or component to perform its required functions under stated conditions for a specified period of time.", began to be become overloaded and was being used outside of it's originally intended definition, as a measurement of failures in a system, to encompass more diverse measures which would now come under other classifications such as safety, integrity, etc.(Randel 1995). Jean-Claude Laprie thus first used the term *Dependability* to encompass these related disciplines in the early 1980 (Wikipeida 2008).

Avizienis et al (2001, 2004) showed that the general, qualitative, definition of *dependability* is: the ability to deliver service that can justifiably be trusted (Figure 2). This definition stresses the need for justification of trust. The alternate, quantitative, definition that provides the criterion for deciding if the service is dependable is: dependability of a system is the ability to avoid service failures that are more frequent and more severe than is acceptable to the user(s). As developed over the past three decades, dependability is an integrating concept that encompasses the following attributes:

- **availability**: readiness for correct service;
- **reliability:** continuity of correct service;
- **safety:** absence of catastrophic consequences on the user(s) and the
- environment;
- **confidentiality:** absence of unauthorized disclosure of information;
- **integrity:** absence of improper system alterations;
- **maintainability**: ability to undergo, modifications, and repairs.

Security is the concurrent existence of

a) availability for authorized users only,

b) confidentiality, and

c) integrity with ‘improper’ meaning ‘unauthorized’.

The dependability specification of a system must include the requirements for the dependability attributes in terms of the acceptable frequency and severity of failures for the specified classes of faults and a given use environment.

2.1. The Means to Attain Dependability

Over the course of the past fifty years many means to attain the attributes of dependability have been developed. Those means can be grouped into four major categories:

- **fault prevention**: means to prevent the occurrence or introduction of faults;
- **fault tolerance**: means to avoid service failures in the presence of faults;
- **fault removal**: means to reduce the number and severity of faults;
- **fault forecasting**: means to estimate the present number, the future incidence, and the likely consequences of faults.

Fault prevention and fault tolerance aim to provide the ability to deliver a service that can be trusted, while fault removal and fault forecasting aim to reach confidence in that ability by justifying that the functional and dependability specifications are adequate and that the system is likely to meet them.

Taxonomy showing relationship between Dependability & Security and Attributes, Threats and Means (after Avizienis, Laprie, Randell, and. Landwehr 2004)

As the definitions of the Availability, Reliability, Safety, Confidentiality, Integrity and Maintainability suggested, only Availability and Reliability are quantifiable by direct measurements whilst others are more subjective. For instance Safety cannot be measured directly via metrics but is a subjective assessment that requires judgmental information to be applied to give a level of confidence, whilst Reliability can be measured as failures over time.

Threats are things that can affect a system and cause a drop in Dependability. There are three main terms that must be clearly understood:

- Fault: A fault (which is usually referred to as a bug for historic reasons) is a defect in a system. The presence of a fault in a system may or may not lead to a failure, for instance although a system may contain a fault its input and state conditions may never cause this fault to be executed so that an error occurs and thus never exhibits as a failure.
- Error: An error is a discrepancy between the intended behaviour of a system and its actual behaviour inside the system boundary. Errors occur at runtime when some part of the system enters an unexpected state due to the activation of a fault. Since errors are generated from invalid states they are hard to observe without special mechanisms, such as debuggers or debug output to logs.
- Failure: A failure is an instance in time when a system displays behaviour that is contrary to its specification. An error may not necessarily cause a failure, for instance an exception may be thrown by a system but this may be caught and handled using fault tolerance techniques so the overall operation of the system will conform to the specification.

It is important to note that Failures are recorded at the system boundary. They are basically Errors that have propagated to the system boundary and have become observable. Faults, Errors and Failures operate according to a mechanism.

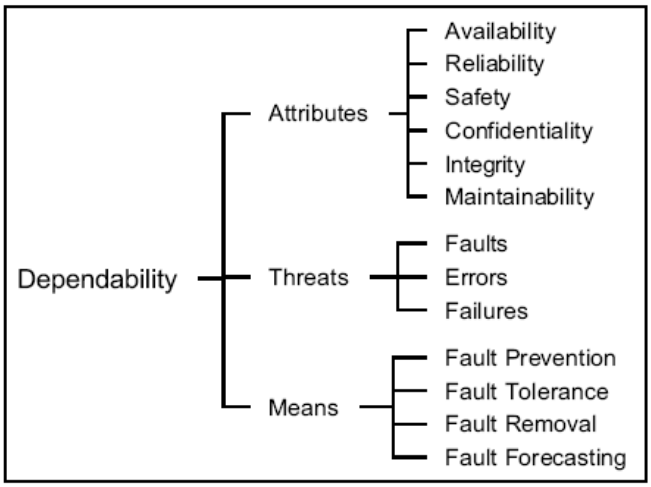

Fig.2 The dependability tree (according Avizienis)

Computing systems are characterized by five fundamental properties: functionality, usability, performance, cost, and dependability. Dependability of a computing system is the ability to deliver service that can justifiably be trusted. The service delivered by a system is its behaviour as it is perceived by its user(s); a user is another system (physical, human) that interacts with the former at the service interface. The function of a system is what the system is intended to do, and is described by the functional specification. Correct service is delivered when the service implements the system function. A system failure is an event that occurs when the delivered service deviates from correct service. A failure is thus a transition from correct service to incorrect service, i.e., to not implementing the system function. The delivery of incorrect service is a system outage. A transition from incorrect service to correct service is service restoration.

3. Model of Safe System

Basically we can divide all systems into two parts. One part should be responsible for data obtaining from the environment (The information sources systems) and the rest of system will be

responsible for the controlling, data maintenance or other system activities as reflect the system environment by means of the actuators (Figure 3).

Generally we differentiate operating and failure states in a status space of a system for data obtaining. In a system transition to a failure state the system either remains in this state (it is an absorptive state) or after repair it is in an operating state again. In the case of the safe system for data obtaining, the status space of failure states is divided into safe and, dangerous failure states. After occurrence of the failure state the system has to transit either to a safe failure state (to manage the failure) or after repair it transits to the last regular state.

For our system for data obtaining we can use known quantities from the information theory, such as entropy and mutual information, which enable to establish sufficient number of state variables to describe the behaviour of a given system.

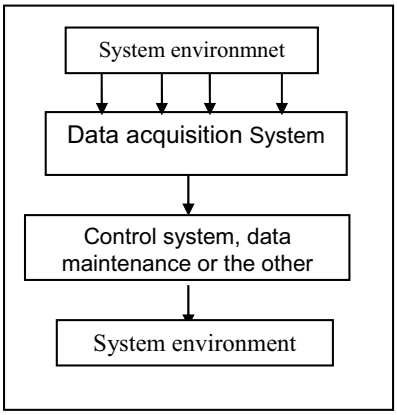

Fig.3. Division of the System into two main parts.

3.1. Data Acquisition System

It is supposed that in the system for data obtaining from Fig.1. is included more information sources then one, all information sources has the same importance's and information content. If we suppose that the probability of the errorless information source's activity has the exponential division we can obtain following table of reliability set of information sources. For example from O'Connor (1988) one can obtain following table.

Table 1. Reliability set of information sources

Number of information sources	Reliability set of information sources
1	0.8000
2	0.9600
3	0.9920
4	0.9984

From the table 1 is clear, that increasing number of information sources sensing the same quantity and quality leads to the increasing reliability set of information sources, but from the certain number of information sources the output reliability increase slowly. If we use two information sources instead of one, the reliability increase, but it is hardly to possible discover which of those information sources has valid information, when one of them has nontrivial error. From this point of view, is clear that the number of information sources must be equal or more than three for possibility of determine not only that all outputs of the information sources are the same, but also determine which element of set of the information sources has error. (Capek 1994).

3.2. Majority system of the set of information sources

The simple majority system of n- information sources is shown in the Fig. 4. It is supposed that we use the minimal number of information sources, i.e. the three information sources. Let we denote the output signal from the first information source $o_{1,}$ from the second information source o_2 and from the last information source $o_{3.}$ The majority of the same output signals from the information sources is supposed be the right value goes from the evaluating algorithm (Capek 2001).

Example: Now we suppose that two information sources give the same right signals. The last information source gives wrong signal. So, if the outputs form the information sources are follows: $o_1 = o_2$ and $o_3 \neq o_1$ is possible suppose that the right value is from the information source N^o 1 and N^o 2.

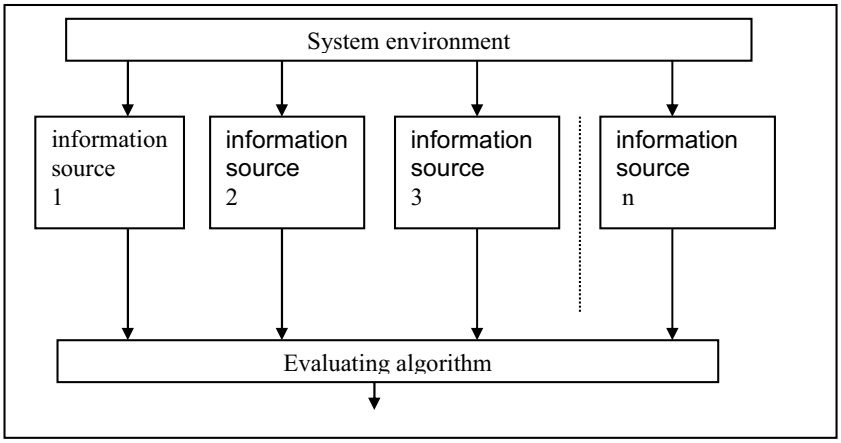

Fig. 4 The simple majority system.

The evaluating algorithm works too simple. The problem gives the nearest output signals i.e. if the all values of signals are different and only one is good. Better results give following major systems with average evaluation algorithm. (Figure 6).

If we denote *a* as average of immediate outputs of set of information sources, we obtain:

$$a = \frac{1}{n}\sum_{i=1}^{n} o_i \tag{1}$$

The wrong information source is recognized from the following differences:

$$\Delta_1 = \left| o_1 - a \right| ; \Delta_2 = \left| o_2 - a \right| ; \ \ldots . \ \Delta_n = \left| o_n - a \right| \tag{2}$$

Example: Again is supposed that the minimal number of information sources, i.e. the three information sources will be used. If is $\Delta_1 \neq \Delta_2 \neq \Delta_3$ and alongside with this fact is $\left| \Delta_2 - \Delta_3 \right| = \varphi$, where φ denote permit error, so the information source N^o 1 is faulty and his information is trust less. For the set of information sources we can make such transformation that we try to transform signals from the information sources into trustworthy information and denoting the possible wrong information source we can transfer the set of information sources into safety systems. (Bariova H., Tomasov,P. 2001) (Figure 5).

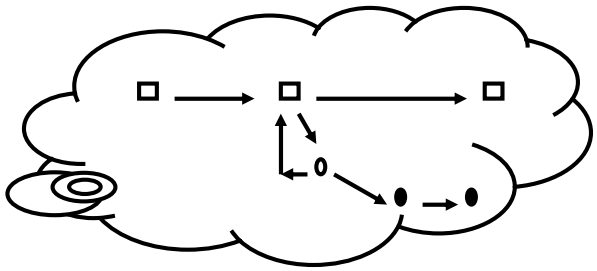

Fig.5 The selection of an appropriate status set of information sources

In the Figure 5 the dot ● denote dangerous failure state, ○ denote safe failure state (only two information sources are in good conditions). The state of information source's system now is changed from the from the safe failure state (2 information sources are good) into the dangerous failure system. (At least one information source is good). If the information sources system is in the safe failure state or dangerous failure state, is need to replace the malfunctioned information sources and bring the information sources system into the regular state. This replacing procedure has difference in time based on the state of information source's system. If the system has safe failure state the replacing procedure should be as soon as possible, in the other case must be immediately done.

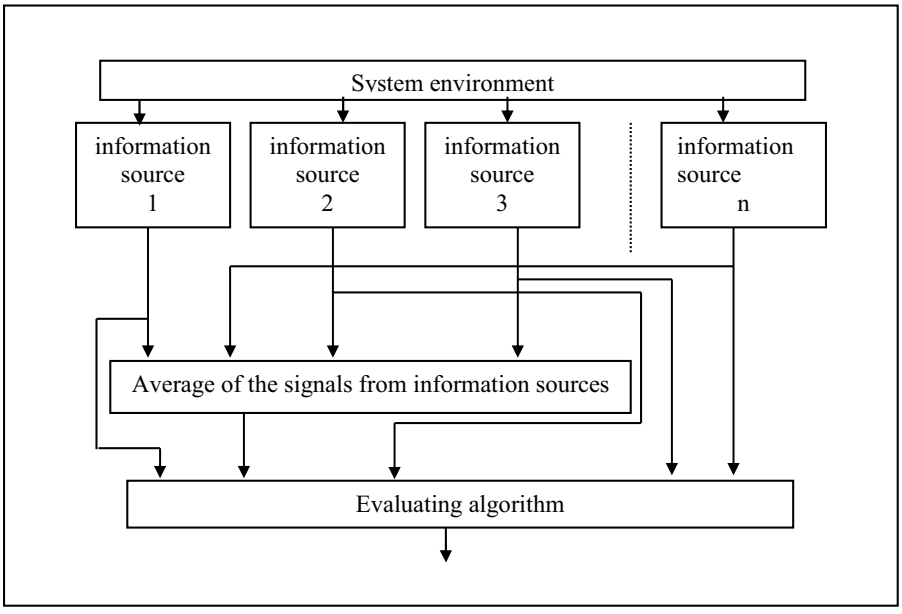

Fig.6 Majority system with average evaluation algorithm

4. Conclusion

In the present contribution was shown that problem of obtaining the trustworthy information from the set of information sources is possible solved by majority system with average evaluation algorithm. If we increase number of information sources we can use for the system of information sources following denotation: safe failure state of set of information sources meaning that one of the information sources is faulty and we need exchange it as soon as possible. The second state is dangerous failure state of set of information sources, in system is at least one information source in good condition, but we have not chance to check it, so the information of this set is no trustworthy. The present contribution do not solve problem of obtaining the same information from different type of information sources Fabian et al (2007) (for example within text documents acquire the same information from different length of document with using different expression of the same information).

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SOFT COMPUTING APPROACHES FOR ACHIEVING SELF-HEALING PROPERTIES IN AUTONOMOUS ROBOTS*

Karl-Erwin Grosspietsch[1], Tanya A. Silayeva[2]

Abstract

To overcome the difficulties of autonomous robots in dealing with complex faults or unknown external situations, in this paper we present a survey and discussion of strategies to base the local control of robot components on the use of adaptive filters. This is carried out for the example of the autonomous hexapod robot OSCAR developed at the University of Lübeck. We describe potential faults and their effect on OSCAR and its trajectories. Then the effect of the adaptive filters for compensating robot faults is presented. The cooperation of several adaptive filters for the faul-tolerant local control in each of the legs of the hexapod robot is sketched. We also discuss the combination of adaptive filters for both fault correction and fault diagnosis. Finally, as an extension, the potential role of fuzzy logic at a higher system control level, especially for dealing with uncertain situation conditions, is sketched.

1. Introduction

Fault tolerance is a well-established methodology to improve the dependability of computing systems [1]. These fault tolerance approaches are usually based on a fault model which describes all expected faults precisely and completely. The fault tolerance techniques are then to cover all these faults as much as possible.

There is a comprehensive set of fault tolerance techniques for different fault classes which is currently used in practical digital system designs. In today's highly complex embedded systems, however, this classical approach usually provides only limited success. The reason is the strongly

* This work was partially supported by Deutsche Forschungs-Gemeinschaft (DFG) under No. Ma 1412/8-1
[1] EUROMICRO, P.O. Box 2043, 53743 St. Augustin, Germany
[2] Moscow Aviation Institute, Volokolamsk Highway 4, 125871 Moscow, Russia

increasing complexity simply with regard to the number even of structurally identical or similar components; additionally, many of these systems are very heterogeneous and have to combine many different components, often including not only digital ones, but also mechanical or other physical components. Especially the interaction and mutual dependencies of these components are very difficult to predict and to formalize by a fault model. This situation is further aggravated in the case of autonomous mobile real-time systems, for example autonomous mobile robots, because here we have the following additional requirements and constraints:

a) usually there are strict time bounds for the required system reaction;

b) the system has to autonomously decide about its movements in an – often only partially known – environment;

c) in most applications there is no possibility of a continuous online fault diagnosis for the system.

These problems and principles of efficient fault tolerance for autonomous robots were studied by us by the example of the autonomous hexapod robot OSCAR developed at the University of Lübeck. The OSCAR robot has six legs and a round body, which allows it to move in any direction. The six legs are symmetrically placed, i.e. we have one leg every 60 degrees and each leg has 3 degrees of freedom. As a result of this symmetry of the robot body, it does not have a preferred front side. Each leg has three joints: one connecting it to the central body, one knee joint and one ankle joint. So the entire system exhibits 18 joints each moved by an associated servo motor.

The analysis of fault effects and their compensation was systematically studied by simulating the OSCAR robot by means of the robot simulator Gazebo. Gazebo is a multi-robot simulator for outdoor environments. It is capable of simulating a population of robots, sensors and objects, and does so in a three-dimensional world. It generates both realistic sensor input feedback and physically plausible interactions between objects since it includes an accurate simulation of rigid-body physics, i.e. robots in the simulation can push things around, pick up things, and generally interact with the world in a plausible manner.

2. Faults and their Effects on Hexapod Robots

The gait of an autonomous hexapod is always complicated as compared to a vehicular robot, simply because it involves a creature-like movement. Of course, when a realistic motion behaviour is designed for such robots, we also have to consider realistic faults occurring in the physical robot

structure. Here, especially the joints between the different parts of a leg are susceptible to internal and external imparities. A hexapod like OSCAR can have imparities due to:

- Aging motors (mechanical friction, low power output, loosening of screws, etc.);
- changing of the moment of inertia of legs causing stresses on their motors;
- material deterioration because of aging due to mechanical stress;
- noise in communicating signals from the CPU;
- an accidental situation or an unforeseen error;
- under-performance of the battery/power-pack;
- electrical faults in the circuitry.

We systematically investigated the resulting functional faults, occuring in the leg components of OSCAR and what effects these faults had on the robot when it moved from one point to another [2]. The following faults were studied:

- Slow response of an ankle or knee joint;
- gradual degradation of an ankle or knee joint;
- abnormal behavior of an ankle or knee joint;
- jamming of an ankle or knee joint;
- improper orientation of a leg;
- extra weight on the robot body due to load;
- vibrations in a joint due to noise in the motor.

Here e.g. slow response of a joint implies that due to friction either in the joint or in the associated servo motor, the requested motion of the joint can fully be carried out, but takes more time. Special subcases might arise if the slowing down effect is symmetrical or not, i.e. identical for the different directions of movement, or shows here differences.

The graceful degradation case denotes the situation where the requested angle movement of a joint cannot be fully carried out any more. Abnormal motor behaviour of a joint is given, if the motor can rotate only in one of the two possible directions, and the rotation into the other direction, e.g. by stuck-at faults in the command bits, is erroneously changed into the opposite direction. Jamming is the less aggravating situation that in one direction, the rotation is simply stuck. As examples, Fig. 1 and 2 illustrate the deviations of robot trajectories due to ankle/knee jamming.

Here, Fig. 1 shows the relatively slight changing of the hexapod´s trajectory, if an ankle joint is failing. Much more aggravating effects occur when the servo motor of a knee joint is failing (see

Fig. 2). In the shown example not only the trajectory is stronger curved, but also the direction of the curvature is opposite to that one of the fault-free hexapod.

Fig. 3 depicts cases of dislocated joints during the motion of the robot. It is shown by means of the 3-dimensional physical model of the OCAR robot, realized in the Gazebo simulation. This is just a snapshot; it should be noted, however, that Gazebo is quite powerful in producing a dense sequence of such snapshots, thus simulating a realistic 3-dimensional movement of the robot, by means of Gazebo´s Physics Engine. Fig 3a and 3b show cases where none of the foots is sufficiently perpendicular, which might cause increasing instability in the next simulated movement steps. Fig. 3c represents an accidental situation where no further movement of the hexapod robot is possible. This is represented by a picture where the robot is lying on its back; in reality the orientation of the robot body might be different.

Fig. 4 shows changes/disturbances of a leg position of OSCAR, due to heavy loads posed on the robot as depicted. It can be seen that the rising simulated weights on OSCAR tend to cause an insufficient vertical orientation of the legs, comparable to the horizontal bending of a human leg, if overloads are placed on it.

Small weights below 10 kg only slightly affect OSCAR´s gait. With loads of the order of 20 kg little instabilities can be observed in the gait. Loads of 30 kg and more lead to instability and loss of balance already a after short path. With loads of 100 kg the robot cannot lift up itself. Even for the cases, where the gait shows characteristic changes, the deviations in the trajectory are only slight[5].

3. Fault Compensation by Adaptive Filters

3.1. Basic Properties of Adaptive Filters

For solving control problems, recently adaptive filters [3,4] have gained growing interest and importance, especially in the field of controlling systems under real-time requirements. Adaptive filters are based on an algorithmically simple form of using a history array of the sensed values of an input variable x to derive, by some kind of weighted summing up of these values, the actually needed output control signal y. The basic strategy of adaptive filters is 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. The most widely used class of adaptive filters are the so-called Least Mean Square (LMS) filters.

The operation mode of the LMS filter 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:

$$y(n)= \sum_{i=0}^{N-1} wi\,(n) * x(n-i)$$

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. Thus, the structure of the adaptive filter is a one-dimensional scheme where the history array, as in a shift register, is shifted along the array of the weight factors; coinciding terms are multiplied and added up. For a more detailed discussion see e.g [4].

3.2. Application of Adaptive Filters for Compensating Faults in Robot Leg Components

We systematically derived adaptive filters to compensate fault effects of the different classes mentioned above.

In the case of slow motor response the remedy is to train the adaptive filter to trigger the servo motor of the joint to higher performance values than originally requested, so that the commanded quicker rotation of the motor compensates the intrinsic slowness of the joint movement. I.e., if the motor degrades with time, the controller upgrades its response to nullify the effect. An advantage of using this scheme is that if the error between the desired and the actual sensor values is zero, the controller does not take any action, otherwise it provides the necessary compensation. So the adaptive filter “blindly” corrects the fault. It turned out to be possible to extend this technique also for compensating most other faults mentioned in section 3 [5].

There are three special cases which need a different fault handling strategy:

1) If a robot leg is dislocated, the robot has to be stopped, and all joints have to be reset to the orientation of a passive waiting state.

2) Faulty ankle behaviour can be compensated quite successfully by appropriately moving the knee joint of that leg. This is controlled by a correspondingly trained adaptive filter.

3) The most aggravating fault case is jamming of a knee joint, as this cannot be compensated by movements of the other joints of that leg. Here only a concerted action, i.e. a cooperation with the other robot legs might solve the problem. To manage such an action, either a training for such a scenario by means of a neural net controlling the legs, or the carrying out of a classical control procedure at high system level is necessary.

The handling of these special cases was integrated with the basic adaptive filter solution mentioned above. So for the for the different joints (and their associated servo motors) of one robot leg, we succeeded in forming one coherent Leg Component Fault Tolerance Layer dealing with faults in this leg. The general strategy of this layer is that first it is checked whether legs are disoriented; this is corrected as described above. Then the use of the trained behaviour of the three adaptive filter controllers (each associated to one joint) of each leg for standard fault compensation is utilized. If a fault situation of the ankle of a leg still is detected, then an attempt is made to correct that by means of appopriately moving the neighbouring knee joint of that leg, as mentioned above, under the control of the special adaptive filter trained for that purpose. As all the adaptive filters mentioned here are carrying out a corrective function, they also shall be called corrective filters.

So, with regard to the trajectory deviations shown in Fig.1 and Fig. 2a, the result of the fault compensation by the adaptive filters is that in the case of fault practically there is no difference to the trajectory of the healthy robot.

To summarize, the main advantages of this correction approach by adaptive filters are:

- the fault model can be confined to a relatively rough simple “macroscopic” model, i.e. faults of the interior of a leg are diagnosed just by means of the macroscopic trajectory behaviour of the robot;
- for evaluating the control parameters of the compensating algorithm we do not need expert knowledge about the detail structure of the considered component; instead we only need a phase of blind training during a “healthy” period.

4. Fault Diagnosis by Means of Adaptive Filters

Mostly, adaptive filters have been proposed for “blindly” compensating faults, thus establishing a fault masking procedure as involved also in other methods of static redundancy, as e.g. triple-modular redundancy or n-modular redundancy [1]. In contrast to these methods, where by massive identical replication of components still a proper behaviour can be achieved as long as the majority of the identical components is still healthy, in our approach, the use of the masking is mostly confined to single faults, i.e. just a maximum of one component fault of that class per leg can successfully be treated by a corresponding adaptive filter procedure.

For more complex faults, especially where two or more legs are impaired, correction steps have to be organized at a higher system level. To do so, however, diagnostic knowledge about the more complex effects would be essential.

So, for these faults, additionally we have considered an approach to enable for those cases at least a diagnosis by means of an adaptive filter [7]; the diagnosis might then be followed by corrective steps carried out at a higher system level. To do so, we used an own, independent adaptive filter for just monitoring the uncorrected state of the leg joint; therefore it shall be called monitoring filter: From the initial behaviour of the leg joint (assumed to be healthy) snapshots are taken; from them a reference model of the considered (healthy) component is extracted.

The coefficients of the monitoring filter are simply trained to reflect the actual state of the component. As in section 3 done for the corrective filters, this is achieved by forming the difference between the filter output variables and the corresponding output parameters of the leg joint, and by adaptively changing the filter coefficients until the difference has been minimized. Thus, the monitoring filter concurrently traces the behaviour of the considered component. Different from the use in section 3, here the filter output is not feeded back to the control of the component [7].

Instead, the output is concurrently compared with the reference model of the component, mentioned above. As long as the component is healthy, no differences are found. When faults are occuring, this is reflected by a difference between the output of the monitoring filter and the reference model.

So, for the example of a servo motor, during runtime of the motor, the monitoring filter then compares the uncorrected values of motor signal variables (their values taken before entering the corrective filter) with that reference model; i.e. we are monitoring the actual motor, and not that one influenced by a corrective control loop. Doing so, here the adaptive filter is trained to recognize different deviation patterns as profiles of different faulty motor states.

So, as a result, one possible evaluation strategy is that a general fault alarm is triggered which then might raise more detailed diagnostic procedures. Moreover, as a very promising result it has turned out that different faults produce also quite different patterns of the values of the monitoring filter coefficients. Thus, there might be the possibility of directly (in the best case again blindly, i. e. without further computational overhead) deriving diagnostic conclusions from the coefficient patterns. First examples of such parameter value patterns and their distribution in time can be found in [7]. Still it is one focus of current research to derive here more general classification schemes.

5. Combination of Monitoring and Correction of Faults

It is also possible to combine the use of monitoring filters and corrective filters. This might be important if we want to cope also with faults that cannot be successfully compensated by the corrective filter. In this case we might have a division of the fault handling tasks: Local (usually simpler structured) faults are also locally treated, by blind compensation, by means of the corrective filter, directly associated to the considered component. Additionally, a higher system traces the patterns of the monitoring filter and decides whether additional correction steps have to be triggered.

With regard to the interaction between the corrective filter and the monitoring filter two possibilities are existing: If as input to the monitoring filter we take the output variables of the component to be diagnosed, the feedback loop to the component controller and its corrective filter would – by construction – also influence the input to the monitoring filter; i.e. the monitoring filter concurrently diagnoses the component behaviour after compensation of local faults. This might be useful, if only other faults shall be made apparent, for further evaluation.

If, however, a complete diagnostic insight is to be documented, we can achieve that by selecting a different input for the monitoring filter: We have to utilize the data of the component parameter variables before they are influenced by the controller of the component. I. e. we have to access the initial component parameter values of the requests to the leg joint, before it is changed by the corrective filter. Under this strategy, the higher system level is provided with complete diagnostic information, i.e. also the faults that are being compensated blindly, are documented.

6. Treatment of Uncorrectable Faults

One possible action in case of an uncorrectable leg fault is the “amputation” of the leg; this is done by rotating the upper and lower leg parts to a horizontal anti-parallel orientation (similar in principle to extremely bending the knee of a human leg), thus achieving a passive state where this leg does not disturb the movements of the other legs [6].

In some complex fault cases, where the corrective filter cannot achieve a sufficient long-term compensation, the corrective filter at least can provide some slowing down of the motor degradation; this time-bounded graceful degradation gives then at least some time e.g. for the monitoring filter to diagnose the fault and to trigger higher system levels for responding.

Simulations of servo motors have shown that for cases where the compensating actions of a corrective filter cannot completely avoid the final entering of an unsafe motor state for all the mission time, at least a delay of that timepoint by a certain time amount can be achieved; an extension of the working phase of the motor of the order of 20 seconds is reported [7]. This would provide enough time to either carry out corrective actions at a higher level, or at least to transfer the robot into a safe passive state.

With regard to higher level corrective actions, one possibility would be that this system level tries to carry out a rigorous system diagnosis, especially also with regard to the correct interaction of the legs. Many causes of failure, however, are not detectable without physical inspection where the robot has to be passivated and maybe additionally has to be disassembled to enable access to certain components. Under the requirements of real-time field operation, this strategy quickly reaches its limits.

A second alternative would be to develop neural nets for training complex cooperation among robot parts, especially the cooperation between different legs for dealing with complex fault cases; this is planned by us for a later project phase.

A third soft computing alternative that can be considered for general control, is offered by rule-based approaches, based on incomplete or vague knowledge. Here, fuzzy logic control might be an interesting alternative [8]. Fuzzy logic control is based on the following procedure: In addition to the normal system variables with their “crisp” values, we define a set of fuzzy variables, which “softly” describe a certain behaviour of the system. We associate as values which can be assigned to them, a number of so-called fuzzy (or linguistic) terms. E.g. to the fuzzy variable “speed of robot walking” we might associate fuzzy terms “very quickly”, “quickly”, medium”, “slowly”, “very slowly”. For each fuzzy term, a “fulfilment” function denotes, for all the values of its corresponding crisp variable, the measure of fulfilment of that term. Fulfilment functions with good practical results can e.g. be realized by trianguar functions, symmetrically distributed around a certain mean value [8].

So, a crisp value of a variable - via evaluating its fulfilment degree with regard to a fuzzy term - can be mapped into that fuzzy term. This mapping is possible not only for one term, but for all terms who are depending on that variable. This procedure is called fuzzification.

There are relatively simple mathematical operations for manipulating fuzzy terms and expressing so-called fuzzy relations between them; they are carried out on the basis of comparing the minimum

and maximum values of the fulfilment functions of the terms. For a nice and very lucid description of the details of this calculus e.g. see [8].

By means of relations between the fuzzy variables, rules can be formulated, which together form a rule set. The assignment of fuzzy values to the fuzzy variables (gained from the fuzzification of crisp values of the normal system variables) then allows us to carry out so-called fuzzy inferences, i.e. a concluding process which produces as output fuzzy terms of certain variables.

A process step called defuzzification finally maps the resulting non-crisp fuzzy terms into crisp values which then serve as the real control parameters for robot behaviour. Here, most methods are based on utilizing the coordinates of the center of gravity of the area under the fulfilment function of the fuzzy term as the most practical way to select a "good-fitting" crisp value [8].

As an example of a property which is critical for the robot stability, let us consider the inclination of the robot top, i.e. its angle formed with the horizontal. A range between 0° and 15° shall be classified (with varying fulfilment degree) as "*low*", 15° to 30° as "*critical* " and > 25° as "*dangerous*". I.e. with regard to the mentioned crisp intervals, the fuzzy terms are overlapping.

As a simplified example just for exhibiting main characteristics, behavioural rules might be of the kind

IF inclination IS "*low*" THEN direction := "*continue*" , movement := "*continue*"

IF inclination IS "*critical*" THEN direction:= "*continue*", movement := "*slow*"

IF inclination IS "*dangerous*" THEN direction:= "*reverse*", movement := "*slow*"

For a given crisp angle value, more than one rule might be fulfilled; so also the resulting direction and movement might both be an overlap of their related fuzzy terms. The desired crisp result values for direction and movement are then derived from the area characteristics of those overlaps and their fulfilment functions.

Based on similar general principles, at the University of Lübeck an approach for a fuzzy-rule based robot anomaly detection engine (RADE) is being implemented; in [8] first experiments are reported how to use similar rule sets for diagnosing defect states of servo motors; the characteristics of some fault effects in the servo motors are identified and described by fuzzy logic. Concluding is done in terms of rules formulated on the basis of fuzzy terms. Starting from very simple and basic rules, depending on the implemented robot behaviour additional rules can be added. This extension of the

data base is planned to be automatized. Also, to the rules weights are added which can vary depending on the online experience of the system; so self-adaptation is to be achieved.

7. Conclusion

In this paper, we have described the use of adaptive filters for the correction and diagnosis of faults in hexapod robots. One advantage of this approach is that the fault model can be confined to a relatively rough simple "macroscopic" model, i.e. faults of the interior of a leg are diagnosed just by means of the macroscopic trajectory behaviour of the robot. Moreover, for evaluating the control parameters of the compensating algorithm we do not need expert knowledge about the detail structure of the considered component; instead we only need a phase of blind training during a "healthy" period.

We also have discussed the use of adaptive filters for fault diagnosis, without or with interaction with a corrective filter. It has turned out that the pattern of the monitoring filter´s coefficient values and their distribution in time might allow conclusions with regard to the observed underlying fault effect. Further work will especially focus on this aspect, and on refining the discussed fuzzy logic approach.

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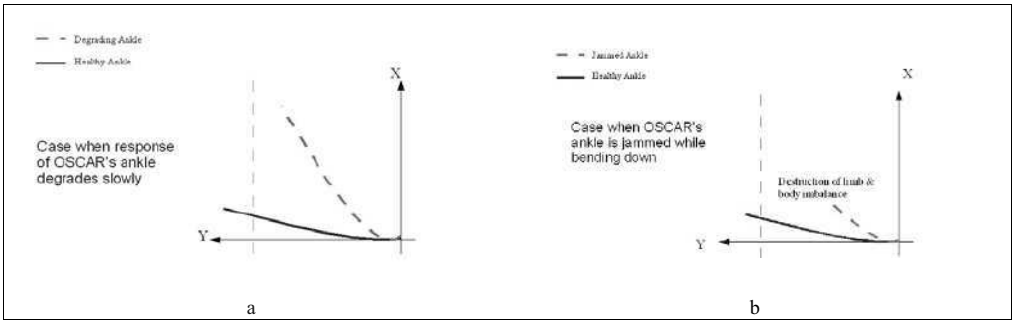

Fig. 1 Robot trajectory in the case that the servo motor of an ankle joint (a) is degrading in time and (b) is fully jammed [5].

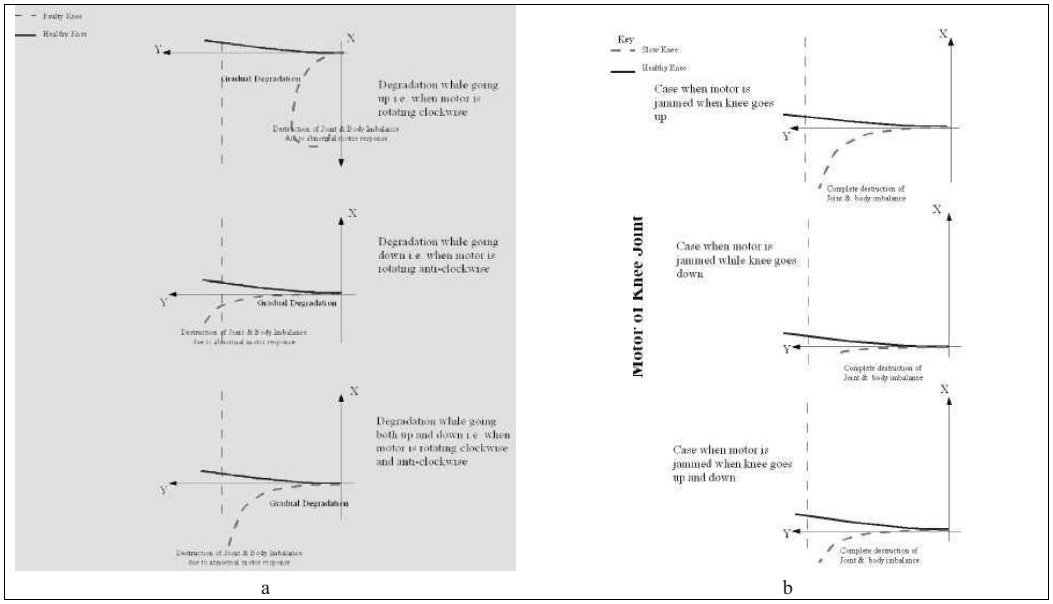

Fig. 2 Robot trajectory in the case that the servo motor of a knee joint (a) is degrading in time and and (b) is fully jammed [5]. It can be seen that the deviation creates even trajectories which, with regard to the direction of their curvature, are very different from those of the healthy robot.

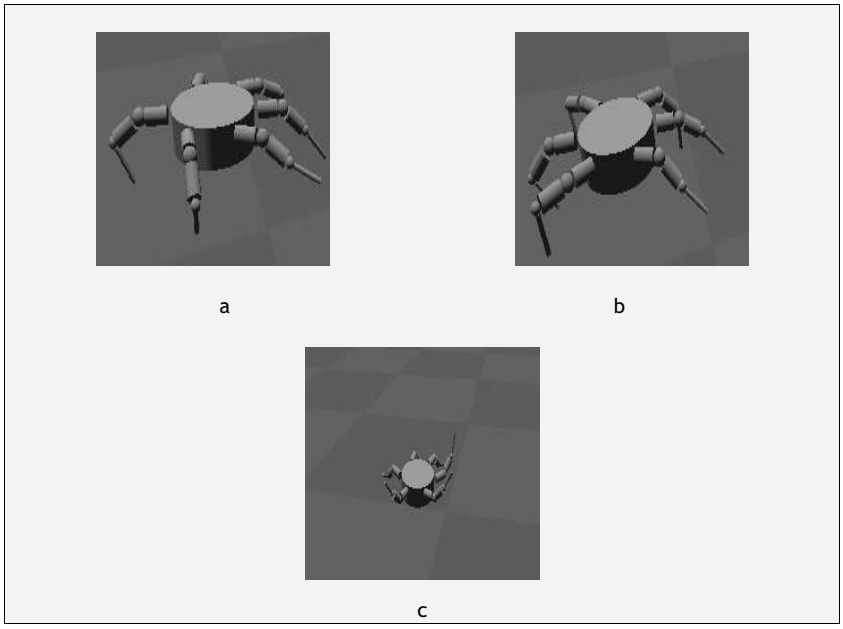

Fig 3 (a) and (b): Dislocation of legs during OSCAR´s movement (output of Gazebo simulation), (c): representation of an accident situation [5].

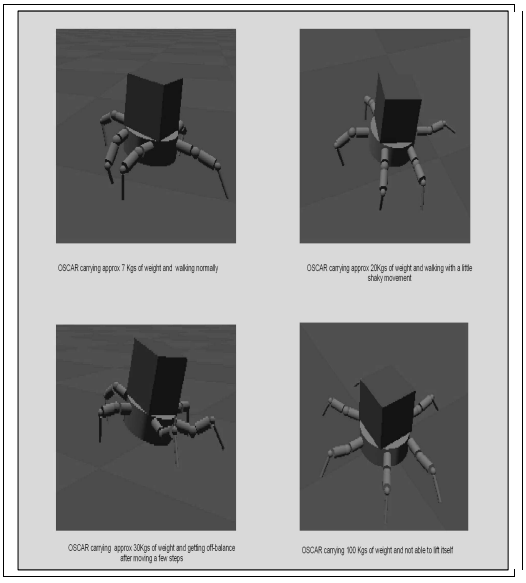

Fig. 4 Illustration of OCAR´s behaviour under heavy load [5]

AN INTEGRATED SYSTEMIC THEORY OF CATASTROPHES

Maximilian Mrotzek[1], Günther Ossimitz

Abstract

There exists hardly a generic, scientific approach to understand and explore catastrophes. We propose an Integrated Systemic Theory of Catastrophes (ISTC) using the System Dynamics method to model and to identify common systemic structures and behaviours of catastrophes. In this paper three core concepts of the ISTC are introduced: (1) Considering catastrophes as radical changed system structures rather than extreme events, (2) studying the time dimension in catastrophes to investigate their development and behaviour, and (3) Catastrophe Archetypes that function as a diagnostic-, planning- and theory building tool, allowing to explore catastrophes systemically.

1. Introduction

Catastrophes fascinate humans as they clearly show them the limits of their own existence. Almost on a daily basis media reports about catastrophic events reaching from personal distress and small-scale local disasters up to large-area infrastructure destructions. The inflationary use of the term catastrophe might sometimes mislead outside spectators to dullness or languidness. This is all the more the case as the total number of catastrophes, their ramifications and aggregated detriments is worldwide increasing. Main reason for the increase is due to socio-economic changes (IPCC 2007, STERN 2007). Ongoing population growth and urbanization yields wide and fast growing areas of high population density, which are prone to heavy catastrophes. We have worldwide increasingly widespread and complex infrastructures and transportation ways that are highly susceptible. Moreover climate change is assumed to be responsible for the rise of natural catastrophes such as droughts, storms and floods.

However, the apparent increase of headlines about catastrophes and disasters should not mislead to the assumption that emergency management is unsuccessful. Due to better techniques and advanced

[1] Institute for Mathematics, University Klagenfurt, Austria; mmrotzek@edu.uni-klu.ac

practices, catastrophes that before would have occurred, can be prevented to some extent. Yet, we have to consider that beyond the limits of technological measures against catastrophes new catastrophes may emerge, which have lower probability but an intensified destructive power (LAPP and OSSIMITZ 2006, MROTZEK et al. 2007). Thus, we are confronted with a world of increasing catastrophe potential.

Typically, the bigger catastrophe hazards become, the more they tend to reach across an increasing number of scientific fields. The Chernobyl nuclear power plant disaster can be seen initially as a catastrophic mismanagement of a security check within Reactor 4 that led to a catastrophic failure of a technical system. With the spread of the nuclear radiation the catastrophe became one of the environment, the health of millions of people, the economy of wide regions and ultimately even one of the political system of the USSR (DÖRNER 1989). This cross-disciplinary character of catastrophes requires an approach that understands catastrophes as a systemic cross-disciplinary phenomenon. Our "Integrated Systemic Theory of Catastrophes" (ISTC) is designed to provide some theoretical background for this interdisciplinary view on catastrophes and disasters.

2. Catastrophe as systemic changes

There are two basic approaches to see catastrophic events:

(1) as extreme events within one field (e.g. an extreme amount of water in a river)
(2) as radical changes of some system (OSSIMTZ and LAPP 2006).

When looking at catastrophes as extreme events, catastrophes are considered as extreme discrepancies to the normal state of the system. This view is for example represented by the "Risk and Vulnerability Program" of the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, with projects like „*Extreme Events and Socio-economic Vulnerability*" (http://www.iiasa.ac.at/Research/RAV/Projects/Extreme_Events.html [18.07.2008]). According to this concept extreme phenomena have catastrophic implications, e.g. "wind" as the normal case and "storm" as the extreme case. A crucial issue is to distinguish the catastrophic extreme case from the normal case and to understand the risks and consequences of extreme incidents.

Considering catastrophes as extreme deviations from the normal case implies that both the normal and the catastrophic case are measured on a common scale. Having a common scale for measuring both the normal and the catastrophic case implies that we consider a structural homogeneity between the normal and the catastrophic when seeing catastrophes as extreme events. A traffic jam

is reduced to an extreme number of cars at the same time on the same part of a road; a flood is considered as an extremely lot of water being carried by the river; an epidemic is seen as an extreme number of sick people at the same time. An extreme load of snow on a roof might cause a collapse of the roof and thus a substantial damage to the building.

When looking at catastrophes as radical change of systems, the inner system structure itself changes. Through this change, the system and its logic does not function the same way as it did before the catastrophe. In a traffic jam people cannot drive along the usual speed; for a flooding river the flow system changes radically in the moment when a river leaves the riverbed or dams are breaking that are keeping the river in its course. In the case of an epidemic the health care system is overloaded and sometimes even massive security measures of hygiene or quarantine have to be taken in order to prevent the further spread of the sickness.

The difference between the two views (1) catastrophes as extreme events or (2) catastrophes as system changes can be seen very clearly in the case of a roof collapsing under an overload of snow. In view (1) we focus on the issue which amount of snow must be considered as being catastrophic. In view (2) we focus on the issue whether the roof does collapse or not. If it collapses, the catastrophe has happened, if not, there is no catastrophe. How many centimeters of snow are needed for the collapse is of secondary interest – the primary issue under view (2) is that the roof collapsed and the house is seriously damaged. Another example would be an earthquake. In view (1) the intensity of the earthquake is considered as the crucial measure for the catastrophe. When defining catastrophes as system changes, the relevant aspect is whether a house collapses under the earthquake-shock or not. Not the magnitude of the earthquake is here the crucial factor but the impact the earthquake has on the house. For an earthquake-secured-house, standing directly next to the collapsed house and being hit by the same earthquake magnitude, the earthquake was not a fundamental system change, as only minor damages occurred and the system “house” is still functioning in the same manner.

3. The role of time in catastrophes

The *time* dimension plays an essential role when considering catastrophes as radical changes of systems. In the sociological theory of catastrophes (Clausen et al. 2003) catastrophes are defined as radically accelerated social changes. We think that catastrophes not necessarily are accelerated changes, as the case of creeping catastrophes indicates. Nevertheless in any catastrophic scenario

time is an essential issue, since we define catastrophes as radical changes of systems and any change requires some time. Two key aspects are the speed of the change and whether the change is permanent or temporarily.

Catastrophic changes of systems might be temporarily or permanent. A high tide is temporarily and when the flow of the river goes back into its riverbed the catastrophe is over. However, changes of the system structure can also be of permanent nature. In the case of a flooding river the river might have formed itself a new bed; in the case of an earthquake the collapsed houses are damaged permanently (not considering human reconstruction).

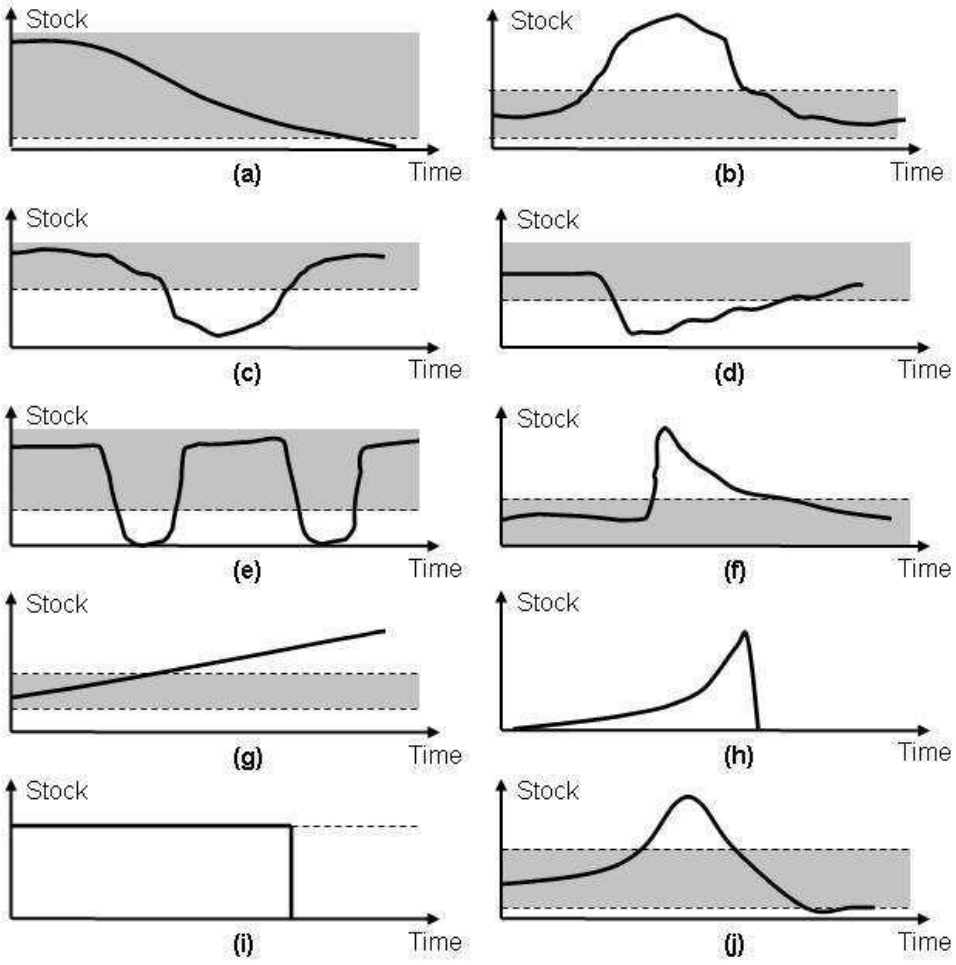

Figure 1. Role of time in catastrophe

The incident of catastrophes to happen may progress slowly and take centuries (e.g. deforestation of the rain forest) or occur rapidly in a few seconds (e.g. tsunami wave). In Figure 1 the progress patterns of ten different catastrophes types are illustrated and examples are given. Here, the horizontal axis represents the *Time* dimension and the vertical axis the behavior of a *Stock* (e.g. population, amount of trees etc.). The grey marked area represents where the stock is its normal state. When the stock leaves the grey marked area the catastrophe, in form of a structural breaking, takes place

The curve in **(a)** shows a creeping and irreversible catastrophe, as it is the case for the age-long deforestation of the Easter Island by the Polynesians (STERMAN 2000, p.125ff.). Initially, when the first settlers arrived, the Easter Island was lushly forested spot. However, as the human population grew over the centuries, the forest was progressively cut mainly for wood for boats, firewood, and to build the Moai, which are the monolithic stone-heads the Easter Island is famous for. At one point in time, there was no forest left. With all the trees on the island gone the Polynesians, who mainly lived from fishery, could build no fishing boats any longer and had to switch to farming to subsist. Farming alone could not feed all and as a consequence of the deforestation the population on the Easter Island fell heavily. For the Polynesians this was not an extreme event but a fundamental change of their lives. By destroying their means of existence (trees) over a long time period, the catastrophe hit them rather suddenly at the very end, the very moment when there was not tree left.

Figure **(b)** shows a temporary "overflow" catastrophe, like a river flooding temporarily some surrounding land (MROTZEK et al. 2007). The riverbed can take only a certain amount of water. If this maximum is passed the river goes over its bed and the river system changes fundamentally as the water gives itself new paths of flow. From this point on, the system "river" has not just an extremely high tide, but it changed its flow structure fundamentally. In general, this catastrophe appears quick, stays some time, and than disappears again quickly. The damages caused by the overflowing water (e.g. destruction of houses) might last beyond the actual flooding.

The curve in Figure **(c)** illustrates similar as the curve in (b) a temporarily catastrophes. Yet, here the difference is that by lowering the stock, the catastrophe emerges. An example is the Irish famine from 1845-1852, where the *stock* represents the amount of food. At this time the Irish population depended heavily on the potato. Due to bad weather and a potato disease known as late blight, millions of Irish starved as there was not enough food to feed all persons. Especially the poor

people were hit by this catastrophe and either died or emigrated. Thus, the population decreased and at one point the land produced enough food again to feed all and the catastrophe was over.

Figure **(d)** illustrates a relatively stable system in which a catastrophe takes suddenly place by a substantial reduction of the stock. Thereafter, it takes the stock a long period of time to get back to its initial state. An example for this type of catastrophe time behavior is the course of an epidemic in a population. The "Black Death" is estimated to have killed between 40%-50% of Germany's population during the late 1340s and early 1350s. Thereafter, it took Germany centuries to get back to its initial pre-pestilence population level (Boockmann, 1987).

The curve in Figure **(e)** displays a reversible catastrophe happening periodically, e.g. a tree loosing its leaves each autumn. Loosing leaves is for the tree a catastrophe since its leaves are necessary to build through photosynthesis – a complex process of sunlight, CO2, and water – the trees energy source: glucose. However, this works only during the milder period of the year when enough water is available. During the winter time water is scarce, since precipitation comes in form of snow, and through evaporation there is a constant loss of water through the leaves. As a consequence, the tree must loose its leaves, its source to gain energy; otherwise it would desiccate. In spring, the tree regains its leaves, the system tree changes again fundamentally, and the catastrophe is over.

In Figure **(f)** a stock overshoots quiet suddenly the normal state, the catastrophe emerges, and it takes a long time to get back to a normal pre-catastrophe level. An example for this type is the nuclear reactor accident in the Chernobyl Nuclear Power Plant. There, Reactor 4 exploded sending a plume of highly radioactive fallout into the atmosphere over a large geographical area. The radiation in this area remains high over many years and it takes a long time that the initial level of radiation is reached.

Figure **(g)** represents the growth of some "indicator variable", which might be indirectly associated with catastrophes of different kinds. An example for such an indicator is the rise of our global temperature which is, not without controversy, supposed to be largely caused by anthropogenic doing. The Intergovernmental Panel on Climate Change (IPCC), consisting out of hundreds of climate scientists from many countries, stated in their 2007 report: *"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."* (IPCC, 2007, p.10). A global temperature rise above a certain level implies (radical) changes of our lives. Direct observed and prognosticated consequences of a rise in global average temperature are: upward-shift of sea level, melting of glaciers and polar caps, shifting of vegetation zones, augmented extreme weather events,

floods, droughts, etc. An imminent danger of global warming is the increasingly amount of devastating hurricanes and typhoons respectively in the North Atlantic and North-West Pacific Region (Kossin et al., 2007). With an increase in temperature the total amount of absorption of vapor in the air rises. This rise is not proceeding linear but rather exponential. Thus, the process of evaporation and condensation per moved cubic meter can feed more energy into a storm which results in a more severe precipitation (Knutson and Tuleya, 2004).

Certain systems are designed in a way that they must grow in order to survive. This implies inevitably a catastrophic end for that system, since there is an ultimate limit for any growth (see Figure **h**). An example for this is a Ponzi-Scheme, which is a fraudulent investment scheme that pays high returns to existing investors just by the money paid by subsequent investors, instead of any real business. A Ponzi-scheme can only carry on as long as new investors enter the business. If no more new investors can be found (which is inevitable due to the exponentially growing need of new investors), the Ponzi-scheme will break down sooner or later. Another example for a Ponzi-like systems are cancer cells, which have the property to grow and divide themselves without limit. This yields inevitably to tumors and metastases. The only sane level for Ponzi-Scheme systems is zero. As soon as amount of Ponzi-Scheme investors or cancer cells starts to grow, the catastrophe is inevitable. The system must collapse when no more growth is possible and there is no way out of the catastrophe.

The curve in **(i)** shows a stable system where in case of a catastrophe the system collapses irreversible and completely. An example for this is a bridge that collapses due to oversized weight. The bridge can carry a certain maximum amount of weight. If the maximum amount of weight is exceeded the bridge collapses. We can find this time behaviour of a sudden catastrophic breakdown in technical systems (e.g. machines, computers) and buildings (e.g. bridge, house).

Figure **(j)** illustrates an overshoot and collapse behaviour. A system grows beyond its carrying capacity and the resulting overcapacity destroys the recovery potential of the system. A classical example is the tragically over-crowding of the mule deer population at the Kaibab Plateau in Arizona (OSSIMITZ 1990). In 1905 the deer population was estimated to be about 4000. The carrying capacity of the Plateau was estimated to be about 30.000 deer. In 1906 US-President Theodor Roosevelt signed the Grand Canyon National Game Preserve Act to protect what he called *"finest deer herd in America"*. Not only was it now prohibited to hunt the mule deer, but it was also attempted to exterminate the natural enemies of the deer such as mountain lions and wolves. The mule deer population exploded. In 1915 it reached 25.000 and by 1924 the maximum was reached

with around 100.000. This was far above the carrying capacity. The deer were starving and in two successive winters 60% of the herd died. Furthermore, in search for food the deer destroyed the vegetation to such an extent that subsequent die-off-rate and birth rate yielded a population around half that which could have been previously maintained.

4. Catastrophe archetypes

Catastrophe Archetypes are identified by combining two resources: (1) General systems research on archetypes (SENGE 1990, WOLSTENHOLME 2003) and (2) the exploration of systemic structure of concrete catastrophe scenarios in different fields as exemplary case studies. The Catastrophe Archetypes are described and modeled both qualitatively (using Causal-Loop Diagrams) and quantitatively (using the System Dynamics method). Causal loop diagrams allow the identification of systemic feedback loops. The System Dynamics (FORRESTER 1961) models should help to investigate the dynamic behavior of Catastrophe Archetypes over time and give clues about conditions when catastrophes do (not) occur. Catastrophe Archetypes help to explore complex "multi-field" catastrophe scenarios which cannot be reduced to a single scientific field. For example, when looking at Adipositas (human overweight illness), one finds that the elements of the relevant feedback loops belong to different fields of sciences (Medicine, Agriculture, Cultural Science, Social Science, Business Science, etc.). None of these sciences alone can identify the systemic structure generating Adipositas as a mass problem in developed countries. Furthermore, Catastrophe Archetypes can be used for diagnostic, planning and theory building purposes. As *diagnostic tool*, they provide a set of systemic structures that can be used to diagnose situations according to their catastrophe potential and possible leverage points to change the existing system structure to a desired state can be identified. As a *planning tool* Catastrophe Archetypes allow looking ahead and reveal how certain actions cause certain reactions in the system over time. Potential problems and possible outcomes can be identified in advance. As a *theory building tool* Catastrophe Archetypes make general prognoses possible and give recommendations that are beyond the specifics of an individual case. Thus, archetypical forms of catastrophe management can be conceptualized. In the following, two examples of Catastrophe Archetypes are given using the stock-flow logic of System Dynamics. System Dynamics modeling is based on a strict separation of stocks and flows (in- and outflows) that change those stocks over time. Stocks are related to discrete points in time, flows to time-intervals (time-steps) between successive points in time.

Escalation Catastrophe: The possibility of a catastrophe is included within the system structure through an escalating feedback loop. We differentiate between two basic concepts of an escalating system. The first one is a Ponzi-Scheme (a fraudulent investment scheme), illustrated in Figure 2 and consisting of two variants.

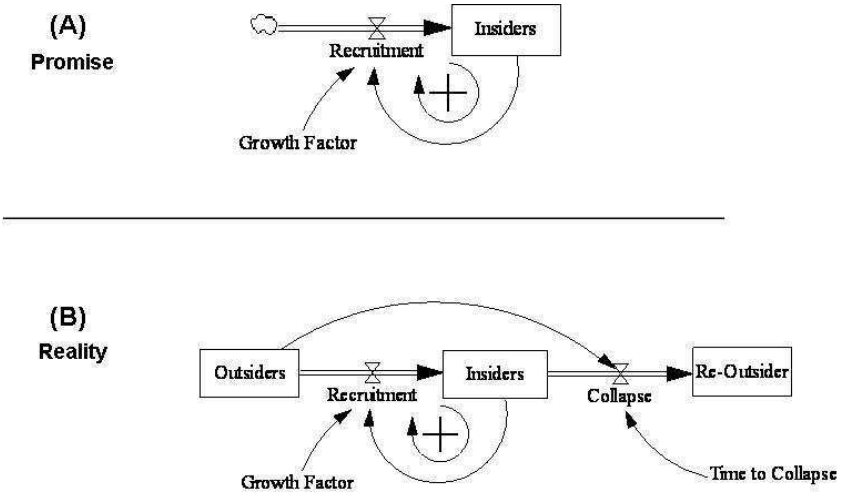

Figure 2. Escalation Catastrophe – Ponzi-Scheme

Variant (A) represents the view of the proponents of the Ponzi-Scheme. The focus is upon the exponential growth process, which appears to be infinitesimal. However, the reality of any Ponzi-Scheme is displayed in variant (B). We can see that the pool of outsiders for recruitment is limited. It drains out through the recruitment process, until no one is left and the Ponzi-Scheme is doomed to death, since it can live only as long as there is a sufficient inflow of newly recruited insiders. The moment no outsiders are left, the Ponzi-Scheme collapses and all Insiders become Re-Outsider.

The second concept of an Escalation Catastrophe Archetype is exemplary illustrated in Figure 3 as an arms race of the former superpowers USA and USSR (Senge 1990). More weapons on one side yield more weapons on the other side and vice versa as one feels put at risk through the increasing armament of the other. Here the escalation is due to a mutual increase of two stocks. In the long run the escalation must stop due to a limiting factor or limiting cycle (not included into the model).

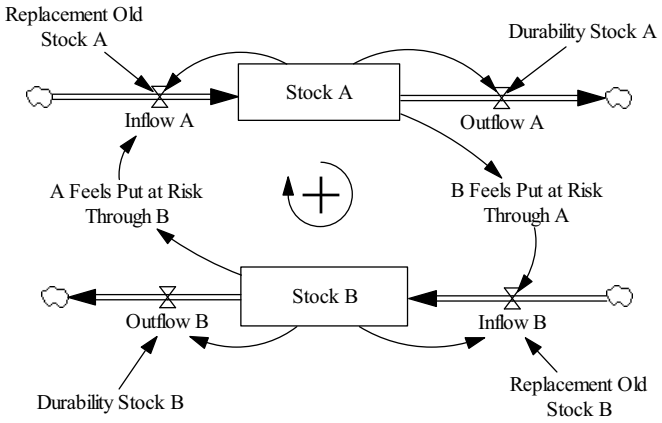

Figure 3. Escalation Catastrophe – Arms-Race

A tricky aspect of this Catastrophe Archetype is the fact that the escalation itself is not considered to be a catastrophe. The catastrophe lays either in the fact that the escalation process ceases at some time or in the side-effects the growth of both stocks have for the system. In the case of the military armament of USSR and USA the Soviet Union economically collapsed.

Attached catastrophe: A stable system is suddenly subjected to a catastrophe. The time behavior of this Catastrophe Archetype is illustrated in point **(d)** of Figure 1. The long term behavior of the system is overruled by some short term catastrophe scenario. We call this type of catastrophe "attached", because it can be modeled by attaching a catastrophe scenario to a calm "normal" system model. In Figure 4 the concept of the Attached Catastrophe Archetype is illustrated for an epidemic in a population. In an evenly developing population, an epidemic catastrophically interferes with the slow-pace-development of the population. Typically attached catastrophes are accelerated in comparison to the "normal" emergence of the system. When simulating attached catastrophes one has to combine a system-model representing the normal non-catastrophe system behavior with a catastrophe scenario. Usually the catastrophic scenario emerges over a much shorter time-span as the "normal" development. In the case of an epidemic in a population we have to model the development of the epidemic in steps of days or weeks, whereas for the "normal" development of the population a time-step of one year is common. It might happen that the catastrophic scenario requires the model to function according to a completely different set of rules, which represent the catastrophic behavior in contrast to the usual non-catastrophic behavior of the system. When modeling attached catastrophes with System Dynamics we build the model in a way that the attached catastrophe scenario can be switched on in order to let a catastrophe overrule the normal development of the system.

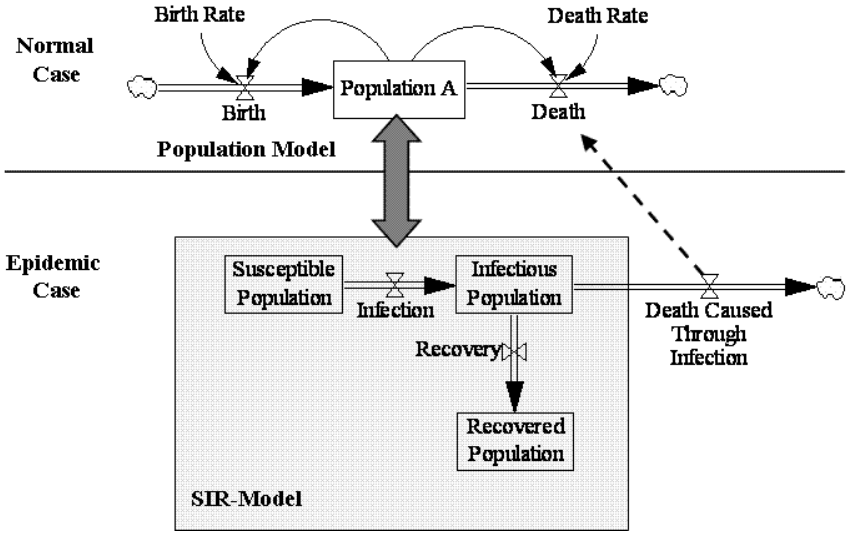

Figure 4: Concept of Attached Catastrophe Archetype

5. Conclusion

The Integrated Systemic Theory of Catastrophes (ISTC) proposes a systemic view on catastrophes. The three core concepts of the ISTC – (1) seeing catastrophes as structural breakings rather than extreme events, (2) factor time in catastrophes, and (3) Catastrophe Archetypes – allow analyzing catastrophes from a systemic perspective. Thus, by knowing the catastrophe system structures in existing systems reveals possible leverage points that help to reduce or avoid catastrophe risks. In the planning process, a systemic investigation towards catastrophe potential gives clues of how to design systems that are sustainable even under catastrophe hazards. We expect the ISTC will have consequences on the following different levels: for catastrophe research, for modeling and simulating catastrophes, and for management and systems education.

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Advances in
Cooperative Information Environments

UBIQUITOUS INFORMATION ENVIRONMENTS: CONCEPTS AND TOOLS

Tom Gross, Thilo Paul-Stueve[1]

Abstract

Ubiquitous information environments support natural user interaction entailing a number of advantages for users. However, they are based on sophisticated concepts and technology that is difficult to design and develop. In this paper we provide an overview of concepts and tools in ubiquitous computing, context-aware computing, and computer-supported cooperative work that can be applied and used to facilitate the design and development of ubiquitous information environments thorough literature review. And we discuss how these concepts and tools can leverage ubiquitous information environments from a users' perspective.

1. Introduction

Many advanced information systems go beyond the traditional interaction paradigm of windows-icons-mice-pointing devices (WIMP) and graphical user interfaces (GUI) in order to provide users with ubiquitous access to information and services. The ubiquitous computing including the calm technology paradigm bring many advantages for users that can only be realised if the corresponding progress in concepts and technologies are made [31]. In fact, for users this 'move toward ubiquitous computing, in which computers will be embedded in our natural movements and interactions with our environments—both physical and social … will help organise and mediate social interactions wherever and whenever these situations might occur.' [23, p. 63].

Developing concepts and tools for such ubiquitous information environments is still a challenge for the team responsible for the result—even if the team is interdisciplinary. We have already developed the UbiProcess model—a generic model describing the interaction process between the users and the information interface [16].

[1] Faculty of Media, Bauhaus-University Weimar, Germany; <firstname.lastname>(at)medien.uni-weimar.de

In this paper we analyse how existing concepts and tools can be used by developers of ubiquitous information environments that are based on the UbiProcess model. In particular we provide an overview of concepts and tools in ubiquitous computing, context-aware computing, and computer-supported cooperative work that can be applied and used to facilitate the design and development of ubiquitous information environments thorough literature review. And we discuss how these concepts and tools can leverage ubiquitous information environments from a users' perspective.

In the following sections we introduce the ubiquitous computing, context-aware computing, and computer-supported cooperative work paradigms as well as their concepts and tools respectively and we then describe how these concepts and tools can be used for designing and developing ubiquitous information environments.

2. The Ubiquitous Computing Paradigm

The ubiquitous computing paradigm was first introduced by Mark Weiser in 1991 [31] and describes the seamless integration of computing into the user's environment. In contrast to virtual reality, where users are equipped with head-mounted displays, data gloves, etc., the idea of ubiquitous computing is to enhance users' environment with sensors and actuators that continuously gather information about the current situation and react to the situation.

2.1. Principles and Their Concepts

Two major principles of ubiquitous computing are relevant for ubiquitous information environments; here we briefly characterise them and describe their concepts.

A major principle of ubiquitous computing is to seamlessly integrate computer technology in the users' everyday life [1, 6, 31] in order to provide 'an observed world that is enhanced by the behavioural context of its user' [26]. This principle is directly supported by the *concept* of providing services and information *anywhere and anytime*. The users do not have to visit dedicated places such as a computer workstation or a video conferencing room to benefit from technology, but the technology surrounds them providing them with adequate services.

Closely related to the principle of the seamless integration of computer technology in users' everyday life is the principle of the disappearing computer [19, 29, 31]. The computing services should be made available through the physical environment [19], a *concept* referred to by Mark Weiser as *embodied virtuality* to stress the significant difference to virtual reality [31]. Physical

everyday objects are enhanced with computing functionality to support users with natural input technology.

2.2. Tools

There are several tools for ubiquitous computing; here we briefly introduce a selection of representatives supporting the above concepts.

2.2.1. Tools Supporting Anywhere and Anytime

Gaia is a meta operating system for resource management of programmable ubiquitous computing environments supporting the seamless integration of computing technology in the everyday life of users. Gaia enables to create so called active spaces—that is, geographical regions where users are supported in performing specific tasks by providing facilities for coordinating hard- and software in a physical space. It provides an event manager service for communication of changes in the environment, a context service that allows registering for specific context information, a presence service that detects the availability of hard- and software and people, a space repository that provides availability information about the resources in the active space, a context file system, a user location-dependent file system, and an application framework that abstracts the access to core functionalities of the operating system for applications. A presentation manager that allows the seamless use of multiple displays for presentations has been implemented on base of Gaia [26].

2.2.2. Tools Supporting Embodied Virtuality

The *Gadgetware Architectural Style (GAS)* is an approach for making available computing services through the physical environment; it supports the principle of the disappearing computer by allowing to enhance everyday objects. Extrovert-Gadgets are physical objects equipped with field programmable gate arrays running the GAS-OS, providing specific sensing, acting, processing, and communicating facilities. The extrovert-Gadgetworld editor allows to create extrovert-Gadgetworlds consisting of multiple connected extrovert-Gadgets [19].

Compound prototypes and paratypes (situated experience prototypes) cope with the user-centeredness and the exploratory interface approach of ubiquitous computing applications during the design phase of ubiquitous computing applications [1]. Compound prototypes allow carrying out user tests; they consist of a representing artefact backed up by powerful computing devices to

deliver the functionality of the application in design. Paratypes allow for diary studies and user surveys; they simulate the usage of the planned application in real-life situations.

2.2.3. Tools Supporting Anywhere and Anytime as well as Embodied Virtuality

Sens-ation is a service-oriented platform for senor-based infrastructures for both developing ubiquitous and cooperative applications. It features an event-based approach to deal with data from real world sensors and software sensors. It provides facilities for the integration of custom inferencing mechanisms and a history for past event storage. Sensors and actuators are connected via software adapters through the gateways. The SensBase reference implementation provides various gateways for different protocols and technologies, such as XML-RPC, SOAP, TCP/IP Sockets, or Common Gateway Interface [13].

Design patterns for future ubiquitous computing systems are proposed as method to formalise existing solutions to known problems are proposed by Landay and Borriello [20]. Chung et al. [7] introduce a pattern language consisting of 45 pre-patterns that describe re-occurring issues in ubiquitous computing application design on base of literature research to provide a basis for further development.

It is important to understand and meet the needs of users when designing ubiquitous computing applications that feature natural input technologies and adjust their output on basis of contextual cues [4]. In a practical experience report the authors [4] recommend paper prototypes in in-field studies for the rapid and early assessment of a planned application, while interactive prototypes provide useful feedback on the use of a planned application. Momento is a tool for situated evaluation of ubiquitous computing applications. The client-server system supports quantitative evaluation with logging mechanisms and qualitative evaluation with experience sampling studies and diary studies. It allows combining iterative design with a situated evaluation approach [5].

3. The Context-Aware Computing Paradigm

The context-aware computing paradigm was first introduced by Schilit et al. [27]. According to the authors a context-aware system ‘adapts according to the location of use, the collection of nearby people, hosts, and accessible devices, as well as to changes to such things over time’ [27].

3.1. Principles and Their Concepts

The core principle of context-aware computing is the system's awareness of its position and situation. This principle requires the concept of *contexts* as descriptions of situations as well as the concept of *context awareness* as detections of contexts in reality.

Dey [9] defines context as 'any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves' and 'context is typically the location, identity, and state of people, groups, and computational and physical objects'. He identifies four categories of context (identity, location, status, and time) and three categories of context-aware functions (present information and services, automatically execute a service, and attaching context information for later retrieval).

Schmidt et al. [28] provide a classification of context information according to human factors and physical environment. They further part each category into three subcategories. The subcategories of the human factors are information on the user, the social environment, and tasks. The physical environment has the subcategories location, infrastructure, and physical conditions. For a better assessment of the current context of a user they propose to take information of previous contexts into account.

An approach to context based on the notion of context in language, a feature of communication that is applied in the process of interpretation and hence emerges in dialog and extends beyond what can simply be seen and heard, is introduced by Winograd [32]. He identifies context as 'an operational term: something is context because of the way it is used in interpretation, not due to its inherent properties' and context-aware computing 'as the design of computing mechanisms that can use characterisations of some standard aspects of the user's setting as a context for interaction'.

In most cases the concepts of context and context awareness are considered as a means to an end—that is, they are underlying other concepts. Here particularly focus on the enabled concepts of awareness and automatic adaptation.

The principle of awareness is characterised early by Lövstrand [21] as the provision of users with the right amount of information about 'what is going on around them'. He identifies three related factors for awareness: the right amount of information, the correct addressee for the information, and timely delivery of information. Providing users with the right amount of information is a critical point in awareness. Users receiving too much information about their context will not be able to

identify the crucial information bits among the multiplicity of the available information—an issue called information overload. Determining the correct addressees for different information bits helps in decreasing information overload. If only users with interest in specific kinds of information get notified their cognitive demand to identify relevant information is lowered. Another critical factor for awareness is the timely delivery of information. If users get informed too late the information might have already rendered useless, if too early the users might forget the information till it is relevant.

The concept of automatic adaptation of applications in dependence of context information is the second key concept in context-aware computing. Automatic adaptation describes the ability of applications to change their configuration to a user's working environment in a way that supports the user's task without the need for the user to intervene. Applications can adapt to changes in the physical environment as well as to changes in the digital computing environment of the user [9].

It interesting to note that Schilit et al. from the very beginning saw the above concepts highly integrated [27]. They define context as the combination of the location of the user, the co-located people, and the resources in that location and they introduce four concepts that are based on contexts: proximate selection is a user interface technique that puts nearby objects to the centre of the users attention; automatic contextual reconfiguration describes the automatic adaptation of the resource information of a computer program to the current context; contextual information and commands describe the provision of context-dependent information and commands to the users (e.g., location dependent file systems or default print commandos); and context-triggered actions are automated tasks that are executed upon specific conditions in the users' context.

3.2. Tools

The following tools for context-aware computing we are introducing here are: the Context Toolkit and the Khonika middleware as well-known classical examples as well as the CAMidO architecture as very recent approach.

3.2.1. Tools Supporting Awareness

Khronika is an event notification service. Khronika receives events—information about real-world events of varying duration, such as appointments—from its clients and stores them. Users can manually browse the stored events or subscribe to specific kinds of events. Subscriptions are processed by event daemons that compare new events to a notification template and send a

notification about the event to the subscriber upon a match. Khronika was implemented for SunOS and several different event browsers, event editors and producers, and event daemon editors and management tools accompany it. An evaluation at EuroPARC showed—besides an overall success of the everyday usage of the system—difficulties to find the right level of formalisation of the event descriptions [21].

3.2.2. Tools Supporting Automatic Adaptation

CAMidO is an architecture that is enables to develop and run context-aware applications. It consists of the CAMidO ontology meta-model for an application specific context description, the CAMidO compiler that generates application specific inferencing and control code, and the CAMidO middleware, a component-based application-server middleware allowing for sensor integration [3].

3.2.3. Tools Supporting Awareness and Automatic Adaption

The Context Toolkit implements a conceptual framework based on six requirements for context processing from a developers' perspective [8]. These six requirements are: separation of concerns (i.e., a clear separation of different conceptual layers such as abstraction of sensor details); context interpretation (i.e., multi-layered abstraction of context information); transparent, distributed communications (i.e., respect the distributed character of context-aware systems); constant availability of context acquisition (i.e., the context-delivering components are always accessible); context storage and history (i.e., maintain historical context information; resource discovery (i.e., automatic detection of available resources). The Context Toolkit implements the conceptual framework resembling the widget-orientated approach of graphical user interface toolkits. It consists of context widgets delivering context information, interpreters processing higher-level information from one or more sources, aggregators concentrating logically related information, services executing actions, and discoverers providing information about available components.

4. The Computer-Supported Cooperative Work Paradigm

The computer-supported cooperative work paradigm views the interaction between users and the system from a pluralistic perspective—that is, it assumes that concepts and tools should be supported to support the interaction among users [e.g., 14].

4.1. Principles and Their Concepts

The most central principle of computer-supported cooperative work is group awareness. Lynch et al. [22] write:

> "Groupware is distinguished from normal software by the basic assumption it makes: groupware makes the user aware that he is part of a group, while most other software seeks to hide and protect users from each other. […] software that accentuates the multiple user environment, co-ordinating and orchestrating things so that users can see each other, yet do not conflict with each other".

The notion of awareness in the context of computer-supported cooperative work is different from the notion used in context-aware computing in that it is focussed on the activity of co-workers. Dourish and Bellotti [10] define awareness as the 'understanding of the activities of others, which provides a context for your own activity' in order to 'evaluate individual actions with respect to group goals and progress'. Begole et al. [2] talk of group awareness to stress the difference to the broader definition of context-awareness. Prinz [24] introduces the terms social awareness and task-oriented awareness to differentiate between the awareness about 'information about the presence and activities of people in a shared environment' and information about 'activities performed to achieve a specific shared task'. Situation awareness is the 'knowing about things that are happening in the immediate environment and includes having both an accurate understanding of the situation and the knowledge to respond appropriately as the situation evolves' [30]. In the case of computer-supported cooperative work situation awareness is computer-mediated and comprises contextual, task and progress, and socio-emotional information.

This central principle of group awareness is supported through several concepts; some important ones are informal awareness as the pervasive knowledge of who is around; social awareness as the information of each others attention and interest; group-structural awareness as the information on the group and its structure and the roles of its members; and workspace as the information of the state and evolution of the workspace and the artefacts contained [17].

4.2. Tools

Several tools support the different types of awareness above.

4.2.1. Tools Supporting Informal Awareness

The concept of informal awareness is supported by instant messaging systems such as PRIMI [15] and by media spaces such as the Cooperative Media Space [12].

4.2.2. Tools Supporting Social Awareness

The concept of social awareness is supported by cooperation tools to allow cooperation and video connections with gaze at the same time, such as ClearBoard [18].

4.2.3. Tools Supporting Group-Structural Awareness

The concept of group-structural awareness is supported by social software and networking tools such as XING [33].

4.2.4. Tools Supporting Workspace Awareness

There are several systems supporting workspace awareness. The are also some infrastructures that provide flexible support for workspace awareness beyond individual applications. They capture group awareness, store it, and distribute it to the interested users. Examples are TOWER [25] and ELVIN [11].

5. Concepts and Tools for Ubiquitous Information Environments

In this section we provide a systematic overview of the concepts and tools of the previous three chapters and summarise them in the following Table 1 (see the next page).

The UbiProcess model [16] is especially designed for information processing in ubiquitous environments and hence suits to the concepts of ubiquitous computing. The gathering and the feedback levels of UbiProcess model do not impose any restriction about the place or time of data capturing and execution of action in the real world and allow enhancing every real world object that can be equipped or detected by sensors and equipped with actuators.

In order to realise applications according to the UbiProcess model the Gaia meta operating system can be used. Besides facilities for integration of sensor information it provides facilities for event management and context services that support the inferencing layer of the UbiProcess model. The context model of the context services is based on Boolean algebra and first-order logic and allows for hierarchical dependencies of context information. Applications realised with Gaia are developed in Lua script, a lightweight scripting language that allows for rapid development.

Paradigm	Concept	Tools
Ubiquitous Computing	Anywhere and anytime	Gaia (meta operating system for resource management of programmable ubiquitous computing environments [26])
	Embodied virtuality	Gadgetware Architectural Style (GAS) (GAS-OS operating system for enhanced everyday objects ; and extrovert-Gadgetworld editor [19]) Compound prototypes and paratyes [1]
	Anywhere and anytime as well as embodied virtuality	Sens-ation (sensor-based service-oriented middleware [13]) Design patterns [7, 20] Momento [4]
Context-Aware Computing	Awareness	Khronika (event-based publish-subscribe middleware [21])
	Automatic adaptation	CAMidO (architecture for context-aware applications [3])
	Awareness and automatic adaptation	Context toolkit (conceptual framework and supporting libraries [8])
Computer-Supported Cooperative Work	Informal awareness	PRIMI [15], Cooperative Media Space [12]
	Social awareness	ClearBoard [18]
	Group-structural awareness	XING [33]
	Workspace awareness	TOWER [25], ELVIN [11]

Table 1. Overview of Concepts and Tools for different interaction paradigms.

The Gadgetware Architectural Style is developed for everyday objects enhanced with hardware modules providing limited capabilities. It provides means to design and realise enhanced objects that can provide services to each other. The UbiProcess model can be applied in a distributed manner with help of multiple extrovertGadgets that provide dedicated services to each other. It can be different to integrate the basic layer of the inferencing level, because GAS does not feature a history mechanism to deal with past events. A eGadgetworld Editor allows the configuration of eGadgetworlds consisting of several eGadgets and hence provides developers with means to realise the concept of embodied virtuality.

Sens-ation is fully compliant to the UbiProccess model. It provides sensors for data gathering, which are connected through adapters to the platform that provide the norming of the raw data. Sens-ation provides a flexible inferencing mechanism that allows to implement custom inferencing mechanisms that have access to all sensor available to the platform and their historic data. The feedback level is realised through actuators. Developers find the levels and layers of the UbiProcess model clearly separated in different architectural components that make it easy to implement ubiquitous information environments according to the model. In [16] we prove the applicability of UbiProcess model with Sens-ation in detail.

The UbiProcess model fits to context-aware computing and computer-supported cooperative work concepts, too. The detailed inferencing level of the model is useful for the design and realisation of such applications, because of the different layers allowing for advanced fine-grained context

descriptions. However, we do not have enough space to characterise the integration of these applications and infrastructures.

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DROWNING IN WORLDWIDE AWARENESS: REFLECTIONS ON WHAT A GROUPWARE USER REALLY NEEDS

Konrad Klöckner, Sabine Kolvenbach [1]

Abstract

Virtual workspaces make it more difficult to maintain a sense of awareness about who else is present in the workspace, where they are operating, and what they are doing. In a physical workspace, people use peripheral vision, auditory cues, and quick glances to keep track of what goes on around them. In a groupware system, the visual field is greatly reduced, and many of our sensory perception for gathering information are unfit since the required information may be absent from the display. Groupware systems like BSCW resolve this problem by offering a variety of awareness features notifying users' actions. Workflow management enhancements on top of BSCW additionally need application specific awareness. In this paper we try to discuss the problem of an overwhelming offer of awareness information, such as activity icons, notifications, RSS feeds, tool tips, etc. and how to tailor the groupware interface to the very different user demands.

1. Dimensions of Perceived Awareness

Awareness to be understood as the overall state of a system [1], is a key factor for CSCW systems. Users can perceive what others are working on. Without awareness, coordinated cooperative work is almost impossible. However, despite its importance, systematic support for this feature in groupware systems is an exception; ad-hoc solutions are prevailing. Awareness about who is present in the workspace, where they are, and what they are doing, is called 'workspace awareness' [2,3,4] - the up-to-the-minute knowledge about another person's interactions with the shared workspace. In face to face shared activity, workspace awareness is a natural, constant, and even unconscious part of people's interaction. From a technical angle, the provision of awareness

[1] Fraunhofer Institute for Applied Information Technology FIT, D-53754 Sankt Augustin, Germany

information comprises three separate yet co-dependent steps. First, the information is gathered, then distributed, and finally communicated [5]. The entire process surrounding the provision of awareness information only works when all steps take place. Without a filter at the occurrence source, all information concerning one user and his or her actions would be available to anybody who wanted it. This of course offers the occurrence recipient the highest level of transparency possible but is not necessarily the intention of the person at the occurrence source, whose privacy is taken away. The conflict between wanting all relevant information and preserving privacy often results in a balancing act.

2. Managing Awareness in SAGE

The SAGE[2] system [6] is based on the BSCW groupware [7]. SAGE coordinates distributed development processes with a platform that establishes a common and shared virtual information space, which is used by team members to create and change tasks, store and access results or agreements, to discuss and negotiate, and to stay informed about distributed development processes. With the integration of situated event and notification services it is guaranteed that the participants have always an overall overview of an engineering process. But this is insufficient for collaborative task management. Users need also support to recognize and solve potential errors and conflicts at an early stage. Examples are upcoming expiration of deadlines, change requests, open issues, escalation and overlapping of tasks, or unsolved interdependences between tasks. The error and conflict management of the SAGE platform informs about anticipated conflicts at an early stage and provides functions that help to solve these conflicts as well as to synchronize tasks and deadlines[8].

2.1. Generating awareness by event information

BSCW has several ways to display information about events [9]:

- **Event icons** in the entries of a folder page inform you at a glance that some action of a specific event category was performed on this object recently. To the right of the object name various event icons may be displayed: , , , and . The icons symbolize that the object is new for the user, has been changed, moved, read, or that an object inside the folder has been changed. Clicking on an event icon returns a list of the recent events of the category symbolized by the icon.

[2] The SAGE project is partly funded by the German Federal Ministry of Education and Research. We sincerely thank our application partners for many fruitful discussions and their support in completing the SAGE prototype.

- A detailed **history** of all events is maintained for all objects, reaching as far back as your BSCW administrator restores events. Choose History from an object's action menu to view this history.
- The **daily workspace activity report sending by email** lists all events of interest across all your workspaces that happened the previous day.
- **Direct email** informs about events immediately.

In the context of a single task, the user is involved in, this event oriented view is fully sufficient. Users that are in charge of managing a large project need quite different awareness mechanisms to guarantee the success of a project. They need overview information on phases and tasks of a project like being on schedule, starting counter measures etc.

2.2. An Overview of the whole project

Gantt Chart is common visualization technique to represent the Work Breakdown Structure (WBS) of a project in the project time schedule. We integrated the Gantt Chart into the SAGE system and explore how it supports users in task oriented team work. Gantt Chart tools typically visualize the project structure consisting of phases, tasks and subtasks in relation to the calendar. The main advantage of a Gantt Chart is that the project manager as well as all team members easily get a sequential as well as parallel view of all project activities, the relationships and the progress.

On the one hand we use Gantt Chart in SAGE for a comfortable and efficient presentation of the whole or parts of the project on the other hand as an interactive navigation tool within the project WBS. As shown in Figure 2 we designed the Gantt Chart in that way that the project vertical structure, the time schedule of all phases and tasks as well as the involvement of all project members is immediately visible. The vertical list structure in the left part of the window visualizes the project WBS and allows the navigation inside the project structure. The horizontal bars in the middle part of the chart show the timeline of the project, the right part lists the project members. Via mouse click on "+" and "-" icons in the vertical list structure phases and tasks may be opened and closed. The bar chart adapts accordingly.

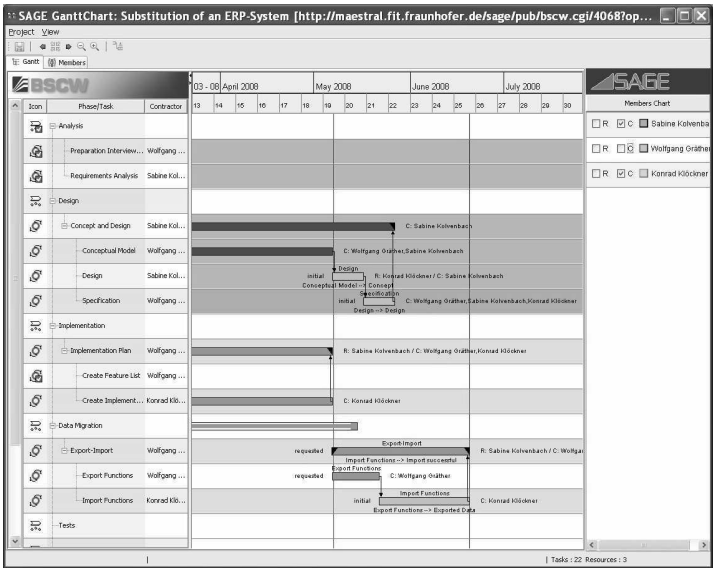

Figure 2 - Gantt Chart

The columns in the list structure are demonstrating different properties of the phases and tasks. As a default the chart shows the state of phases and tasks by different symbols in the first column, their names in the second and their contractors in the third column. The chart diagram is titled by the calendar, depending on the zoom factor, years, month, weeks, or days. A vertical red line symbolizes „today“, blue vertical lines begin and end of the project. The bars representing the phases and tasks are coloured according to their progress. For visualization of the progress we use the traffic light model: “green” shows “according to schedule”, “yellow” symbolizes “critical” and “red” means “overdue”. In order to get an instant overview on dependencies of tasks, arrows are connecting them. The labels of the bar edges inform about the names of the phases and tasks, status, the requestors and contractors, and the inputs from other tasks. The project member list assigns a colour to each user. By selecting a user the Gantt Chart shows the user’s personal task list. All tasks the user is involved in as requestor and/or contractor are highlighted in the chart diagram by this colour. By selecting several users the colours are mixed. This is a useful mechanism to identify successful cooperation between team members. If two or more team members are often participated in tasks that are according to schedule or have been done successfully in time, this may be a hint for an efficient cooperation and helps to set up an efficient team.

In order to immediately change the scheduling of tasks and their fulfilment in the underlying groupware system the project manager may open the respective phase or task by double-clicking the item either in the list or in the bar chart diagram.

2.3. Critical Tasks

For all team members, but especially for project and team leaders, it is important to be informed which tasks are critical. Time critical are all tasks that will be done or are finalzed after the deadline of the superordinated task, phase or project end.

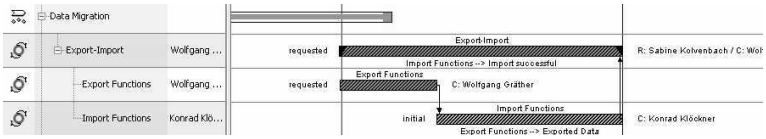

Figure 3 - Critical tasks

Figure 3 illustrates critical tasks in the phase 'Data Migration'. All critical tasks marked by shading. The task 'Export-Import' contains two subtasks. The task 'Export Functions' starts firstly and delivers the result 'Exported Data' to the task 'Import Functions'. This task has to report to the superordinated task that the import was successful. Only when the first task has been done the second task can start. The duration of the superordinated task is the sum of the duration of both subtasks and the expected end of the superordinated task will be after the end of the phase. Therefore this and the tasks that cause the time exceeding are critical.

3. Conclusion

In the course of the development of the SAGE system we learnt a lot from our application partners. They know much more in detail what their customers need to manage highly flexible development projects. The result of many discussions with our application partners is that for various user types the demand for awareness support is quite different. Depending on the situation a user is in he needs different support. Whereas a user in the function of a developer mainly relies on task related awareness, a team manager more often needs awareness that supports him to keep track of the overall project including timelines, overdue tasks and resource reallocation demand.

A system with special attention on user-defined workflow needs some highly configurable awareness supporting mechanisms in order not to overload the user with information that he does

not need in a specific context. In future, we plan to expand and validate the SAGE platform with these mechanisms through additional field studies with our application partners.

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WIKI SYSTEM AS A KNOWLEDGE MANAGEMENT TOOL

Antonín Pavlíček, Antonín Rosický[1]

Abstract

The article focuses on the use of wiki systems as a Knowledge Management tool and also as educational tool. The first part describes the system, explores its weak and strong points and points out the reasons behind growing popularity of wiki in organizations. Later on we address possible non-traditional uses of wiki system, e.g. using wiki systems for problem solution. We conclude with practical experiences with wiki system in education, which we have earned at University of Economics, Prague.

1. Knowledge management tools

When we look into the history of knowledge management, we can discover a number of technologies that were aimed to facilitate or enable knowledge management practices. Including things like: knowledge bases, expert systems (successful or not), software help desk tools, mail conferences, various types of document management systems and IT/ICT systems enabling/supporting information/knowledge flows (most notably Lotus groupware). It's safe to predict, that the development of knowledge management will not stop here. Today we are witnessing the massive growth of collaboration applications and multimedia tools. Internet (and most notably world-wide web) had caused unprecedented increase in collaboration and instant information/communication. Classical web has been replaced by the web of the second generation (web 2.0) and knowledge management tools have undergone similar "revolution" too.

In recent years (since 2000) there is a clear trend towards on-line (internet based) social computing tools, for example e-learning web systems, website content management systems, web conferencing, RSS & podcasts, blogs and most notably (from the perspective of our paper) wiki

[1] University of Economics, Prague, Department of System Analysis; {antonin.pavlicek | rosicky}@vse.cz

systems. Wikis have rapidly developed and provide unique self-governing approach to the actions related to knowledge-work capture, transfer and creation of knowledge. Tools based on wikis are rather unstructured and work though creation of new forms of community, network or matrix.

2. Wiki system

Wikis are a type of social software (usually web based) that makes it easy to communicate online. Its main feature is, that it is as simple to edit as it is to read (often WYSIWYG), the wiki makes for the perfect online collaboration tool. The primary purpose of a wiki is to allow its users to collaborate in "open space". From other collaborative applications distinguishes wiki its ability to allow an infinite number of users to add, edit, share, and link content easily, without any knowledge of the underlying system. With wiki system it is easy to organize and retain knowledge, ideas and facts. Today many companies use wikis as their favourite collaborative software and as a replacement for static intranets. There may be even greater use of wikis behind firewalls than on the public internet.

A defining characteristic of wiki technology is the ease with which pages can be created and updated. Generally, there is no review before modifications are accepted. Many wikis are open to alteration by the general public without requiring them to register. Sometimes logging in is recommended. Edits usually can be made in real-time and appear almost instantly online. This can facilitate abuse of the system. Private wiki servers usually require user authentication to edit pages, and sometimes even to read them [Wikipedia-wiki, 2008].

Currently, there are many different wiki systems available, majority of them being free and use open source platform (major advantage of open source – beside its price – is the fact, that since the code is public, they are suitable for easy individual customization). Generally, wiki are based on database system (MySQL is the favourite one) and programming language/script (PHP, Java, Phyton). The most widespread system is probably MediaWiki, which powers also the Wikipedia. It is written in PHP and runs in a typical LAMP (Linux Apache MySQL PHP) stack; easily handling a large number of simultaneous users.

However, the purpose of this paper is not technical description or comparison of different systems[2], but rather pointing out to some general characteristics of wiki systems and explaining, how they should be useful as a Knowledge Management tool.

3. Wiki in organization

Organizational knowledge is usually scattered everywhere – from email, to intranets and network drives, it's buried on people's PCs, deep in company databases and people's minds. An enterprise wiki, unlike some other solutions, is complex, inexpensive and over other (often failed) knowledge management tools has following advantages:

- is easy/intuitive to use and modify
- is easy to implement
- facilitates collaboration (many authors working on one document)
- fosters cooperation (easily recognisable new additions and changes)
- enables knowledge sharing
- keeps everyone updated (provides instant access to the company knowledge wiki base)
- offers strong searching capabilities
- does not require expensive hardware/software
- enables using of effective features of web 2.0 (RSS, tagging ...)
- has bottom-up approach to site structure and navigation
- has very simple templating.

As Mark Choater [2006] correctly observes, wikis fall conceptually under the broad concept of content management. However, wikis bring unique characteristics that differentiate them from a run-of-the-mill content management systems since wikis emphasize ease of content creation.

No wonder that magazine InfoWorld proclaimed year 2004 to be the "Year of the enterprise wiki". Knowledge located in wiki system could be seen as a single, searchable, structured repository. However, we should admit that current on-line tools in the general are still heavily based on text and code, and thus suitable mainly for the *explicit knowledge* transfer. However, since group benefits from members talking to and learning from each other, it is clear, that a wise company takes all the measures necessary to create such successful group. Using a wiki may not be

[2] For detailed comparison visit The WikiMatrix Web site (http://www.wikimatrix.org) or Wikpedia comparison article (http://en.wikipedia.org/wiki/Comparison_of_wiki_software), which provide a wealth of information about wiki software and its properties.

proverbial "silver bullet" for collaboration and information-gathering issues, but can be the key to a locked door.

4. Wikipedia as a case study of successful wiki system

"The encyclopedia that anyone can edit" – is the motto of the world's biggest[3] and fastest growing encyclopedia today. The motto itself points to the major strength (as well as weakness) of a wiki system – its openness and peer-production nature. In case of Wikipedia, productive activities are voluntary and non-monetary. No one forces anyone to contribute – people do so, because they want to and because they can[4]. Thousands of its authors (regular web surfers) volunteer their time and knowledge to help fulfill the community's goal of creating high-quality encyclopedia for everyone. As Jimmy Wales (the founder of Wikipedia) has put it: "Imagine a world in which every single person on the planet is given free access to the sum of all human knowledge. That's what we are doing."

There are just 3 basic imperatives, which made Wikipedia so popular and successful:

1) Keep it *open*
2) Keep it as *easy to edit* as possible
3) Foster the *community* spirit

Success of this free encyclopedia is based on the assumption, that collaboration among multiple users will improve content over time. Thanks to above mentioned imperatives, Wikipedia is written, edited and supervised by over million registered users worldwide, hard-core of about ten thousand Wikipedians accept responsibility for the large variety of operational/technical tasks. How effective is such big labour force was clearly demonstrated by the MIT study, according to which a random curse/vulgar word inserted into a Wikipedia article is removed within 1,7 minutes [Viégas, 2004].

5. Problems of openness and peer system

Polish Wikipedia displayed from November 2004 through February 2006 hoax personal article about Henryk Batuta, a fictional socialist revolutionary and Polish Communist. In May 2005 an

[3] As of May 2008, Wikipedia contains over 7 million articles in over 200 languages. Its content is offered for free, created by thousands of volunteers on an open platform. According to alexa.com it has become one of the most visited websites.

[4] Phenomenon of voluntary participation is not restricted only to Wikipedia, the same principle lies behind the creation of Linux and any "voluntarily" activity. It can be explained by Maslow's hierarchy of needs (social, esteem and self-actualization needs).

anonymous Wikipedia user created fictional article on former USA Today editorial director John Seigenthaler, Sr. indicating, that he have been directly involved in the Kennedy assassinations.

These and many other incidents expose the most obvious weakness of the Wikipedia model: Anybody can claim to be an expert on any subject5. A university professor can find himself arguing with an eager high school student as with a peer of equivalent training/expertise.

Some critical academics also claim that bad quality of some entries (partly because of intentional vandalism, partly thanks to ignorance of authors) excludes Wikipedia as a reliable scholarly resource.

However, in comparison with established and probably most respected source – encyclopaedia Britannica has Wikipedia been rated surprisingly well. Nature journal's comparative analysis of 42 science entries in both internet encyclopaedias showed just small difference: Wikipedia contained at average four inaccuracies per entry, commercial Britannica suffered three. Britannica disputed the charges, however as Ray Cha sensibly observes "the main point is that Wikipedia works amazingly well and contains articles that Britannica never will. It is a revolutionary way to collaboratively share knowledge." As Tapscott [2007] concisely concludes, Wikipedia's openness leaves it vulnerable to inaccuracies, edit wars, and vandalism, but it is also the reason why it's constantly growing, adding new entries, covering new niches, and always reviewing and updating facts. It taps an almost infinite wealth of talent, energy, and insight that far exceeds what Britannica's closed model can muster.

According to Tapscott [2007], peering works best, when following conditions are present:

1) The *objec*t of production is *information* or culture, which keeps costs of participation low for contributors (sharing information is quite costless while sharing physical objects brings costs).
2) Tasks can be *chunked* out into bite-size pieces that individuals can contribute in small increments and independently of other producers (i.e. entries in encyclopedia or small components of a software program)
3) The *costs* of integrating those pieces into a finished end product, including the leadership and quality-control mechanisms, must be low.

[5] In February 2007, a prominent Wikipedia administrator and employee, nicknamed Essjay (later self-identified as Ryan Jordan), was found to have made false claims about his academic qualifications (supposedly double doctoral degree) and professional experiences, while he was just a 24 years old college drop-out.

4) There are designed *rules* for cooperation, coping with free-riders, motivation and a system of peer review with (informal) leaders, who can help guide and manage interactions and settle disputes.

All above mentioned conditions are in case of Wikipedia satisfied, that is why it achieved such miraculous success. The same applies to several other open source projects – from Linux to Open Office. So, let us conclude, that if a prosperous system based on peering is to be created, definitely should follow the four above mentioned rules.

6. Using wiki for problem solution

Wiki is a powerful tool not just to store the knowledge; it can be successfully used to harness the power of group (crowd). Wiki system – or to be precise collective intelligence of its users – can be used to solve wide variety of knowledge-related problems. In the connection with group behaviour, we can divide those problems into following groups:

Cognition problems – the problems with definitive solution. Examples of such problems include questions like: "Where is the best place to build new library?" and – surprisingly – also guesses: "Which country is going to win the most Olympics medals?". If we need to get the best possible answer (or guess), let's ask a group of people what they think about it.

Coordination problems – this kind of problems require members of a group (market, car drivers, family) to figure out how to coordinate their behaviour with each other, knowing that everyone else is doing the same. Finding optimal price or getting safely home from work through traffic jam is the proof that group intelligence works.

Cooperation problems – involve the challenge of getting self-interested, distrustful people to work together, even when narrow self-interest would seem to dictate that no individual should take part in it.

Out of above mentioned three types of problems, wiki seems to work quite efficiently to tackle the latter two of them – coordination and cooperation. In the case of cognition, probably the on-line questionnaire/pool would be more effective.

The group intelligence (Surowiecki [2005] calls it "The wisdom of the crowd") has a far more important and beneficial impact on our everyday lives than we recognize. But groups (wiki users included) tend to work well just under certain circumstances:

1) groups should be *well managed* (possibly self-managed)
2) groups need *rules* to
3) maintain *order* and coherence

When above mentioned 3 circumstances are granted, another four conditions are necessary for collective intelligence to be "wise" and "unbiased" [Surowiecki, 2005]:

1) *diversity* of opinions - each person should have some private/unique information, even if it's just an eccentric interpretation of the known facts
2) *independence* - people's opinions are not determined by the opinions of those around them (in other terms - prevent herding)
3) *decentralization* - people should be able to specialize and draw on local knowledge
4) *aggregation* – there are mechanisms in place to prevent turning private judgments into a collective decision)

We should keep in mind these requirements when "populating" newly created wiki. Founder should ensure, that the group of its users will satisfy above mentioned imperatives, otherwise the "collective intelligence" and other related positive effects could be reduced.

7. Practical experiences with wiki system

At the previous pages we tried to outline some general problems and rules related to wiki systems. Now we focus on some practical experiences and "best practices" related to setting up and running operational wiki system. We earned them during operation of wiki systems[6] supporting our lectures at University of Economics, Prague.

7.1. How to create successful wiki system?

Success in the case of wiki (as well as any web 2.0 application) lies in the willingness of users to participate in it. In university environment (which was our case) it can be achieved by "command" – since the participation in wiki system is credited as a part of a final course grade. However, even

[6] These wiki systems can be found at http://newmedia.vse.cz and http://sa320.vse.cz

in this case, it is useful to adopt some practices, which makes use of wiki easier and more fun. Such patterns, easing wiki adoption, could be:

- *Publication of lecture slides/notes* – makes students to come and download them on regular basis. That helps to create "regular" patterns in visit.
- Publication of additional study materials and relevant *www links*. Students seem to like use our wiki as a starting point for the lessons related web browsing. Very helpful and frequently used was ability to add new interesting links by themselves.
- Frequent actualization is another reason for the users to visit wiki system. The system can be used as Bulletin board for messages to the students.
- *"Guided" log-in* – during the first lesson teacher helps the students to create their user accounts and gives a brief instruction, how to work with the system. This has enormous effect – ensures that every student has ability to work with wiki system.
- Use the wiki system as a system for *homework submission*. Students come and share their homeworks, they inspire each other at the same time. Openness of such submission process also promotes competitiveness and honesty. We have pretty good results with this particular use of wiki as a "storage place" for homeworks and final projects. Students also appreciate, that their work is not destined for "drawer" and is made public. That motivates them towards better achievements.
- *Discussion* part – this is a bit tricky. Discussion supports grassroots movement of the wiki system, however it is rather difficult to make student start to write it. We have experienced failure of the effort to create global discussions, since just small part of students was taking part in it.

7.2. Expected problems and how to solve them

Generally, we should not forget that bottom-up strategy is the best one in the case of wiki system. Success of a wiki depends on building active, sustainable participation. This needs that the system is both useful and simple while meeting the needs of users without requiring them to spend lots of extra time.

Probably the biggest "challenge" of using wiki in educational process is its inherent openness. Sometimes, however, it is better to have system, which is locked for outside users and offers certain degree of privacy. In our case, we solved this problem by a "compromise" – the system is generally closed for anonymous users, however after log-in we don't impose any further limitations, so the

students can enjoy openness of the wiki as they wish. The only exceptions are a few pages dedicated to teachers' announcements, which can obviously be modified just by teachers.

The openness of the system can bring some troubles, most notably determination the authorship of the work. We solved this problem by logging the history of changes, through which the author's effort and additions are traceable.

Other trouble, related to the openness is the thread of copy-cating. This issue must be taken into account by teacher when assigning homework – splitting the work in such way that prevents copy-cat attitude.

Group work – students are often demanded to cooperate and work in groups. This can lead to "free-riding" of some team members. Above mentioned logging of the system changes can help detect such attitude.

Preference of text-based information can be also a trouble. Wiki systems are generally text-oriented. Insertion of graphical elements is limited generally just to the pictures (jpeg), any more complex graphical layout is impossible.

Students also sometime complain about wiki syntax, which (even thou it's easy) is not as natural to them as use of text editor (e.g. Microsoft Word).

The last trouble, we would like to address here is archiving. New semester presents the question of what to do with the "old" content. Since we are using MediaWiki system, the best solution we came with is "archiving" the students project under historical categories and preserving the "teacher's" part, so there is no need in the new semester to write it all again from the scratch.

8. Conclusion

We are convinced, that wiki system (when properly handled) can be effective and interesting knowledge management tool as well as educational tool. Although there are limitations and known issues, where wiki systems fail, when properly set-up and managed, the wiki system can be very useful tool both in Knowledge management and education.

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Privacy/Security/Trust
- A clash of Systems?

TOWARDS UN-PERSONAL SECURITY

Michael Sonntag[1]

Abstract

In current politics, security is paramount and mostly improved by reducing privacy. But do those two always have to be diametrically opposed? Are technical solutions to provide security while maintaining privacy, perhaps with an option for disclosure in certain cases, e.g. when a crime occurred, possible? This paper discusses un-personal security, i.e. security measures where it is not necessary to identify the person or only to a very limited amount. When this is a feasible option and what such measures are or could look like is described together with a categorization of security approaches in the light of privacy.

1. Security and identification

Security and privacy are generally seen as diametrically opposed: You can only have one of the two. If security is improved, privacy must be reduced by the same amount. Similarly any increased amount of anonymity brings about a matching decrease of security. But is this really correct for all kinds of security and privacy as Schneier discusses in [1]? For instance, a fence increases physical security, but does not affect privacy as it can be seen through easily. Additionally, it keeps out all persons without a need for identifying them. Contrarily a curtain will improve privacy, but not keep out burglars. However, less visibility of valuable items might render this house a less desirable, and therefore more "secure", object of attacks. Similarly a completely anonymous "whistleblowing hotline/E-Mail account" improves privacy and does not reduce security at all. On the contrary, it even increases it through the possibility to communicate misuse, lax following of security rules, or active circumvention without fear of retribution. These are examples of the independence of security and privacy in the physical area. Whether such an approach is viable in the Internet or for computer systems this paper discusses.

[1] Institute for Information Processing and Microprocessor Technology, J. Kepler University Linz, Austria; sonntag@fim.uni-linz.ac.at

Additionally, amassing data on persons through surveillance in the hope of increasing security, as seems to be the target of recent legislation, leads to even larger danger: Break-ins with consecutive disclosure, identity theft, extortion, employee misuse etc. become more likely the more interesting and tempting the target is. While the fact that a certain person is an employee of a specific company is not very interesting and can be deduced in other ways quite easily, the fingerprint, voice patterns, exact ways through the building including their timing, log-on and –off times etc. are much more desirable: Not only as direct information, but also as preparation for then much more dangerous attacks.

So reducing personal information and maintaining, or even increasing, the level of security should be a prime target in all circumstances: Design, development, etc.

2. Categorizing security in the light of privacy

Because security is not always the direct opposite of privacy, as seen above, measures to improve it can be classified according to their implications for privacy.

2.1. Personal security

Security measures will impact privacy only, if they are tied to individual persons or groups with a known membership: Like in the fence example a lock on the door of the server room does not detract from privacy in itself, as it affects all persons alike in not being able to open the door. Still, the key to this lock is connected to a (single) person: Only one person can hold it at any time (physical key) or, at least should, know it (password, PIN etc.). This we call "personal" security, as it is tied to a person, regardless whether this refers to the barrier or the implements to overcome it for entitled person, and will not fulfil its security purpose without this association. Note, that this does not mean that the person must be *fully* identified every time and for everyone ("personal data" according to privacy laws), just that this is at least possible for someone ("*indirectly personal* data").

What person(s) are actually - or potentially - identifiable results in a second level of distinction: Whether it is "positive", "neutral" or "negative" personal security. Positive personal security means, only those who may get access, in whatever sense, must be identified and all other persons remain completely anonymous, while neutral personal security results in everyone being personally identified in some way. What we call negative personal security will identify solely attackers.

2.1.1. Examples for positive personal security

Personal security measures are those, where the person to be granted access is identified, while attackers and other persons, like passers-by, remain anonymous.

- Keys, passwords, tokens for authentication: Through using the token the presence of the person owning or carrying it is detected. Depending on the "key", this is a unique identification or as a member of the limited group of "carriers". Whether the identification is possible only for the "lock" or everyone (e.g. RFID tokens), does not affect the basic problem. On the other hand, persons forcing the lock are not identified by the act itself; only perhaps some other remaining traces like fingerprints might enable this.
- Automatic locking: When users frequently leave their computer unattended, automatic locking is a useful measure: The system is secured without the need to identify any other person. Only idle time or the absence (but not the presence!) of a token/person/… is measured in some way. This must be distinguished from the unlocking method (see keys or tokens above).
- Encryption: Encryption prevents access by anyone without a need for their identification. Similar to passwords only the person successfully decrypting the data is identified in the process through knowledge of the key. This especially applies to backups, where a lot of personal information is contained in a condensed form. Related to this are cryptographic checksums which enable the detection of modifications through some shared secret, identifying both sender and recipient, but nobody on the transmission path or any external person.
- Sandbox (signed code): When executing signed code in a secured compartment only the identity of the signer must be known. Users of the program remain completely anonymous as well as any persons who modified the code.

2.1.2. Examples for neutral personal security

In these measures everyone is identified or becomes identifiable when combined with additional data: Users as well as attackers, but innocent bystanders as well.

- Mandatory ID cards: Everyone needs to advertise her/his identity continuously, perhaps even electronically readable (RFID-Tags; see [3] for an example of their use as implants to identify patients), regardless whether currently in a place where identification or even constant locating is necessary or not.

- Video surveillance: Every person in the area monitored is affected and can potentially be traced and identified through the recording. This happens independently of whether the object to secure is being manipulated or not (see [4] for a vivid description of video surveillance in London, at that time compared to now surely significantly less invasive, and [5] for an assessment of its consequences for security).
- Automatic unlocking: When a computer is unlocked because of detecting the presence of the/an authorized person in a unique way this means, that everyone generally matching the description, like wearing a token of a certain kind, looking similar to the owner etc., needs to be checked - whether they are the person to look out for or not.
- Data retention: Information on all users is collected just in case, regardless whether there is something suspicious going on or not. Typical examples include all kinds of communication, like E-Mails and VoIP/telephone calls, but also IP address assignments in the Internet. Similar to video surveillance it provides a look into the past to identify attacks, but simultaneously on all other activities as well. These might be quite legal, but still hard to explain or embarrassing.
- Intrusion Detection Systems: They continuously monitor all network traffic, and sometimes computers, for their actions, for instance running processes (perhaps including the window title, which often contains the filename or title of the document), data sent/received, …. Although not all data they see is personally identifiable and stored, it is nevertheless a point of all-encompassing surveillance of all users without exceptions.

2.1.3. Examples for negative personal security

Approaches implementing negative personal security will only identify attackers, but not affect entitled users or others. Such measures are rare, but one example are Honeypots: Systems specifically designed for - and intended to be - attacked. As they are not in normal use but pose only as closely supervised tempting and seemingly innocuous targets, ordinary users will not be identified or affected at all, except in rare cases of errors, like mistyping URLs or IP/E-Mail addresses.

Another example is the "quick-freeze" procedure as required by the Convention on Cybercrime [2]: If a crime occurs, information necessary to track back the perpetrator can be frozen: It will not be deleted, but is not disclosed immediately either, except to a limited degree in certain circumstances. This helps to ensure data is available for a later proceeding where everything is checked in detail

and only afterwards the information retained is actually disclosed. Negative personal security comes closest to anonymous security – for ordinary users it is the same.

2.1.4. Comparison of the three personal security classes

These three variations of personal security can be ordered according to their detractive influence on privacy: Negative personal security is most desirable, as everyone remains completely anonymous except the bad guys, which is generally seen as appropriate and a necessity for law enforcement. Next in the hierarchy in positive personal security, where only persons successfully and directly coming into contact with the system are affected. Here privacy is less of a problem as such activities will be archived without a regular inspection or much interest in this. Additionally there usually exists a contract between the persons affected and the one able to identify them. Only in case of misuse the information will be analyzed (or when flowing an illegal agenda). Still it is worse, as the definition of "misuse" can be set rather arbitrarily and might include "being suspicious" for whatever reason[2]. The worst security measures are the neutral ones, where everyone is affected, even if intending neither legitimate use nor illegal access. Although in many cases no specific search will take place like in positive personal security, regular inspections will happen and accidentally noticing facts and misuse becomes much more likely. Additionally, this information is "tainted" in its view, as these are not "positive" actions taken, but at least "perhaps suspicious" ones. And because this security measure incurred costs, incentive exists to make this data pay off in some way, providing further motivation for investigation and usage.

2.2. The role of identification in security

In the common approach, "security" means:

1. Identification of the person requesting access
2. Checking whether this person is allowed access

Obviously, this is a non-anonymous process. It should be noted, however, that in many cases there is a slight difference: The second part must be formulated "checking whether this person should *not* be allowed access" (white- vs. blacklist). While this seems to be the equivalent, there is an important distinction: It assumes that a possibility exists to identify the "criminals". That this is not

[2] In the sense of "driving while black": Being investigated out of prejudice because of a completely unrelated property. See for instance the recent privacy scandal of a German supermarket chain investigating private aspects of their employees to detect possible misbehaviour, which incidentally included the videotaping of customers entering their PIN code when paying ([6], [7], [8]).

a very valid assumption airline security exemplifies. Numerous persons are not allowed to fly because of a name which is similar or identical to someone *suspected* of terrorism, and many terrorists are allowed to board planes as they have not yet been unmasked and done nothing illegal yet. A computer science equivalent are blacklists for computers sending out spam ([9]; but see also the controversy about the power of these organizations and its possible misuse [11], [10]): Although most servers employ one or several of them, spam still is a huge problem. The opposite, whitelists for computers intended to send mails (see SPF, Sender-ID and the new DKIM), have not been successful yet.

Classifying persons according to their security level also means that there is always a path less secure than others. So a very important attack vector is to achieve a high permission level, to be subsequently allowed to do everything without further checks. If, on the other hand, security is independent of the person, everyone is always subject to the same precautions and no less-secure alternative is available to try to get into. Take the x-ray scanning on airports to prevent weapons brought on planes as an example: No identification is necessary and smuggling them onboard becomes very difficult. But if an alternative exists, e.g. persons pre-screened and identified by their fingerprint are allowed a fast-boarding lane without scanning, security actually deteriorates. Evading the all-person scanning is difficult, but it is quite possible to circumvent a fingerprint scanner unobtrusively (or bribe someone) and carry onboard whatever desired.

In the classic way described above security depends on two difficult and indirect aspects: The identification of the person and his/her classification. But if the dangerous element itself is looked for, anonymity remains, no indirection step is necessary, and security hinges only on the functioning of the scanning system. Speaking metaphorically, this "un-personal security" is therefore looking for the wolf instead of checking all sheep whether they are really sheep.

It must be conceded, however, that such approaches of directly looking for "problems" are only possible when the problem can be diagnosed directly: It is e.g. comparatively simple to identify a prohibited weapon, but quite difficult to detect the mindset and intentions of persons. In computer science it is quite "trivial" to identify viruses or trojans, but hard to decide whether an advertisement E-Mail is wanted and expected by a person (→ ham) or not (→ spam).

Therefore in practice a combined approach will be necessary: Security without identification should be used whenever the "danger" can be identified directly, and identity-based measures only as a secondary approach when solely the "normal" behaviour is recognizable.

2.3. Un-personal security

"Un-personal" or "anonymous" security are security measures which never affect privacy, i.e. working without identification of the person attempting access, regardless whether this should be allowed or not. This means that only proactive, but not reactive, security is possible here: As any misbehaving entity cannot be identified later (the difference to negative personal security), logging plays no role whatsoever. However, it does not follow from this that the fact of a breach of security cannot be detected: Only that the culprit cannot be identified by such measures alone.

As can be seen from the examples below, un-personal security is not suitable for every aspect of security, but still for a long list of very useful approaches, such as:

- Firewalls: Any undesirable connection is just blocked without logging (which remains possible, but then it would be personal security), keeping out all potential intruders. This works extremely well on the packet level and resembles the example from above: A fence with some holes of a very specific shape. Important to note is that the decision whether to pass a packet or not is taken independently of the person it refers to (sender or destination), i.e. solely on the port, the IP address or any other not personally attributable content data like dangerous URLs, with the deep inspection coming closer to personal security.
- Application gateways: These exist on a router and check certain traffic, for instance web pages, against a list of known exploits or classes/methods of attack. They are in general independent of the requesting person and the server and only inspect the content according to technical properties. Usually suspicious content is just blocked, but logging or notifications to administrators are possible as well; but these would then no longer be classified as un-personal but rather as negative personal security if the recipient would be identified (the server is often not attributable to a single person, or only to a weakly protected legal person).
- Anti-virus/-spyware programs: Similar to application gateways but checking for viruses, trojans, spyware, rootkits etc. in E-Mails, network traffic, and files. As the sender E-Mail and IP addresses are usually forged, no real and identified person is involved at all.
- Write protection: Physical or logical write inhibitions protect against modifications and deletion without the need for any identification. It should be noted however, that this is un-personal security only if *nobody* is allowed write access (positive personal security otherwise).

- Sandbox (unsigned code): Applets are executed in web browsers in a so-called sandbox: They cannot access the local file system, connect to servers other than they were loaded from, or call operating system routines and are therefore limited in their abilities to do harm. Similar measures are taken for JavaScript. Both seem to work very well in practice as signed code for which these restrictions are lifted (and where the author is always identified, although not necessarily with his/her real name or only as an organisation → personal security) is very rare.
- Code verification: Checking that some program will only do what it is allowed/is legal to do. This applies especially to checking for exploits or bugs. As only the code is inspected and the "quality" of its author (or publisher) is ignored, no connection to any person is present. If the source of the code is known, it could be classified as positive personal security instead.
- Checksums: They protect against transmission errors. However, they are not that useful as any attacker can easily recalculated them. Countermeasures like cryptographic checksums will usually not be un-personal security any more, as the fact of shared knowledge of the key involved allows identification. Only if the shared secret is know by many entities (but e.g. itself strongly secured on smartcards), anonymity remains.
- Double execution with variance: Targeting the same area as code verification is multiple performance of some action with slight variations and checking whether the results are identical. This can be directly related to code verification (e.g. executing the same program with stacks growing in opposite directions to check for buffer overflows), but is generally applicable (like executing a query twice on different servers, with different sorting, additional elements, …).
- Tripwires: This approach checks a system for modifications as compared to a "baseline" established at a point in time where it was presumable in perfect order. As only "anonymous" files, or rather their checksum, are compared with a previous version, no personal data is touched. If nothing suspicious is found, no action like logging takes place, and if an alert occurs only the changed files are mentioned (that these belong to certain people is of no consequence here; moreover these are usually executable files with no personal content). Who modified a file also plays no role in this check.

2.4. Responsibility for security and privacy

Security is generally not the obligation of the affected person: *Objects* are secured *from* other *persons*, not the person from the object (→ safety). This leads to a "do it for me" attitude, where

security is seen as a necessary evil. From this also stems the dislike and the ubiquitous circumvention actions for more intrusive security measures, which's reasons are not connected with privacy ("too complicated", "takes too long", "inconvenient", "hampers work", …). Security is therefore hard to guarantee as continuous monitoring and training is necessary: Who is affected by the measures has only little interest in their success.

Privacy on the other hand is a "do it yourself" task: Everyone is responsible on his/her own to guard their personal data. Only when passing it on, others become responsible in addition - but only for ensuring that the rules set by the person are fulfilled. E.g. when participating in mail-in competitions, name and address are disclosed and optionally their use for advertising can be prohibited. The company organizing the competition is responsible for guarding the privacy only to the extent defined in law and the scope allowed by the person itself; i.e. those which did not cross out that line granting the use for public relations.

This dichotomy is mirrored e.g. in Austria in the legal framework as well: Security breaches are often crimes[3] and therefore prosecuted by the police and the criminal courts. Privacy on the other hand is, with very few exceptions if not breached by a public body, a private matter only and therefore citizens must organize investigations themselves and go to civil courts. From this the comparative importance follows: A security breach is a serious thing (investigation and prosecution is paid for by the state), while a privacy infraction is more of a gentlemen's misdemeanour (and brings with it the risk of the process costs). This is mirrored in the police activities[4]: There were numerous incidents with child pornography and various kinds of computer fraud in many years, but there was never even a single case connected with privacy to investigate. The reason for this is not because no privacy problems exist or there are so many other crimes, that no resources for investigating them are available: They are just not seen as important and when they occur, which is usually in companies which "loose" personal data of customers or employees, this is nothing to be made public, but rather kept secret if possible at all.

A similar distinction exists in business coverage: Numerous companies sell "security" in various forms. Hardware, software, services, education etc. are readily available in a huge and lucrative

[3] Like unauthorized computer system access (§ 118a StGB), message interception (§ 93 para 3 TKG), computer fraud (§ 148a StGB) etc. See also the European Convention on Cybercrime [2].
[4] Personal account of the head of the unit responsible for computer forensics in a large part of Austria.

economy. Contrastingly, companies specializing on increasing or ensuring privacy are rare[5] and small, but those dealing in personal data, the opposite of anonymity, are again many and huge.

3. Approaches towards un-personal security

To achieve security without identification three general approaches are especially important:

1. Fences: General security barriers intended to keep out unwanted entities. They can be general, like bars on a window, when nobody is expected to cross this particular boundary, or specific, i.e. with a kind of door. The latter then usually needs to be combined with some kind of identification, although not necessarily directly personal one like a kind of token where possession alone is enough, of the entities allowed to bypass it.
2. Automatic anonymous searches: Detectors for illegal objects like metal (→ weapons) or drug detectors work anonymously, but are usually employed only as negative personal security, i.e. persons detected as positive will be identified in a second step (the testing itself is anonymous!).
3. Seals: They provide authenticity through their complicated design but do not identify their (exact) source, i.e. who placed them there. Examples are security elements on paper money, which ensure its authenticity, but do not identify the source of the money, i.e. through whose hands it passed. A seal only identifies its issuer, which is typically not a single natural person and additionally unrelated to the security check.

According to this distinction the examples provided above as well as the approaches discussed below in more detail can be classified as shown in Table 2. The last two are examined in more detail below as examples towards un-personal security, but which are not completely anonymous so not actually belonging to that group. The final subsection describes an approach for those circumstances where un-personal security is impossible, but improving privacy is still important.

[5] Examples are anonymization services like JonDonym (http://www.jondos.de/) regarding web browsing and Anonymizer (http://www.anonymizer.com/) for E-Mail and other services.

Security measure	Fence	Anonymous search	Seal
Firewall	**X**		
Application gateway		**X**	
Antivirus SW		**X**	
Write protection	**X**		
Sandbox	**X**		
Code verification		**X**	
Checksum			**X**
Double execution		**X**	
Tripwire			**X**
Automatic anonymisation		**X**	
Data safe			**X**

Table 2: Un-Personal (or close to this) security measures vs. the three general approaches

Automatic anonymisation

Automatic anonymisation refers to the practice of continuous surveillance (which in itself is personal security!), where any suspicious activity is searched for fully automatic and, if none is found, the data is automatically anonymized or deleted completely. Only positive matches will remain, resulting in negative personal security if identification follows. If simply the access is denied, this method comes very close to un-personal security of the "fence" type. It can be compared to a hole in a fence with a peculiar shape or a fishing net with a minimum size of the netting: Everything matching can pass unnoticed in any direction, frequency, appearance etc. anonymously, but those entities not matching the "exception" will be stuck. Note that the permission depends solely on the external "shape" of the entity passing through: No identification is necessary to pass, i.e. no list of "allowed shapes" exists and no inner properties (content) are checked. In a way, any unwanted entity makes its decision itself: Its own shape is preventing it from getting through, not the decision of some other person whether its shape is acceptable or not. As the shape alone is not always sufficient, especially in IT, any method which is fully automatic and does not require identification, i.e. only looks at one or more properties (external → fence, content → automatic anonymous searches) not allowing identification even together, can be subsumed under this heading. Through this, neutral personal security can be transformed to negative or even un-personal security.

A prime example from the non-IT world is the section control on highways: At a certain place every single car is photographed digitally, the license plate scanned, and the same happens again at a position further on. Depending on the time the car required to reach the second place the average speed can be calculated. If it is below the speed limit, all data is immediately and completely deleted: It is impossible to identify any car - and therefore person - afterwards if the speed limit was obeyed. But when a car drove to fast, the data is stored and transmitted to the police for further processing.

An example from the IT area are network intrusion detection systems (IDS): Only alerts are stored, and perhaps tried to trace back to the originator. Still, every packet on the whole LAN segment is copied, investigated, and stored. So this configuration would be neutral personal security, as identification is typically possible within a company. But when all the traffic is not copied but only inspected and generalized to achieve a baseline to compare with, no personal data is stored any more. Still, persons are identifiable for a short period through investigating the content as well as source and sink of the packets. If the investigation ignores the payload content and only focuses on the flow, i.e. the protocol, and generalizes source and sink ("Computer of user 12" → "Development department"), anonymity has been reached. As these modifications are one-way only and if they are performed immediately this closely resembles the example of section control above.

3.1. The data safe

A data safe is a personal virtual safe deposit box for electronic documents. It can contain e.g. electronically issued permits or documents proving rights or status, like an electronic birth certificate. These are stored online safely, i.e. protected through backups from loss and through encryption from unauthorized access.

When requested by someone to prove a fact with a document stored there, three options exist: Firstly the document may be retrieved and passed to the person, or secondly the interested party could be allowed access to the data safe; perhaps not the whole but only relevant documents. Both approaches are not anonymous at all. The third option is that the data safe administrator could be asked by the data owner to confirm to the third party that certain documents exist and are valid. Obviously this depends on the operator, who needs to be very reputable (and could for instance be the government itself, then posing no problem in this respect), and the document, which must be identifiable as genuine by the operator. The big advantage of this variant is that the data itself need *not* be provided to the third person. Only the confirmation by the operator that a certain class of data

exists is transmitted, removing the transmission of superfluous data and acting like a seal[6]. Obviously this works best when not the information itself is required, but only whether a certain property exists: A typical case for checking permissions in a distributed system.

One practical instance are public cigarette vending machines: In Austria they can only be operated by persons above the age of 16 years, which is usually proved by first inserting a banking card[7], and then only buying the cigarettes. However, it is not the birth date which is stored on the card but just a single bit marking whether the owner is older than 16 years or not. Here the vending machine owner simply trusts the secure (such cards are very hard to counterfeit because of cryptography) seal provided by the banks[8], which presumable correctly checked the age of the person the card was issued to.

3.2. Four-eyes approaches

Approaches requiring multiple persons for identifying the person some data relates to are not really un-personal security, as seen comprehensively identification of the affected persons *is* possible, although it becomes much more complicated and both misuse by employees as well as through external persons, e.g. by hacking, increases in difficulty. Effectively, in normal operation it is equivalent to un-personal security, but if enough reasons exist, by a special procedure the veil of anonymity can be pierced.

The basic idea is that the personal information is split in two or more parts, which are connected through a unique but non-identifying common element, for instance a random number. These two, in theory also more are possible, parts must be stored and secured separately. Any person should have access to a single part only. To identify which person is connected to which data, or the reverse, therefore two persons must work together and combine data from separate systems. For each of them alone the data is either completely anonymous or not available at all.

Example for such approaches are pseudonyms in certificates for electronic signatures. The person owning the certificate remains anonymous to all recipients of signed documents. It is important to note that this might be even a legally fully valid signature, like an enforceable contract! However, the certification authority *does* know the real identity of the certificate owner. Through inquiring there, with sufficient reasons and permissions, it can be ascertained who actually electronically

[6] See for example SET (Secure Electronic Transaction, an Internet credit card payment system), where merchants receive from the payment provider only a confirmation that a valid credit card exists, but not the card data itself.
[7] "Bankomatkarte", "Maestro-Karte"
[8] Whether the person holding the card is actually the owner is not verified, but this has been discounted as too complicated to verify and not necessary, as other ways to circumvent the limitation exist as well.

signed a document. On the other hand the certification authority has no access to the signed documents and is therefore ignorant of the actual use of the certificate[9]. While this scheme is not that interesting for a normal certificate, it becomes so when the certificate contains special attributes, e.g. age, permissions to sign for other entities etc.

Another application for the four-eyes approach is automatic unlocking in a wide sense. This has been described briefly above, but cannot be subsumed here directly as it is: Unlocking a specific computer requires not identification as an authorized person only, which could be separated and pseudonymized, but as a single user. Still, when the identity of the user is less important than the permission as such, this approach *can* be used. Consider for instance subscriptions to electronic libraries: While a username and a password can be shared easily amongst several persons and be used (almost; depending on other precautions) simultaneously, this is impossible or much more difficult with a physical access token. Regarding the type of security, a password means direct personal identification, but a token, like smartcards, key generators, USB dongles etc., need not be coupled to an identity (although currently they usually are – the owning person/company): Their presence alone would be sufficient to prove authorization.

4. Conclusions

Un-personal security has been introduced, classified, and explained according to several examples in this paper. Its importance is constantly increasing, as e.g. identity theft, which was for a long time a problem mostly occurring in the USA only, has now reached Europe as well. Therefore the desire for privacy becomes stronger, although remaining secondary to security in the view of the general populace - at least as long as they are not affected personally[10]. Approaches to combine both are therefore urgently needed. Security independent of identity, i.e. decisions based on some properties and not the unique identification of a person, must therefore be investigated and have been outlined. The three main avenues for this are fences, anonymous searches, and seals.

Although un-personal security cannot be used to counter all security threats and is not suitable in all circumstances, it deserves a much larger focus. When identification is necessary, a four-eyes approach should be followed: This is better than the typical current usage of full identification in all situations and where all data is stored on a single server, so only a single barrier must be overcome

[9] Inquiries for revocation lists could provide some information, but even just collecting such data is prohibited.
[10] See e.g. the recent privacy discussion on teacher evaluation in school portals in Germany ([12]).

to obtain all information on someone. Negative personal security is another option with comparatively little privacy infraction, which is still able to improve security.

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SECURITY AND PRIVACY IN AN ENTERPRISE SEARCH INFRASTRUCTURE FOR MOBILE DEVICES

Christian P. Praher[1], Jakob F. Praher[2]

Abstract

With the advent of new powerful smart mobile devices that combine the properties of up to now individual appliances like cell phone, Personal Digital Assistant (PDA), or consumer electronic device, new mobile use cases emerge. Especially in the field of enterprise computing, many new fields of application and possibilities of how to incorporate mobile clients into the corporate environment arise with these powerful mobile devices.

This paper first provides a quick overview about the evolution of mobile computing. The focus of it lies in the issues of security and privacy in the context of an enterprise search environment with regard to mobile computing. Firstly, an overview about a traditional enterprise search security architecture that is only operated within secure corporate walls is given. Then the problems that emerge from integrating mobile clients accessing enterprise information from an insecure network like the Internet are highlighted, and general ways of how to solve these issues are presented. Finally, a web Single Sign On (SSO) enterprise search infrastructure for mobile devices on the basis of common web technologies and the Security Assertion Markup Language (SAML) is proposed.

1. Evolution of Mobile Computing

Mobile computing has become a real catchphrase within information technology over the past few years and the term may denote many different things ranging from portable desktop computers, over mobile phones to embedded, ubiquitous computing devices. Within this paper, mobile computing generally refers to *smartphones*, which represent smart mobile devices that combine the

1 Institute for Information Processing and Microprocessor Technology (FIM), Johannes Kepler University Linz
[2] Mindbreeze Software GmbH

following three characteristics into one single device, that have as yet only been found in individual appliances[12]:

- **Communication**
  As their name implies, smart*phones* are phone centric devices, which means that they comprise all the features usually found in a "normal" mobile phone. Smartphones also have the property of being heavily interconnected. Besides the traditional cellular networks primarily used for voice communication, smartphones traditionally also possess wireless Local Area Network (LAN) interfaces for high speed data transmission, as well as Body Area Network (BAN) connections like Bluetooth or infrared, utilized for ad hoc networking and as a cable replacement for attaching peripherals to the device.

- **Computing**
  A distinct feature that sets smartphones apart from traditional mobile phones or feature phones[3] , is that they possess a complex operating system that can be extended through third-party applications. Also, smartphones offer Personal Information Manager (PIM) functionalities like calendar, address book, task-lists, etc., which were usually found in Personal Digital Assistants (PDA) and pocket PCs.

- **Consumer Electronics**
  With the ongoing miniaturization of electronic devices, more and more functionalities of typical consumer electronic appliances find their way into mobile phones. Amongst others, typical modern smartphones comprise the features of a digital camera, mp3-player, Global Positioning System (GPS) receiver or accelerometer for measuring acceleration due to gravity.

1.1. Convergence of Technologies

Accompanied by the technical convergence of multiple appliances into one single mobile device, is a convergence of mobile application development with desktop application development.

Three of the most important ways of creating applications for smartphones are *mobile web applications*, *Java Micro Edition (ME) applications* and *native applications*, with each technology having its unique strengths and weaknesses[9].

[3] A feature phone is an average cell phone with additional feature support like amongst others high resolution display, camera, or mp3-player[4]

1.1.1. Native Applications

Generally, native applications as "first class citizens" of the mobile operating system, offer the best access to information exposed by the operating system, like e.g. the device context, PIM data, or any other accessible data. By being closest to the hardware, they usually also offer the best performance. Drawbacks of native applications are that they are bound to a particular platform and that they typically take longer to implement than their web or Java ME counterparts.

Modern smartphone platforms, like e.g. Apple's iPhone[4] , or Open Handset Alliances (OHA) Android[5] , have very sophisticated native programming libraries that allow for application development similar to that of desktop computers.

1.1.2. Mobile Web Applications

Mobile web applications represent the other side of the mobile application development spectrum. They offer very little to no access to device data, but have the benefit of being operating system agnostic and are traditionally easier to develop than other types of applications.

The techniques for developing mobile web applications have matured a lot over the past few years and have today almost completely converged with desktop web development standards[9]. Only some years ago, back in 1998, the Wireless Application Protocol (WAP) 1.0 was introduced which was built upon a proprietary network protocol stack and offered a very restricted markup language in form of the Wireless Markup Language (WML). WAP 2.x introduced in 2002 showed first tendencies towards an unification of mobile and desktop web development. Finally, todays smartphone devices with their modern mobile browsers like e.g. the WebKit[6] based Apple iPhone Safari, mark the complete convergence with the traditional World Wide Web (WWW), Internet Protocol (IP) based network protocol stack and the application development standards maintained by the World Wide Web Consortium[7] .

1.1.3. Java ME

Java ME applications effectively lie in between native and web applications, by offering more functionalities than mobile web applications and still being easer to develop than native applications. Additionally, Java ME possesses the advantage of being operating system

[4] http://developer.apple.com/iphone/, last viewed 2008-07-14
[5] http://code.google.com/android/, last viewed 2008-07-14
[6] http://webkit.org/, last viewed 2008-07-14
[7] http://www.w3.org/, last viewed 2008-07-14

independent. A major drawback of the Java ME platform is that it is very fragmented with varying levels of API support amongst different devices[9].

Like native and web applications, the Java ME platform has evolved with the wireless device market, by offering new libraries specifically targeted at new handset functionalities like Bluetooth, Web Services or location APIs. The Mobile Service Architecture (MSA)[8] currently marks the latest step in the Java ME evolution.

1.2. Smartphone versus Desktop Computing

In case of todays new smartphone devices, the difficulties in application development are not so much rooted in API deficiencies, but rather stem from other mobile device inherent limitations like e.g. limited processing power, storage capacities and battery life, a completely different form factor and totally different usage scenarios compared to desktop computers[9].

This of course also impacts mobile application security and privacy. Whereas it is e.g. no big issue to prompt a user on a desktop computer several times for a password, this can rapidly become very cumbersome on a mobile device, which only features a 12-button cell phone keypad.

With mobile devices it is possible to access company data over insecure networks, which demands for augmented security and new ways of protecting data.

2. Enterprise Search Security

The primary purpose of an enterprise search infrastructure is to provide people with a highly efficient access to the vast information stored within their enterprise data sources. Access is typically performed by the means of a search interface. The connected data sources can be as various as the corporate application environment and could e.g. comprise local and network file systems, Content Management Systems (CMS), Document Management Systems (DMS), web servers, etc. Basically, the enterprise search infrastructure acts as an agent system that analyzes and accesses information on behalf of the acting client user (see figure 1).

[8] http://java.sun.com/javame/technology/msa/, last viewed 2008-07-14

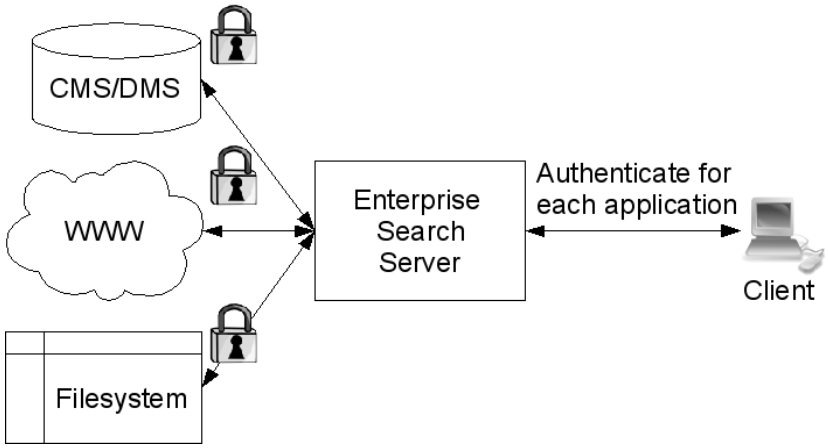

Figure 1: Enterprise search security basic architecture

Naturally, the various different connected data sources may all implement their own security mechanisms with proprietary authentication and authorization schemes. As figure **1** shows, this consequently means that the user has to provide her appropriate credentials for every application which is involved in the search result. In a real world scenario this could mean that the user has to provide different credentials for every application. Often the user may not even have a chance to know which credentials to supply, since the enterprise search application hides away the implementation details of the underlying data source and provides the search interface through a portal like federating interface.

A solution to that problem is to use a Single Sign On (SSO) architecture that authenticates the user once and allows for accessing various data sources with one login. Today most enterprise SSO environments are typically created by the use of the Kerberos[9] protocol, initially created by the Massachusetts Institute of Technology (MIT) in the 1980s. Figure **2** shows a high level view of a SSO based enterprise search architecture.

[9] http://web.mit.edu/Kerberos/, last viewed 2008-07-14

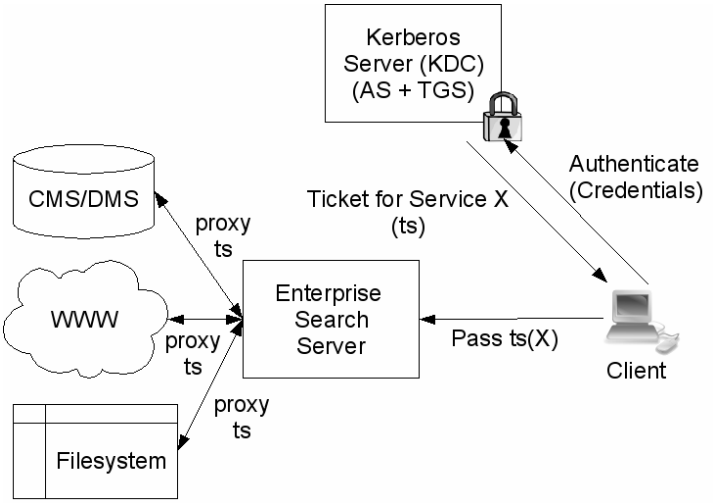

Figure 2: Enterprise search security Single Sign On (SSO) architecture

The basic Kerberos authentication process is as follows[11, 3]:

The user first types her credentials as user name and password into her client login window. Only the user name is transferred to the Kerberos Key Distribution Center (KDC). The private password is a shared secret known only to the KDC and the user and is never transferred over the network, but rather used as a private key for encrypting "message digests". The KDC consists of Authentication Service (AS) and Ticket Granting Service (TGS). The AS authenticates the user and gives her a Ticket Granting Ticket (TGT), which gets stored in the cache of the client machine and usually is valid for some hours. The TGT serves as an authentication token for getting access tickets from the TGS to the secure applications within the enterprise search environment. The TGS returns a new service ticket (ts) for every secure application the client wishes to access. With the given ticket from the TGS, the client can finally authenticate itself at the secured application and can establish a connection

Within the enterprise search infrastructure, the search query service acts as an agent satisfying the requesting user's information need. This so called "user impersonation" is performed by delegating (proxying) the received tickets. It does not itself perform any authorization and is also not aware of the contents of the received tickets

While Kerberos has many advantages like SSO, strong security, wide adoption, etc., it also suffers from some drawbacks that make it particularly hard to implement in a distributed mobile scenario.

Kerberos is usually operated within secure corporate walls behind a firewall. To enable access to a Kerberos KDC from the Internet, the corporate firewall has to be configured to open ports for Kerberos that otherwise do not need to be accessible.

Furthermore under some configurations, Kerberos may not work when the clients use Network Address Translation (NAT) or dynamic IP addresses via Dynamic Host Configuration Protocol (DHCP).

The long validity of the Ticket Granting Ticket (TGT) that spares the user from repeatedly retyping its credentials could also impose a security threat to mobile devices. If the mobile device gets lost or stolen shortly after the TGT is issued, the user stays authenticated for several hours until the ticket expires, which leaves great potential for damage to the enterprise data.

Another serious drawback for mobile devices is that only very few platforms support Kerberos out of the box.

3. Mobile Web Single Sign On (SSO) Infrastructure

As figure **3** illustrates, besides the limited capabilities of mobile devices, the most significant difference regarding security compared to desktop computers operated within the premises of the company, is that they are typically operated from outside and are not physically connected to the corporate networks. Direct access to the company's network is provided only by the means of Virtual Private Networks (VPNs).

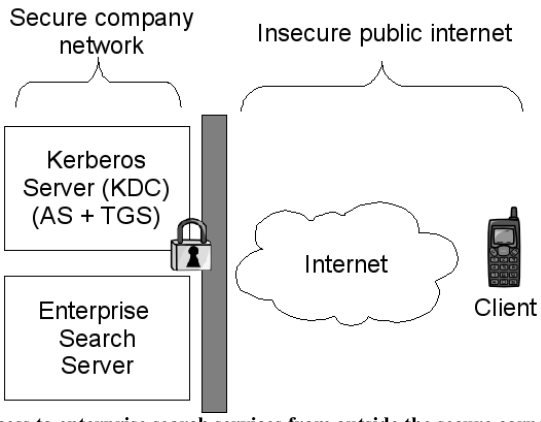

Figure 3: Access to enterprise search services from outside the secure corporate network

An interesting alternative to accessing the whole corporate network infrastructure through a VPN is to create an architecture that allows a secure access to the enterprise search infrastructure over the insecure Internet. In this sense making the application's native network stack security aware, enables possibilities for the security infrastructure to provide client specific forms of user authentication and authorization.

The following claims should by all means be supported by such an architecture:

- The support of mobile wireless devices must not compromise the existing security architecture.
- The infrastructure must answer to the possible technical limitations of mobile devices.
- The authentication mechanism must correspond to the handling of mobile devices, which is very different to that of desktop computers.
- As little as possible sensitive data should be stored on the mobile device to avoid data corruption in case of theft and loss. If nonetheless the device gets stolen/lost, their should still be a last security barrier that keeps an unauthorized user from instantly accessing the enterprise data.

3.1. General Possibilities of Securely Authenticating a Mobile Device over the Internet

The basic technologies driving the WWW like IP, Transmission Control Protocol (TCP), Hyper Text Transfer Protocol (HTTP), eXtensible Markup Language (XML), Transport Layer Security (TLS), etc. can almost be considered *ubiquitous* and are hence a good starting point for a wireless client implementation. Many platforms, like native applications, Java ME and even modern mobile AJAX based web applications have support for these technologies[9].

3.1.1. TLS server side certificates and HTTP Basic Authentication

The simplest approach of creating a secure mobile client would be to use basic authentication over encrypted secure HTTP (HTTPS). It has the advantage of being available on a great number of devices and platforms. Even simple WAP 1.x/2.x mobile browsers are capable of supporting this technology, and by designing the client search interface as simple WML or XHTML (MP) website, one would reach a great number of devices.

However, this approach has some serious drawbacks that outweigh the benefit of a large client base. The most significant disadvantage is that the user would have to provide separate credentials for

every data source connected to the enterprise search server (see figure 1), which renders this approach inappropriate in practice.

3.1.2. TLS client side certificates

An extended version of the TLS approach is to use client side certificates in lieu of HTTP basic authentication. This bears the advantage of strong two factor authentication. Another benefit is that the user would never have to type in any passwords, since the client certificate would unambiguously identify her.

Still, two disadvantages strongly militate against this architecture. Firstly, the installation of the client certificate together with the private key in form of e.g. a PKCS#12 file, would mean a high security risk if the device was lost or stolen. An additional safeguarding mechanism like e.g. remote wipe would have to be employed, to prevent unhindered access to the enterprise data in case of device corruption. The second, in terms of finding a workaround implementation even more severe disadvantage is, that client certificates can not be securely delegated[10]. Since in enterprise search queries are performed on behalf of the user, she has to be impersonated for gathering information about access rights to respective data sources. Impersonation based on client certificates would mean that the private key together with the public client certificate would have to be handed over to the server. This is practically unacceptable as it would open a dangerous loophole for malicious servers, which would then have the entire client identity.

3.1.3. Application level authentication

In the recent years, many standards and specifications have evolved in the field of Web Services that allow for securing HTTP based applications at the *application level*. Application level means that the security information is not a separate layer inaccessible from the layer above, but is directly encoded into the transferred meta data. Web Services-Security (WS-Security)[10] , Security Assertion Markup Language (SAML)[11] , XML Signature[12] and XML Encryption[13] are amongst the most important specifications for secure Web Services.

[10] http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wss, last viewed 2008-07-18
[11] http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=security, last viewed 2008-07-18
[12] http://www.w3.org/TR/xmldsig-core/, last viewed 2008-07-18
[13] http://www.w3.org/TR/xmlenc-core/, last viewed 2008-07-18

WS-Security markup can be included into the SOAP-header and defines three general-purpose mechanisms for associating security tokens with message content, which are[8]:

- User name Token Profile
- X.509 Certificate Token Profile
- SAML (Security Assertion Markup Language) Token Profile

This means that WS-Security is the messaging language, whereas SAML is the security language[1]. WS-Security is very closely related to SOAP based Web Services as it is directly defined in the SOAP header. This is opposed to SAML, which provides many different bindings like e.g. a SOAP binding, HTTP POST binding, HTTP-Redirect binding, URI binding, etc. [6] and is hence independent of the underlying carrier technology. This allows it to be used in non SOAP based distributed scenarios, which are especially attractive for mobile devices, since they are technologically less demanding. E.g. the Internet search company Google proposes a web-based Single Sign-On (SSO) service for their Google Apps[2] on basis of SAML and its HTTP-Redirect binding.

The following shows an overview of a proposed architecture for securely authenticating mobile clients over the Internet by using SAML, which conforms to the claims stated in the previous section.

3.2. Proposed Web Single Sign On (SSO) Enterprise Search Infrastructure for Mobile Devices

Figure 4 shows a high level view of a web based SSO enterprise search infrastructure for mobile devices on the basis of SAML, proposed by the authors of this paper.

The following is a brief overview of the proposed architecture:

- There exists one single web Search Portal that federates n different enterprise search Query Services. Figure 4 shows two, Query Service 1 and Query Service 2.
- The mobile user directly accesses this single portal over HTTP. The actual mobile client could be a native, Java ME or even a mobile AJAX web application.
- The next key entity is the SAML Assertion Provider or Identity Provider (IdP). It acts as a meta authentication framework and knows, depending on the actual enterprise application infrastructure, how a SAML assertion has to look like. A SAML assertion is a package of information that supplies statements made by a SAML authority like e.g. an Identity

Provider[7]. Most importantly the SAML assertion holds the authentication statement, which specifies that a subject was authenticated by particular means at a particular time. The means of authentication describe how the subject was authenticated and is described in the authentication context. SAML 2 supports many authentication context classes, like e.g. Kerberos, Password, Public Key – X.509, Smartcard, etc.[5]. Besides the authentication statement, the SAML 2 specification defines the attribute and authorization decision statements.

- Every Query Service is connected to n different data sources, like e.g. a file system or a CMS/DMS, via Data Source Interfaces. Such a Data Source Interface has access to the SAML Assertion Provider and can hence check the assertions forwarded by the Query Services on behalf of the accessing subject for validity. In order for a new Data Source to be integrated into the enterprise search environment, a new SAML aware Data Source Interface has to be provided.
- Finally, Kerberos acts as usual by maintaining the user access base and issuing the tickets necessary for authentication and authorization.

A typical use case within the above described infrastructure could be as follows:

The Search Portal completely delegates authentication to the SAML Assertion Provider. This can be realized by redirecting the HTTP user agent's location to the URL of the SAML Assertion Provider. This ensures that the Search Portal obtains user credentials in the form of a SAML delegable assertion. The credentials together with the search request is passed on to selected Query Services. Like the Portal the individual Query Service does not directly perform data source specific authorization of the credentials and simply forwards it to all its connected Data Source Interfaces. Since the Data Source Interfaces are connected to the SAML Assertion Provider, they can authorize the given assertion with the included user authentication information against the Assertion Provider and take specific authorization actions depending on their Data Source's access policies.

The result of the proposed infrastructure is a delegable and well defined security architecture that solely builds on open Web standards and allows for connecting mobile clients from within insecure networks, especially the Internet. A key aspect of this architecture is that it separates the security- from the search-infrastructure.

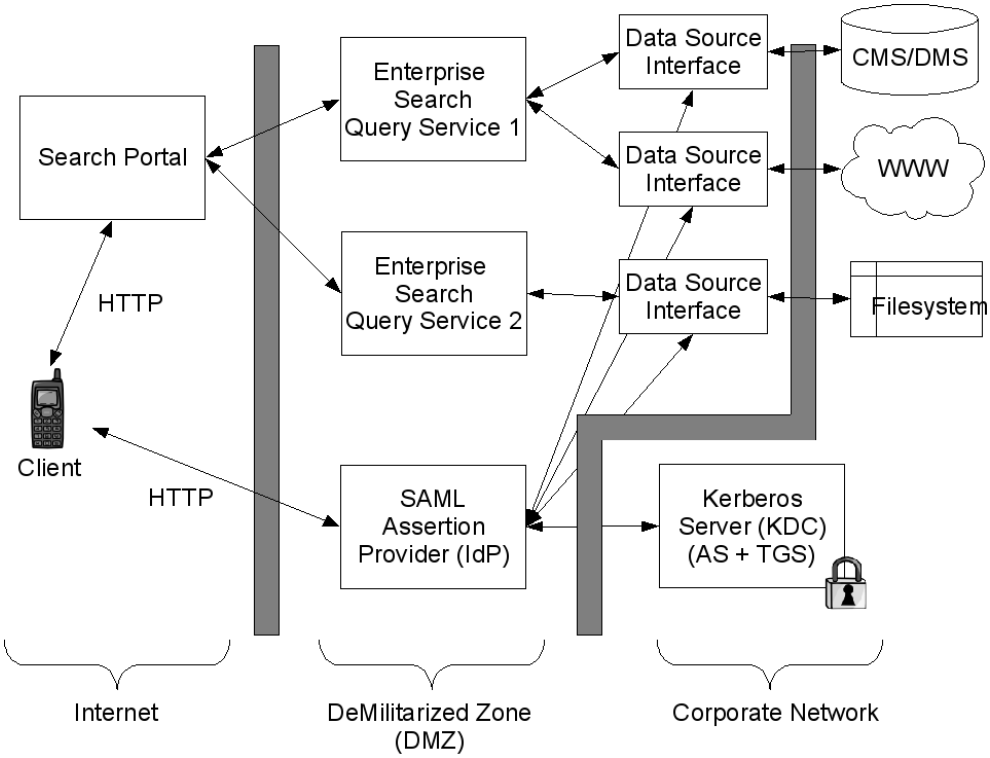

Figure 4: Proposed mobile web Single Sign On (SSO) enterprise search infrastructure

3.3. SSO Requirements with Respect to a Mobile Environment

Basically, the proposed infrastructure should be realizable on a large number of smartphone platforms, including native, Java ME or even (mobile AJAX) web applications.

As an additional security enforcement, some kind of *session token* could be sent to the user on authentication. This token could e.g. be a 3 or 4 digit number that the user can easily remember. For every search request, the user has to supply this code for being able to issue the request. In case of theft or loss of the device, this prevents a third party from instant access to sensitive enterprise data.

Another consideration specific to mobile devices could be to reduce the validity of the SAML assertion to a rather short time. Instead of being valid for several hours like e.g. a Kerberos ticket, only several minutes up to an hour could be a reasonable time range for the SAML assertion of a mobile device. This would increase the likelihood of the device being “locked” in case of theft or

loss. As with the proposed session token, this can only be understood as a preliminary precaution until further security enforcements take place.

4. Conclusion

Mobile device technologies evolve at a fast pace, opening new fields of application to distributed mobile infrastructures that have not been able to be realized still some years ago. While hardware features rapidly mature and mobile software application paradigms seamlessly converge with those from desktop computing, mobile devices still possess their unique characteristics that influence application development. Their handling is very different from that of desktop computers and they are operated in quite different scenarios compared to stationary devices.

This paper focuses on the adoption of mobile devices within an enterprise search infrastructure. While new compelling smartphone devices like e.g. Apple's iPhone will most likely be key enablers of a shift in enterprise computing towards the usage of mobile clients, this paper outlined that their incorporation into existing desktop centric architectures is challenging and can not be easily done due to their distinct properties. Mobile devices are usually operated outside the secure corporate walls. Employees working with mobile clients connected to the corporate infrastructure through untrusted networks requires the enterprise infrastructure to adapt.

An approach for leveraging an existing enterprise search infrastructure based on Kerberos authentication is proposed within this paper. Security is provided on the application level by means of the Security Assertion Markup Language (SAML) over HTTP. This combination allows it to be deployed on a large number of mobile client platforms. The proposed infrastructure represents a secure, federated architecture which offers the great benefit of Single Sign On and a clear separation of the security- from the application-infrastructure.

Further refinements of the proposed architecture should involve measures of pro actively preventing third parties from unwarranted access of enterprise data in case of loss and theft of the mobile device.

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TRUST BUILDING MECHANISMS FOR E-MARKETPLACES

Radoslav Delina, Anton Lavrin, Jozef Bolha[1]

Abstract

Identified trust building mechanisms varied according to their complexity and acceptability, especially among low e-skilled companies. Appropriate selection and user friendly implementation can enhance trust and liquidity on the web business platforms. In the paper we present results from the research focused on the trust issues on the B2B platforms. To identify suitable trust building mechanisms and strategies regarding implementation into a business network, a questionnaire survey was carried out which was focused on trust building mechanism significance and minimum necessity. The results show the significance of the e-skills of the company, which affect the trust perception in more sophisticated mechanisms and several other interesting implications. The research can help to build effective trust strategy on B2B web based platforms.

1. Introduction

In electronic *commerce*, where the buying and selling of goods or services is conducted online [15], trust has received significant attention, as it is related to growth in this area of business. 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, reliable and legal [17].

Within *Seamless* and APVV project, the potential trust building mechanisms were identified. Mechanisms as information quality trust marks, references, reputation, contract execution support, online dispute resolution, escrow services and standardization were identified and examined from the aspect of their significance and impact.

[1] *Technical University of Kosice, Faculty of Economic, Slovakia; Radoslav.Delina@tuke.sk*

2. Trust building mechanisms

Trust is a *complex* notion. Current literature on trust tends to be theoretically fragmented and the definitions show a great degree of disparity [3;23]. In the field of B2B relations many studies do not even define trust and those that do refer [3;24] the trust was defined as confidence in the other party's reliability and integrity. The trust is perceived firstly, as a belief, sentiment or expectation about the trustworthiness of an exchange partner, secondly as an intention or behavior reflecting vulnerability and uncertainty on behalf of the party who trusts, hereto referred to as the 'trustor'. It means "a willingness to rely on an exchange partner in whom one has confidence". On the other hand, in a retailing setting, trust was defined as consisting mainly of credibility and benevolence [8]. Credibility refers to the vendor's expertise to do the job effectively and reliably. Benevolence is the vendor's intentions and motives to be beneficial to the buyer in a new situation for which there is no previous commitment (ibid).

Based on *several* definitions of trust and institutional aspect of B2B electronic marketplaces, we have developed new definition of trust where:

The trust is objectively and subjectively quantifiable confidence of trustor in particular level of competency, honesty, security and reliability of other subject or third party in specific context based on historical activities and functionalities of e-environment.

This definition is not focused only on the interactions between business partners but also on the trust into the environment and its functionalities supporting realization of these interactions and in the ability of this environment to maintain and manage these interactions. The management and maintenance of interactions relates also with ability to solve trust violations and restoring the former status.

3. Trust building research methodology

The research objectives of presented research are based on the research within the European IST project - Seamless (www.seamless-eu.org) [8] and related APVV project (eNalytic). The main objectives were:

- the analysis of potential TBMs acceptance,
- the identification of TBMs significance to the increased trust and
- the minimum necessity of TBMs for joining the marketplace.

To identify suitable trust building mechanisms and strategies regarding implementation into a SEAMLESS platform, 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. The research was focused on two sectors (textile and building and construction) and carried out in 6 EU countries (5 NMS and 1 western EU country, 150 companies). 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.

4. Results

4.1. Trust building mechanisms identification

Within trust building mechanisms, which can increase the trust on electronic business platforms,the key role play:

- *information quality* - The quality of published information could highly improve credibility within all business networks. Companies, registered at the networks or marketplaces are asked for information and some level of validation could increase trust of these marketplaces. Credibility is also the dominant reason for validation of some kind of information. It is necessary to validate information at the well-balanced level, because validation could also increase costs. The most important information published on electronic business networks are contact information, company size, financial data, product/service categories and description, status of business activity etc.
- *trust marks/certificates* - For the purposes of quality presentation, different kinds of trust marks or certificates are provided by companies. These information attributes are awarded to companies by trusted third party and can induce trust in the company. For the business networks we see two dimensions of certificates: international and domestic. However, domestic certificates need to be examined from two viewpoints: how the domestic certificate is trusted by the domestic partner and by the foreign partner.
- *references* - References are another part of possible trust building mechanisms on a business platforms, which can be divided into two parts: “Business partners” and “Conducted businesses”. Regarding references on significant partners, the company without a trading history at the business platform, can add in the registration phase “external

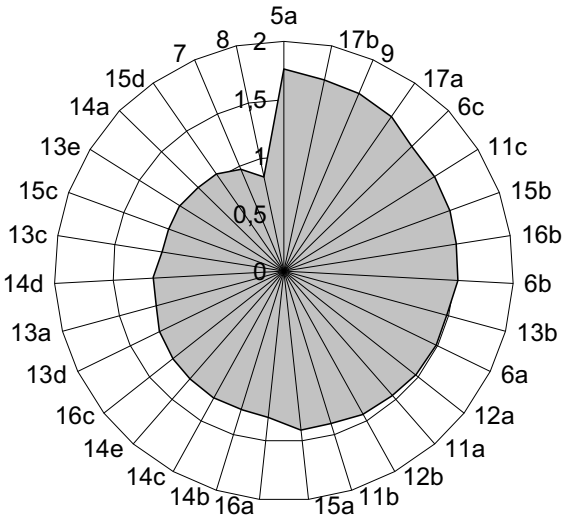
business partners" (this means traditional business partners apart from business platform). Internal business partners are business partners registered on the relevant platform. A company can include these business partners into a reference list within the registration phase or after the trading process. In both phases, the business partner should have the option of approving the publishing of such information (for example, if a buyer wants to publish his supplier as his significant business partner, this supplier will have the option of refusing or approving it).

- *reputation* - reputation mechanisms are trust building mechanisms providing evaluation of past business activities between partners on the platform. Reputation building mechanism can consists of feedbacks, discussion forum, rating and historical data aggregation and can provide a self-regulation function of trust on business platform. According to source credibility theory [14], it will be suitable to calculate aggregated ratings and feedbacks by weighted average where the weight is determined by the rating of raters (companies providing feedback).
- *contract execution support* - Contract execution support can be supported in the platform in several ways by providing one or more of following services: "Integration data from negotiation into contract proposal form", "Basic contract clauses", "Outsourced comprehensive database of contract clauses provided by specialized company" and "Explaining contract clauses and conditions".
- *online dispute resolution* - Online Dispute Resolution (ODR) is a branch of dispute resolution which uses information and communication technology to replace the traditional out of court processes to facilitate the resolution of disputes between parties. It primarily involves negotiation, mediation or arbitration, or a combination of all three [20]. Online dispute resolution is generally recommended for the best future practice of e-marketplaces. For the business platform we have identified following possibilities/functionalities: *ODR advisory support* as simple list of experts, which can save time and leave self-selection to the company. It is also necessary to provide advice on how to start an ODR process or what are the key success factors in the process. *Technical support*, which has to solve technical problems and minimize inconveniences when conducting business transactions. *Limited ODR* as a model, when only the minimum of the ODR services as mediation are provided. When more complex problems emerge, external partners are usually offered. *Outsourced specialized ODR service*, as for example a strategic alliance. The willingness to participate in ODR should be clearly stated in "Company Profile" and in each contract.

- *escrow services* - Escrow services (ES) reduce the potential risk of fraud by acting as a trusted third party that collects, holds and disburses funds according to buyer and seller instructions. Escrow services are usually provided by a licensed and regulated escrow company. As a escrow service provider we see three basic possibilities: internal ES provided by platform, bank as traditional ESP and external specialized ESP.
- *standardization* - As standardization is one of the most important requirements by professionals in the field of e-marketplace processes, we have examined which possibility will help the issue of standardization in addition to the already mentioned mechanisms (for example contract platform and especially clauses also supporting standardization, etc.).Service agreement (Code of Conduct, Terms and Condition Agreement and SLA) and ontology/multilingual issues were identified as the main issues for any e-marketplace.

4.2. Trust building mechanisms significance and need

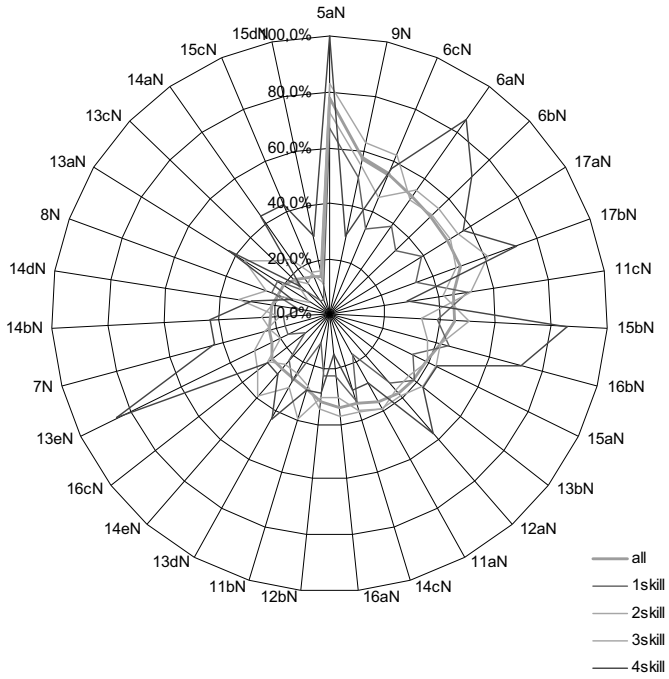
For the trust building mechanisms significance analysis, the mean of answers was used (0 – no significance, 1 – medium significance, 2 – high significance to the trust increase). The results are presented on graph 1. In this graph, trust building mechanisms are sorted by significance. As we see, less significant mechanisms are information about company size and age. Most important are Code of Conduct, status of business, multi-language support, detailed product description, international certificates, technical support etc. More detailed analyses you can see in project report [8].



Graph 1 Trust building mechanisms significance for trust increase

Comments:
5a Contact information; 6a Description of company's focus; 6b Product/service categories; 6c Detailed product/service description; 7 Company size; 8 Year of foundation; 9 Status of business activity; 11a National level certificates or marks of companies on the local market; 11b National level certificates or marks for foreign companies; 11c Known international established certificates; 12a List of important business partners; 12b List of conducted business; 13a Positive-only feedback from the partners; 13b Positive and negative feedback from the partners; 13c Discussion forum; 13d Reports with aggregated historical data about the platform business activities of the company; 13e Rating presented as a simple symbol; 14a The integration of business negotiation outcomes into the contract; 14b Contract negotiation process tracking and recording; 14c Basic contract clauses and templates; 14d Database/service with complex contract clauses for the fee provided by specialized company; 14e Explaining contract template clauses and conditions; 15a Advisory support - recommendation of ODR experts to users; 15b Technical support; 15c Limited ODR; 15d Outsourced ODR service by specialized company; 16a Internal escrow service; 16b Bank will be the mediator; 16c Trusted Third Party; 17a Multilingual support with standard terms; 17b Code of Conduct;N means Necessary element for joining the e-market; 0 no increase of trust; 1 medium increase of trust; 2 significant increase of trust

On following graph 2, we present significance for trust increase according to different level of e-skills (skills with e-commerce and e-marketplace functionalities). We see high differences esp. in high e-skilled companies (companies with e-marketplace experiences) and no e-skilled companies.



Graph 2 Trust building mechanisms significance according to different level of e-skills

Comment: the same as in graph 1

5. Implications and recommendations

From the conducted research [8], we are able to identify following basic implications and recommendation for the e-marketplace development:

- Information about company size is not important and will not significantly increase trust.
- A combination of positive and negative feedback is more trusted and requested than positive only feedback.
- A discussion forum will not significantly increase trust, although it can serve as an explanation for negative feedbacks.
- The integration of negotiated data into a contract proposal will not increase trust, companies in that case prefer that the data within the contract proposal is correct.
- More simple mechanisms in ODR are more trusted than complex ones. The level of increased trust is higher for e-skilled companies.

- Companies prefer the bank as an escrow service provider.
- 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.
- Most companies will accept the model, where access to negative feedback is needed in order to accept the publishing of their negative feedbacks.
- Companies do not tend to view as necessary the mechanisms with automation or where outsourced specialized company is proposed. Again, the critical factor for accepting is e-skills.
- Generally, the higher the e-skills of the company, the higher the trust in more sophisticated mechanisms.

According to the survey, 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 are needed to be implemented at the initial phase of the e-marketplace project, because many participants entering the marketplaces have usual low e-skills.

Acknowledgements

This work has been funded by the Slovak Research and Development Agency under the contract No. RPEU-0025-06 and by the European Commission through IST Project SEAMLESS: Small Enterprises Accessing the Electronic Market of the Enlarged Europe by a Smart Service Infrastructure (No. IST-FP6-026476).

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Authors

TRAUNER VERLAG
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IDIMT-2008
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The increasing importance of information as a vital resource for organisations and individuals requires an increasingly complex management of information, using an interdisciplinary and holistic approach from various standpoints: sociological, technological, commercial and educational.

The annual IDIMT conferences provide an interdisciplinary forum for exchanging concepts and visions in the area of information management, knowledge management, business engineering, information technology, system theory, and related areas. The international setting, the heterogeneity of cooperating technical and economic research institutes and the different scientific, economic and historical background of the researchers guarantee a multifaceted view on these topics.

The main focus of this year's conference is the management of information, innovations, system development, projects, organisations, and business. Due to the many unknowns in these fields they are not really manageable – hence the title of the conference. Nevertheless Information and Communication Technology together with Systems Thinking provide a basis for management activities.

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

- Information Management
- Performance Management
- Software Project Management
- Systems Thinking in Management
- Business Excellence
- Cooperative Information Environments
- Security and Safety as a Systemic Challenge
- Privacy versus Security
- Human Factors
- Future Developments of ICT

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ISBN 978-3-85499-448-0
www.trauner.at