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# **Information Systems Architecture and Technology**

**Models of Decision Making  
in the Process of Management  
in a Risky Environment**



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Wrocław University of Technology



# **Information Systems Architecture and Technology**

*Models of Decision Making in the Process of  
Management in a Risky Environment*

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## INTRODUCTION

*The world is a very risky place and that risk has to be borne by someone. Such risk exists because much of what happens in a company depends not just on the internal management decisions of the company, but also on wider market conditions, about which management can do virtually nothing.*

David Blake, *Financial market analysis*, McGraw-Hill Book Company, England, 1990

The whole history of the market economy is based on the capital, its skillful investing in projects or businesses, which, thanks to its competitiveness generate for its owners (shareholders) an attractive rate of return and multiply the value of their capital. Minor national limitations, geographical or cultural of the contemporary market economy cause that the direction of capital movement are risk factors for the activities carried out by the company. In such an environment, in which the changes in the market are difficult to determine, and sometimes even impossible to predict, investment decisions are the most difficult ones. For this reason, and because of the passage of time related to the implementation of investment decisions (decisions effects can be observed in the future) the uncertainty of effects is critical to the decision making process. In a competitive economy, each element is reflected in the form of the price (cost). The risk, defined as the uncertainty of the results, has its price.

All capital investors like the idea of high return gaining. Necessity of keeping rate of return from invested capital in dynamically changing environment as high as possible makes managers apply IT technologies in decision making process.

Making investment and financing decisions in a company determines its future. The ability to pursue goals is an art that requires thorough knowledge in many areas such as decision-making, financial management, risk assessment, forecasting, etc., as well as experience and creative abilities of the managers. Today's managers are not just passive consumers of research knowledge but also its creators. Each company is exposed to a number of risks from a variety of sources. An important part of enterprise management is an accurate identification, analysis and risk assessment. The difficulty of assessing the level of risks affecting the value of the company depends on the

quantification of the individual components. It is difficult to measure and assess legal and operational risks but it should not be underestimated.

Risk is an attribute of any human activity, especially a business activity. It always occurs. Uncertainty is a feature of reality representing the impossibility of determining future events accurately. Its sources are objective factors arising from the variability and complexity of the situation and the subjective mental processes.

Business decisions in a risky environment require a large amount of objective data, information, experts opinions presented in a quantitative manner, eg. in the form of probability distributions, describe the uncertainty around key project variables and then calculate in a concise manner possible impact of uncertainty on the expected rate of return on investment. Modern computer technology makes it possible to carry out even the most demanding analyzes.

Uncertainty, and therefore risk assessment is also dependent on the degree of confidence in the opinion formulated by the decision maker, their ideas, solutions, etc. The experiment testing the potential effects of their decisions on the living organism, which is a company is difficult and costly and often impossible. Hence, contemporary theories focus attention on the construction of suitable models that support the decisions of managers by allowing them to somehow “spy” the effects of their decisions. The main purpose of modeling is to understand how the company operates to analyze its performance and to propose possible improvements.

An improvement of decision making process is possible to be assured by analytical process supporting. Applying some analytical techniques, such as: computer simulation, expert systems, genetic algorithms can improve quality of managerial information. Managers have to remember that “What’s worked before, especially in the recent past, becomes an acceptable pattern of behaviour – except that the market will then do something similar, but different enough to deceive us” Combining analytical techniques and building computer hybrids give synergic effects – additional functionality – which makes managerial decision process better. Different technologies can help in accomplishing managerial decision process, but no one is in favour of information technologies, which offer differentiable advantages.

The book entitled *Information Systems Architecture and Technology – Models of Decision Making in the Process of Management in a Risky Environment* focuses on very hot topics in the field of today’s various computer systems based applications and is devoted to information systems concepts and applications supporting exchange of goods and services by using different business models and seizing opportunities offered by IT systems.

The selected and reviewed chapters have been divided into three parts:

PART 1. *Models of Decision Making*

PART 2. *Models of Risk Management in Decision Making Process*

PART 3. *Decision Support Systems*

The book provides an interesting representation of research in the area of contemporary management information systems – concepts, models, services and applications, requirements and models.

The first part – *Models of Decision Making* – presents considerations of model of decision making by managers. It deals with the process of collecting, representing, protecting and distributing the business information exemplified by practical use of that information in managing process.

The second part – *Models of Risk Management In Decision Making Process* – considers special models designed for finance and investment management. It starts with statistical methods of financial analysis and then discusses some special models for financial and investment decisions taking focusing on various methods that are risk undertaking in managerial decision process.

The third part – *Decision Support Models* – describes the ideas of system that would support knowledge management in organization and decision processes especially.

## **PART 1 MODELS OF DECISION MAKING**

Dynamic development of the IT technologies creates the possibility of using them in the dynamic management process modeling and decision making process supporting.

Chapter 1 concentrates on a formal model of the real world, in which events took place and is suitable for the description of the event, analyzes its content, evaluates its credibility and graphically presents the reconstruction results. The main purpose of chapter 1. is an implementation of an autonomous system of events reconstruction which would have the ability to verify presented reports, reconstruct the course of events based on facts and reports of observers. It evaluates the probability of occurring event by means of graphical visualization of event and also uncovers motives for making decisions in the reports.

Chapter 2 considers the Set of Experience Knowledge Structure (SOEKS) as a method for recording experience of decision events. Those events can refer to any type of decisions including routine standardized nodes in business processes as well as an ad-hoc decision made in unexpected circumstances. System thinking offers a range of tools for gaining deeper insight into problems. The question that this work is trying to answer is how those concepts can be merged. The Authors' hypothesis is that it is technically possible to use SOEKS both in hard and soft system thinking.

Chapter 3 focuses on the results of the survey conducted within a group of software engineering specialists. The aim of the survey was to identify the role of the best practices in the software development process based on agile methodologies. If the practices are applied, obvious questions arise: when to use the practices and what is their usefulness? The main aim of the work stems from these questions. The considered set of practices consisted of the quality assurance practices. The practices were considered in terms of their impact on supporting some selected problems encountered during software development process.

## **PART 2. MODELS OF RISK MANAGEMENT IN DECISION MAKING PROCESS**

In a competitive economy, the main objective of all management decisions taken is the company's growth benefits to the owners. The increase of the benefits achieved, inter alia, by maximizing the market value of the company. Making the right decisions and effective implementation of development activities is one of the most important conditions for achieving maximum market value of the organization. It is a difficult process because it affects all business areas. Basic development decisions are the investment and financial decisions.

Chapter 4 presents a Value Based Management (VBM) concept that has been developed since the 1980s. VBM is defined as a business management system, in which all decisions are taken by the managers – at the financial, investment and organizational level, and they aim to maximize the value of invested capital. In this chapter the author makes an attempt to define VBC, and describes the most important tasks of VBC. The analogy between the VBM cycle and Controlling cycle is presented and on this basis VBM studies and tools are classified. Exemplary VBC tools, applied in Polish companies were also presented.

Chapter 5 considers the method of selecting an optimal financial portfolio. In this case, fuzzy integrals are convenient tools for criteria aggregation, especially the discrete Choquet integral. The portfolio constructing can be seen as a multiple criteria decision making problem (MCDM). This is mainly due to the development of the theory of finance, which provides tools for synthetic evaluation of many aspects of business, in particular the ratio analysis and cash flow analysis. The use of Choquet integral as a non-additive approach allows to model not only the relevance of the criteria but also the interactions between them. The aim of this chapter is to show how to address the problem of selecting an optimal financial portfolio using fuzzy measures and fuzzy integrals.

Chapter 6 presents risk tail measure – namely Expected Shortfall (ES) in relation to the method of an investment efficiency evaluation – Net Present Value (NPV). There are a lot of factors that influence the level of cash flow generated by the investment. Hence, the implementation of risk and uncertainty in the process of investment profitability calculation plays an important role. There are methods that include a risk factor in a direct or an indirect way. Monte Carlo simulation is the example of the last group of methods. The application of simulation process and receiving probability distribution of NPV as a result is an attempt of risk presentation in an investment project. Expected Shortfall answers the question: “What is the expected loss incurred in the worst  $\alpha$  cases?”

Chapter 7 considers cash flow which is the foundation of investment profitability determination. Considering the importance of the element in the process of profitability assessment, the main problems, connected with the amount of cash flow assessment techniques and risk – which is crucial as well – are shown. The methods, which take risk at cash flow into account, are considered.

Since financial decision should be supported by financial analysis chapter 8. considers the model of profitability (Du Pont model) and well known profitability ratios related to it. The discussion of historical development of Du Pont model is presented, and then its limitations indicated. On that basis a new model, specific for Polish corporations, has been proposed and discussed. The model has been then applied to two exemplary Polish corporations income statements. The merits of the model have been discussed.

### **PART 3. DECISION SUPPORT SYSTEMS**

The organizations are founded on decisions, the businesses of organizations are based on decisions. Decision making therefore cuts across every segment of an enterprise. For decision making to be successful, the information on which these decisions are based should be reliable and accurate.

Chapter 9 presents and discusses two basic sources of accounting information used in the decision making process of organizations. The first source is the information from financial accounting while the second one is the information from management accounting. The next part of this chapter therefore takes a closer look at the nature of information generated from financial and management accounting. The relevance of these data in decision making in enterprises as well as the processes and procedures involved in providing both financial and management accounting information is also considered.

Chapter 10 shows the originality of Polish capital market and the specificity of financial structure in Polish enterprises. Presented results of foreign economists are showing, that financial structure for companies from different markets could be significantly different. The analysis of a sample of 250 both stock and non-stock Polish companies has been performed. Furthermore, the research, whose goal was to verify whether financial structure of domestic firms differs significantly from those of foreign ones (especially foreign firms, that run their businesses on developed countries capital markets) has been conducted.

Chapter 11 presents a relation between general efficiency of use of information resources, information technologies in management process and management expenses. Development of the efficiency is determined by change of parameters of basic activity and by decrease, sometimes – increase of expenses for management.

Chapter 12 describes the idea of a system that would support knowledge management in virtual teams focusing on three dimensions of virtual work: location, organisation, time. Due to globalisation and economic reasons the number of people working as a team in a virtual environment is increasing. Sometimes managers do not realise how knowledge is distributed among team members. Uneven distribution of knowledge may be a potential risk in case when in a particular single team a member for some reason leaves the team. Authors suggest a model that would support the manager of a virtual group to track knowledge concentration in a team and advise when an action should be taken.

Chapter 13 presents the need to monitor the risk during the process of knowledge transfer. The authors discuss the concept of knowledge transfer, risk assessment and its classification, show what negative consequences of crossing the main parameters of the project are. The chapter attempts to identify suitable risk assessment methodology to define the risk during technology transfer. Finding a method of risk evaluation is required to define what risk means, how it can be measured and what is its place in technology transfer

Chapter 14 presents information and computer tools in supply chain management. This work presents the significance of information in supply chain management. According to the results of Computer Sciences Corporation, the implementation of processes that conditioning the transparency of goods and information flow in supply chains is one of three key competences of undisputed market leaders in creating supply chains. Many different information and computer tools could be implemented in the enterprise to help the information flow management. This work discusses the results of two surveys conducted in Polish enterprises. The level of information and computer tools implementation in departments of logistics is quite high only in big enterprises and the smaller ones lag behind. In this work the mobile solutions for supply chains management are also presented. They can redefine interactions of enterprise with suppliers, customers, and business partners making possible the creation of adaptive supply chains with fulfillment velocity, inventory visibility, and supplier coordination versatility. The most common tool is smartphone but according to the experts, RFID solutions will soon gain significance.

The book contains contributions accepted by reviewers of the submitted works. We hope that the book will be considered as a forum for presentation of original works on a good professional level and for discussions integrating different subjects of enterprise management and changes as well as information systems planning, designing, development and implementation.

We thank all the Authors who have submitted their works to be published in this book.

Wrocław, September 2013

*Zofia Wilimowska*

**PART 1**  
**MODELS OF DECISION MAKING**



Tomasz KAPŁON\*

## **STRATEGY OF EVENT RECONSTRUCTION**

A proposition of new approach to problem of events reconstruction was presented. The procedure of reconstruction of the course of events, in where details are known only from reports formulated by observers in natural language was determined. Proposed formal model of the real world, in which events took place is suitably for description of the event, analysis its content, evaluation its credibility and to graphical presentation of the reconstruction results. The strategy of determining the tracks of actions of entities where we defined two main notions: the point of change the entity's activity and the trace of the entity activity, was presented in detail. Those notions are sufficient for representing and processing of the reports from events

### 1. INTRODUCTION

Explicit interpretation of information included in reports written in the natural language is a task in itself complicated. Moreover, when we expect an objective interpretation, the acquisition, understanding and reasoning on the knowledge should be made by the autonomous artificial system. The early works took a top-down approach to language understanding, representation of events and reasoning, like Schank's scripts [1]. Some modern work offers statistical techniques to learn knowledge automatically from texts but either need a supervised learning of semantics from annotated corpora [2] or the learning is unsupervised but semantic roles are pre-defined by hand. More interesting are articles which deal with inducting events schemas and prediction of event scenarios in unlabeled texts [3, 4]. However, especially in [5], author propose the unsupervised learning of stereotypical sets of events and entities that define common-sense situations in the world rather than reconstruction the course of the events. The suggested solution goes one step further. The main purpose is implementation of autonomous system of events reconstruction which would have ability to verification of presented reports, reconstruction of the course of events based on facts, reports of

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observers, ability to evaluate the probability of occurring event, graphical visualization of event and also uncover in the reports motives for making a decision. Sometimes there are situations when the event reconstruction is highly necessary and available are only eyewitness reports, further these reports are written in natural language and are subjective. In nontrivial, exceptional situations reconstructing the course of the event and his credibility are crucial to solving crimes or providing background on newsworthy stories. Therefore seeking the way of reconstructing course of events which will meet a criterion of at least a supposed credibility is justified. Applying formalized methods of reconstructing the course of the event allows for avoiding unjustified simplifications, unrealistic assumptions or subjective interpretations of the observers of the event which can be implemented by observers in reports. Formalization is giving hope for reliable and objective reconstruction of the event. The idea of reconstruction of events from reports, is based on recognizing and understanding action of identified entities in the time and space and also on schematic manner of formulating the report by humans. We assume that relations of observers will consist of propositions fulfilling certain conventionalized outlines. So we assume that sentences will be formulated according to scheme compound of groups of words about categories the *AGENT*, *ACTION*, *LOCATION* and *TIME*, and in elaborate sentences also *OBJECT*, *MANNER*, *INSTRUMENT* and other. Moreover, we can expect, then again according to the certain convention, the observer will organize his statement both temporarily and personally and for every entity will carry the begun topic on all the way to the moment, in which he will finish him or a need to conduct the topic for the next entity will follow. In this case we assume that the change of the topic is explicitly determined by the place, time, or both simultaneously to keep continuity of the statement and set the point of the return to interrupted topic

Such a structure of the relation facilitates automatic analysis and getting information, in particular tracking topics through and reconstructing behaviors of entities by their identification and establishing moments and places of their individual action.

For above problems and assumptions we present a general system specification of reconstruction of the events based on observers reports formulated in the natural language. The proposed structure of reconstruction system enables also to eliminate the subjectivity at creating the image of the event thanks to contextual and objective interpretation and verification of the reports.

In next points we introduce, in point 2 definitions of basic notions used at the formal recording of the event and the accepted model of world, in which the system of reconstruction is encoding and is processing the knowledge about the event. In point 3.1 a general system structure of the event realizing the procedure of reconstruction was described. In point 3.2 variants of the procedure of reconstruction were discussed. In point 3.3 an example illustrating applying the proposed system of reconstruction was presented.

## 2. MODEL

Reconstruction of the course of the event which took place in the real world is setting the discussed system. The real world is enough diversified and folded the attempt to take all his elements into account and to copy processes occurring in it is impossible. This complexity extorts, at the modeling of processes occurring in the real world accepting the number of restrictions and simplifications. Certain standard (customary) simplifications of the description of world are also applied in verbal communication. At naming entities of the real world - we say, e.g. "bird" because either we don't know his detailed name or this name in our opinion isn't essential. At describing processes, for similar reasons notion "moved" can be used to the description of the move, e.g. 'ran' or 'slipped down', etc..

Conclusion: already alone observer relating the event uses some model of the real world. Moreover one should assume that every observer has his own model of world. Out of necessity so, in analysis of happening occurrences in the real world one should use only certain models of this world. More distant reasons for omitting some entities at the modeling and processes which indeed are found in the real world, result from their insignificance for the analyzed class of events. The discussed system of reconstruction of events uses the model of the real world, in which four components are essential: space, in which the event took place, entities existing in this space, possible operations entities and rules and restrictions applying to entities in the considered space can carry which out.

### *Definition 1.1.*

*A model of the real world SW is a 4-tuple,  $\langle \Pi, \Omega, O, ACT \rangle$ ,*

*where:  $\Pi$  – space of SW with set P of locations,*

*$P = \{p_1, p_2, \dots, p_n, \dots, p_N\} \subseteq \Pi$  – set of locations in space  $\Pi$ ,*

*$\Omega$  – set of rules (laws) and restrictions in SW,*

*$O = \{o_1, o_2, \dots, o_j, \dots, o_J\}$  – set of entities in SW,*

*$ACT = \{act_1, act_2, \dots, act_K\}$  – set of entities activities in SW.*

In the real world certain changes happen with the nature of world and the activity of entities. These changes can be observed by observers and every observation can be remembered.

The observer has an ability to observe changes happening around him, of knowledge acquisition to their subject and an ability to announce its knowledge and the opinion in the form of the coherent narration in the natural language has.

Every observer locates entities, their activity, moments of beginning and finishing and the place of changes of the activity of entities. Every such a fifth determines the point, in which the change of the activity of the entity was observed.

*Definition 1.2.*

*A place of change entity's activity is a 5-tuple:  $DP_j(t_i) = \langle o_j, act_k, p_v, t_i, t_j \rangle$ , where:  $o_j$  – entity (event participant);  $o_j \in O = \{o_1, o_2, \dots, o_j\}$ ,  $act_k$  – activity of entity  $o_j$  in moment  $t_i$ ;  $act_k \in ACT$ ,  $p_v$  – location in space  $P$  of entity  $o_j$  where  $(p_v = x_v, y_v, z_v) \in P$ ,  $t_i, t_j$  – activity  $act_k$  start and stop moment;  $t_i, t_j \in T$  where  $T = \{t_1, t_2, \dots, t_j\}$  – set of activity's moment of change.*

Set of places  $DP_j(t_i)$  creates the spatio-temporal image of changes in  $SW$ . Temporally ordered sequence  $DP_j(t_i)$  of entity  $o_j$  determined a trace of changes its activities.

*Definition 1.3.*

*A trace  $TR(o_j)$  of the entity  $o_j$  activity spatially and temporally ordered set places of change entity's activity  $DP_j(t_i)$ .  $TR(o_j) = \{DP_j(t_i); t_i \in T, o_j \in O\}$ .*

Fragment marked off from the temporary-spatial image of changes is called the event.

*Definition 1.4.*

*An event  $E$  in  $SW$  is spatially and temporally ordered set of activities  $act_k \in ACT$  of entities  $o_j \in O$  in space  $\Pi$  in time period  $\langle t_p, t_k \rangle$ , where  $t_p, t_k \in T$ .*

### 3. SCHEME OF RECONSTRUCTION

Any reconstruction is initiated by a question about the course of the event, where  $t_p$  and  $t_k$  and the fragment of the  $\Pi$  space, i.e. the time and the place of the event are determined. In response observers formulate reports in the natural language or in the internal representation, which use.

Independently of the form of report either semantically coherent sequence of sentences in natural language or set of  $TR(o_j)$  traces, of which arguments are determined by notions or phrases of the natural language is received.

The way of understanding used notions by observers must be verified with reference to rules and  $\Omega$  restrictions of  $SW$  world, restrictions of context of the event and features of entities participating in it. Replies of observers are dependent on their way of perceiving reality, state of the knowledge grounded in frames of context of the event and from the ability of formulating statements, so  $EI_R \cong E$ .

## 3.1. GENERAL RECONSTRUCTION SCHEMA

Reconstruction of events is performed by the artificial autonomous e.g. a reconstructing agent. The effect of the reconstruction process is the visually coherent version of course of the event and/or the report describing the event. For that purpose the following steps are performed:

Step 1. *Basic contextual semantic analysis of the meaning of the report*

Analysis is performed based on the formal model of image representation of semantics sentences (IRS) [6, 7]. A set of semantic schemas of all sentences from report with specified and categorized semantically groups of words *AGENT*, *ACTION*, *TIME*, *LOCATION* and other, if appear is a result of analysis.

Step 2. *Detection and tracking the entities activity and contextual temporal and spatial analysis*

The system identifies all entities  $o_j \in O$  and their activities  $act_k \in ACT$  as well as determines and organizes moments  $t_i$  i  $t_j \in T$  and locations  $p_v(t_i) \in P$  of changes the entities' activity. A spatio-temporal image of changes the entities' activity is a result.

Step 3. *Verification of the correctness of the semantic meaning of reports*

The verification consists on checking the compliance of entities activities with rules and restrictions in *SW* included in  $\Omega$  and with restrictions imposed on entities and activities in  $\Pi$ .

In the end throwing away these elements of reports which are at variance with the real state of world is possible. Also calculating measures of the credibility for next activities is possible what leads, after determining the trace of  $TR(o_j)$  changes, to the possibility of determining measure of the credibility each trace  $TR(o_j)$  in event  $E$ . In consequence appointing the value of the measure of credibility is possible for next events versions.

Step 4. *Appointing spatio-temporal images of event*

Three types of images are determined. First type  $EI_M(o_j)$  are images get based on the own report of each observers individually for each entity.  $EI_M(o_j)$  show the subjective observers' judgment about event  $E$ . Second one,  $EI_O(o_m)$  are images obtained out of  $E_M(o_j)$  images by superimposing  $EM(o_j)$  images on themselves for next entities, subjected to verification towards  $\Omega$  with set periods containing moments of time and areas containing locations, for which values of credibility measures were determined. These images show ranges (temporary and spatial) possibilities of  $DP_j(t_i)$  positioning in  $TR(o_j)$  traces. They contain none inappropriate to the context of event areas of entities activity pointed by observers.

Step 5. *Generating a visualization and/or a report of the course of the event*

## 3.2. VARIANTS OF RECONSTRUCTION

One should consider two variants of events reconstruction. The first one, schematically shown in fig. 1., consists in delivering reports from observers ( $o_{mi}$ ) to a reconstructing agent ( $A_R$ ) which have ability to understand and analyses meaning of reports, the evaluation of semantic correctness of reports and creating different versions of event. The reconstructing agent can generate visualization of the event and/or its description in natural language.

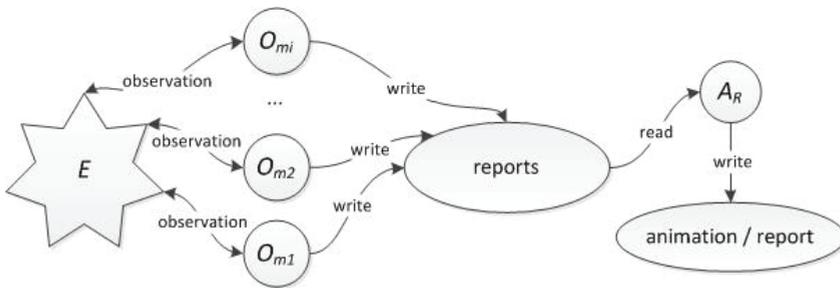


Fig. 1. Outline of reconstructing the event based on reports

The second variant (fig. 2.), it is cooperation of observers ( $o_{mi}$ ) consisting in the exchange of knowledge, for which establishment is a purpose shared and explicit in the given context of understanding sense of phrases, determining the suitability of names and their designatums, setting a scope and names contents. After meeting above conditions, observers hand the knowledge over about their observation to the reconstructing agent ( $A_R$ ) which makes an appraisal of reports semantic correctness and creating of different versions the course of event, like in the first variant.

## 3.3. CREATION OF SPATIO-TEMPORAL IMAGES. AN EXAMPLE

In reconstruction of event, according to the general outline of events reconstruction, a detection and tracking entities activity and organizing changes of initiatives on the timeline and their correlation with places of changes is the second step. Getting temporary-spatial image of entities activity changes in  $\Pi$  is a purpose. Semantic schemes get during semantic analysis of observers reports are a base.

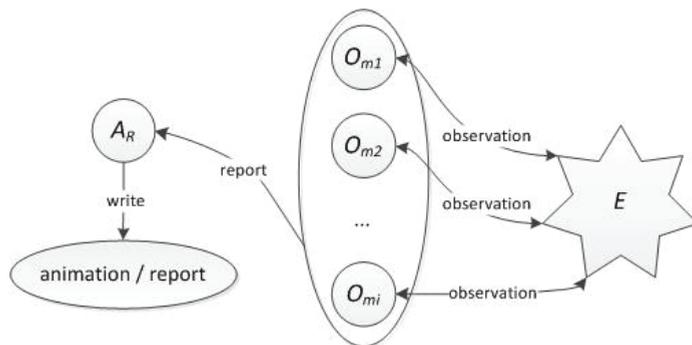


Fig. 2. Reconstruction of the event carried out by cooperating observers

Let's trace the strategy of appointing the trace of entities activity on an example of simplified linguistically report. This simplification doesn't cause loss of generality of deliberations because simplifications concern proper names of entities.

(1) At four o'clock  $o_1$  went quickly from B1 to B4 building. (2) In the same time  $o_3$  stood beside B3. (3a) Moment later  $o_2$  went in the direction of B4 and (3b) on half roads light a cigar. (4a) More or less then  $o_3$  stopped and (4b) then ran fast in the direction of B5, (4c)  $o_1$  also started running. (5a) First to B5 reached  $o_1$  and (5b) jumped up and down for joy like a child. (6a) then  $o_2$  threw away the cigar, (6b) lunged forward and (6c) reached B5 a few seconds after  $o_3$ . (7a) When  $o_3$  jumped there as  $o_1$  (7b) then  $o_2$  finally there appeared.

Using the IRS [6] we receive as a result of analysis set of semantic schemes described in Table 1.

All groups of words are included in a scheme, of which categories (in step 1) were recognized and determined in all analyzed sentences. In Table 2 set of  $DP_f(t_i)$  created based on content of Table 1 was shown. Variables  $t_\gamma$  and  $p_\gamma$  describing moments which in the report weren't determined or isn't connected directly (only contextually) with identified moments and locations.

In the meaning of report about  $o_3$  activity lacks the mention between  $DP_3(t_p)$  and  $DP_3(t_{\gamma_3})$ . But  $DP_3(t_{\gamma_7})$  must exist, what follows from the knowledge about the activity  $act_5$  and  $act_6$  and their different locations. Since both these activities refer to states (*to stand* and *to stop*) results from their character, that in order to go from the state *stand* to *stop* making a move between them i.e. activities are necessary e.g. *to go* or *to run*.  $DP_3(t_{\gamma_7})$  in the  $TR(o_3)$  trace appears as a result of contextual analysis of meaning of report made in step 2 of reconstruction schema.

Table 1. Semantic outlines of sentences of the report of the observer

sentence	AGENT	ACTION	MANNER	OBJECT	LOCATION	DESTINATION	TIME
(1)	$o_1$	$act_1$ (went)	<i>quickly</i>	---	$p_1$ (from B1)	$p_3$ (to B4)	$t_1$ (four o'clock)
(2)	$o_3$	$act_5$ (stood)	---	---	$p_2$ (beside B3)	$p_2$	$t_1$ (the same time)
(3a)	$o_2$	$act_1$ (went)	---	---	$p_{75}$	$p_3$ (in direction of B4)	$t_2$ (moment later)
(3b)	$o_2$	$act_2$ (light)	---	<i>cigar</i>	$p_{76}$	$p_{76}$	$t_{73}$
(4a)	$o_3$	$act_6$ (stopped)	---	---	$p_{77}$	$p_{77}$	$t_{73}$ (more or less then)
(4b)	$o_3$	$act_7$ (ran)	<i>fast</i>	---	$p_{77}$	$p_4$ (in direction of B5)	$t_{74}$
(4c)	$o_1$	$act_7$ (running)	---	---	$p_{78}$	$p_{79}$	$t_{74}$
(5a)	$o_1$	$act_{10}$ (reached)	---	---	$p_4$	$p_4$	$t_5$
(5b)	$o_1$	$act_8$ (jumped)	<i>like a child</i>	---	$p_4$	$p_4$	$t_6$
(6a)	$o_2$	$act_9$ (threw away)	---	<i>cigar</i>	$p_{710}$	$p_{710}$	$t_6$ (then)
(6b)	$o_2$	$act_4$ (lunged)	---	---	$p_{710}$	$p_{710}$	$t_7$ (then)
(6c)	$o_2$	$act_{10}$ (reached)	---	---	$p_4$	$p_4$	$t_{78}$ (a few seconds later $o_3$ )
(7a)	$o_3$	$act_8$ (jumped)	<i>as <math>o_1</math></i>	---	$p_4$ (there)	$p_4$	$t_{78}$
(7b)	$o_2$	$act_{12}$ (appeared)	---	---	$p_4$ (there)	$p_4$	$t_{79}$ (then)

Table 2. Points of the change of the activity and tracks of the activity of entities

$TR(o_1)$	$TR(o_2)$	$TR(o_3)$
$DP_1(t_1)=\langle o_1, act_1, p_1, t_1, t_{74} \rangle$		$DP_3(t_1)=\langle o_3, act_5, p_2, t_1, t_{77} \rangle$
	$DP_2(t_2)=\langle o_2, act_1, p_3, t_2, t_{73} \rangle$	$DP_3(t_{77})=\langle o_3, act_{77}, p_{77}, t_{77}, t_{73} \rangle$
	$DP_2(t_{73})=\langle o_2, act_2, p_{76}, t_{73}, t_6 \rangle$	$DP_3(t_{73})=\langle o_3, act_6, p_{77}, t_{73}, t_{74} \rangle$
$DP_1(t_{74})=\langle o_1, act_7, p_{77}, t_{74}, t_5 \rangle$		$DP_3(t_{74})=\langle o_3, act_7, p_4, t_{74}, t_{77} \rangle$
$DP_1(t_5)=\langle o_1, act_{10}, p_4, t_5, t_6 \rangle$		
$DP_1(t_6)=\langle o_1, act_8, p_4, t_6, t_9 \rangle$	$DP_2(t_6)=\langle o_2, act_9, p_{10}, t_6, t_6 \rangle$	
	$DP_2(t_7)=\langle o_2, act_4, p_{10}, t_7, t_{78} \rangle$	
	$DP_2(t_{78})=\langle o_2, act_{10}, p_4, t_{78}, t_9 \rangle$	$DP_3(t_{78})=\langle o_3, act_8, p_4, t_{78}, t_9 \rangle$
	$DP_2(t_{79})=\langle o_2, act_{12}, p_4, t_{79}, t_9 \rangle$	

Columns in Table 2 contain  $TR(o_j)$  traces of entities  $o_j$ . Temporary ordered  $DP_j(t_i)$  was shown for individual entities  $o_j$  in fig. 3. And fig. 4. shows spatially ordered  $DP_j(t_i)$  for the considered event. Based on  $TR(o_j)$  traces the spatio-temporal image of event  $E$  is created.

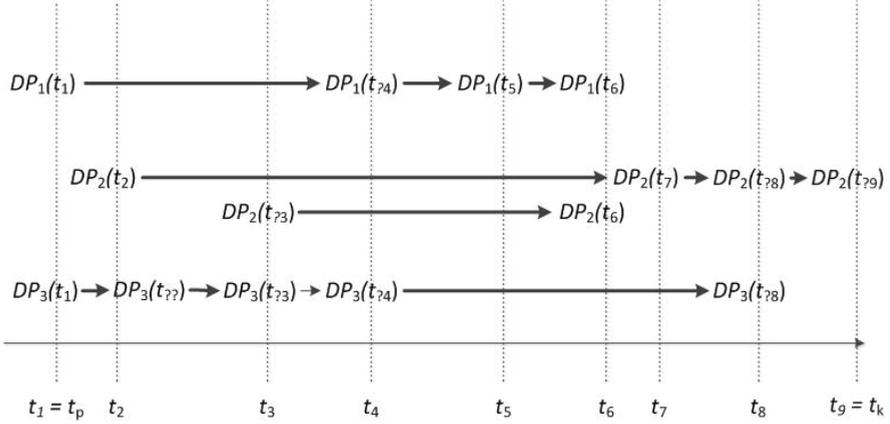


Fig. 3.  $DP_j(t_i)$  temporarily ordered creating  $TR(o_j)$  traces

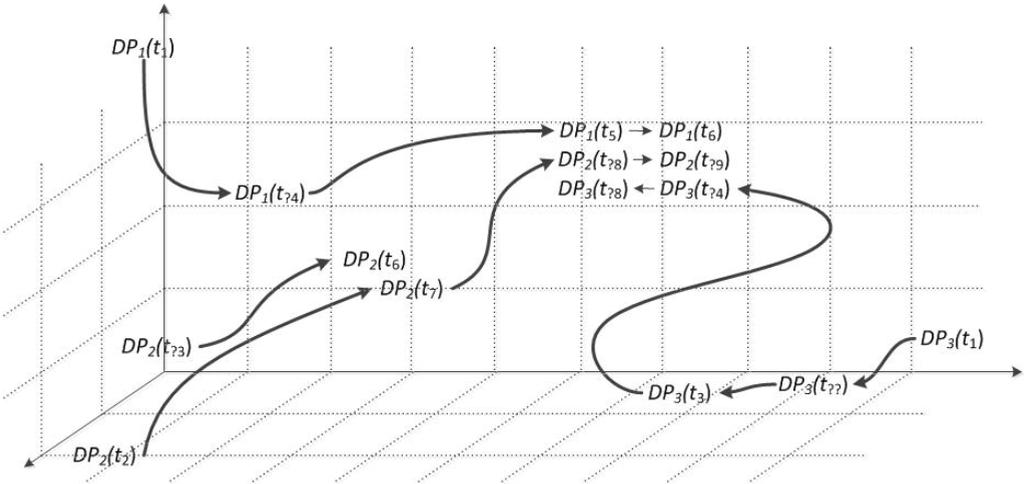


Fig. 4. Spatial image of the event  $EI_R$

In this way steps 1, 2 and 4 in the process of reconstruction of event were done.

#### 4. SUMMARY

The procedure for events reconstruction reported by observers was determined in the paper. Formal model of real world  $SW$  proposed in point 2 (def. 1.1) and implemented there notions of the point of change the entity's activity  $DP_j(t_i)$  (def. 1.2) and trace  $TR(o_j)$  (def. 1.3) create formal methods to description of event, analyzing its contents, concluding about its credibility and the presentation in the visual form.

Two variants of reconstruction were determined. The procedure of determining, crucial for reconstruction of event, points of change the entity's activity,  $DP_j(t_i)$  positioning in time and space, creating spatio-temporal images of event and determining trace of entities activity was shown on the example. The possibility of creating objective image  $EI_R$ , purpose of the work, was also presented.

Further works will focus on detailed answers of general outline of reconstruction, among others contextual detecting changes of omitted activities in reports (see:  $DP_3(t_{??})$  in Table 1), the verification of semantic correctness, evaluation of reports credibility and visualization of obtained results.

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## **ALLYING SYSTEM THINKING AND SET OF EXPERIENCE KNOWLEDGE STRUCTURE**

The approach of system thinking is completely different from traditional forms of analysis. Even the ancient meaning of word analysis is “a breaking up”. Set of Experience Knowledge Structure is an atomic record of decision event that can be grouped together and form some form of decision DNA of an organization. The question that this paper is trying to answer is how those concepts can be merged.

### 1. INTRODUCTION

#### 1.1. SYSTEM THINKING

The System thinking is a process of understanding how things works, but the focus is on the whole systems and not theirs components. In organizations, systems consists of people, structures, and processes that work together to make organization “healthy” or “unhealthy”[1]. Peter Senge in the book titled “The Fifth Discipline: The Art and Practice of the Learning Organization” focuses on group problem solving using the system thinking method in order to convert companies into learning organizations.

The five disciplines that lead to organizational learning:

- “Personal mastery is a discipline of continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality objectively.” [2]

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- “Mental models are deeply ingrained assumptions, generalizations, or even pictures of images that influence how we understand the world and how we take action.” [2]
- “Building shared vision – a practice of unearthing shared pictures of the future that foster genuine commitment and enrollment rather than compliance.” [2]
- “Team learning starts with dialogue, the capacity of members of a team to suspend assumptions and enter into genuine thinking together.”[2]
- “Systems thinking – The Fifth Discipline that integrates the other four.” [2]

This approach questions traditional approach that states that decomposition to smaller parts and knowing their relations provides to understanding of whole system. The manifest of system thinking is that we cannot build the best car just by using the best parts from different cars on the market, because a car is a system and it is more important how good is the final system and not how good the distinct parts are.

System thinking offers a range of tools for gaining deeper insight into problems. Starting from simple causal-loop diagrams and system archetypes to more complex computer simulation models.

## 1.2. SET OF EXPERIENCE KNOWLEDGE STRUCTURE

Set of Experience Knowledge Structure(SOEKS) is a method for recording experience on decision events. Those events can refer to any type of decisions including routine standardized nodes in business processes as well as ad-hoc decision made in unexpected circumstances. The goal of this structure is to persist individual experience in explicate way to enable organizational learning based on gathered record. The individual decision event is perceived in for perspectives:

- Functions that covers some transitions, mapping, calculation referred as some algorithm.
- Variables covers capturing the values and state of exposed decision factors.
- Constrains that refers to limitation and boundaries within parameter can change.
- Rules that refers to known logic that was relevant to this decision event.

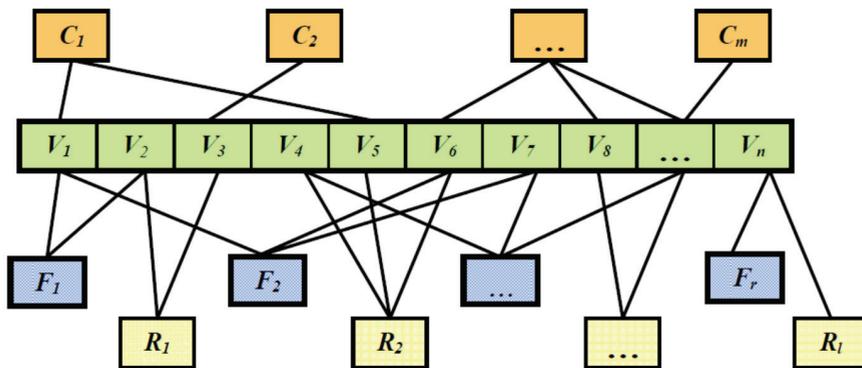


Fig. 1. Graphical representation of singular SOEKS record [3]

This structure focuses on ease of recording explicit decision factors, the main goal is to catch as much information about the decision event as possible. Those atomic pieces of organization experience should be refined, evaluated and if it is valid it should be incorporated in larger structures that batch similar experiences into larger structures. Finally if we gathered all those records together we will have all explicit knowledge about decision making in an organization.

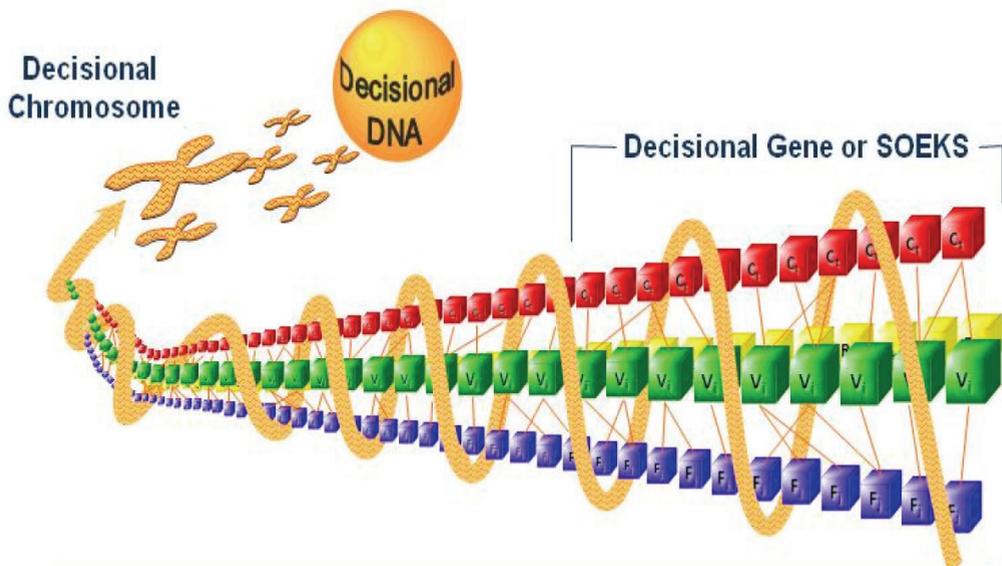


Fig. 2. Decisional DNA metaphor [4]

## 2. APPLICABILITY IN ORGANIZATION LEARNING

A learning organization is the term given to a company that facilitates the learning of its members and continuously transform itself [5]. Learning organizations develop as a result of the pressures facing modern organizations and enables them to remain competitive in the business environment [6]. System thinking is an integration framework originally proposed to integrate aspect related do personal development, explicit knowledge artifacts, goals, team work and effective communication. The main advantage of system thinking is focus on iterations on high level and how they influence the whole system. This approach help to avoid unintended consequences by focusing on an element as part of the whole system in opposition to traditional analysis that use decomposition and induct from atomic elements. SOEKS can be considered in this approach as some form of mental model for a decision event, but the technique can vary depending how we tackle a system.

### 2.1. HARD SYSTEMS

A hard systems thinking uses a structured methods, operational research to model a system. It requires that problems with such problem are well defined, there is an optimal solution. The distinguishing characteristic of all hard systems thinking is the belief that all real-world problems can be formulated in the following way: there is a desired state,  $S_1$ , and a present state,  $S_0$ , and there are alternative ways of getting from  $S_0$  to  $S_1$  [7]. In such approach we can use simulations and other even traditional analytical techniques to find optimal solution. There is even complete methodology called Structured systems analysis and design method for hard systems. In those approach SOEKS will become a data format for decision event record that can be used directly in decision support using a distance function define similar to those known from case based reasoning. The difference between case based reasoning and SOEKS based reasoning will differ only in area of focus and ease of capturing. Case base reasoning(CBR) as technique base on the same approach as SOEKS to find solution based on similar past problems. The true advantage of SOEKS the ease of recording user experience by distinguish decision factors into variables, functions, rules and constrains enables capturing more statistically relevant data then CBR normally would. The advantage would be minimized be by the all factor known approach in hard systems. The second difference that matters is focus on concrete decision event not on the whole case which make it easier to manage in terms of knowledge management, on another hand CBR approach will have better audit capabilities. It is safe to say that SOEKS in hard systems could be used as mental model for understanding how thing work and how decisions are made based on similarity of experience.

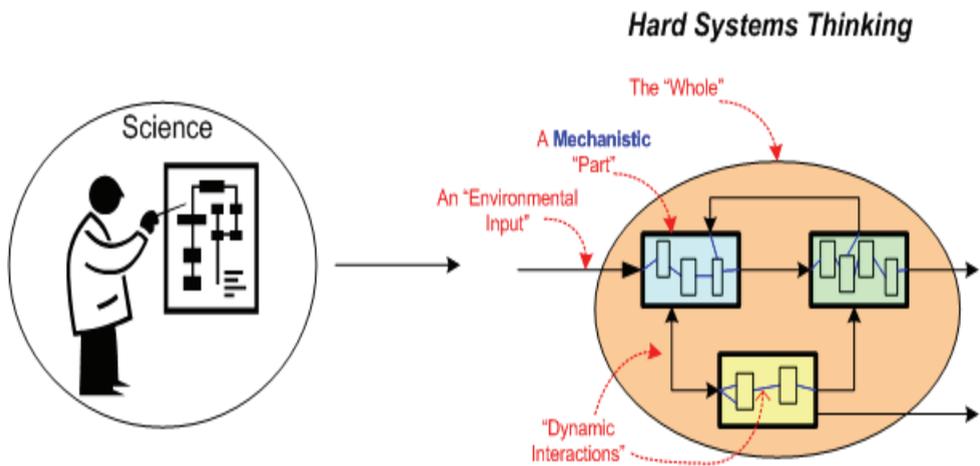


Fig. 3. Hard systems thinking [8]

## 2.2. SOFT SYSTEMS

Soft systems thinking is in opposition in hard system thinking on principle that problem can or cannot be defined. Soft systems thinking argues that in real word even a well defined problem could not the true problem and we will only focus on symptoms not on the disease. In fact in system thinking in management or computer science there are many terms correlations to medicine that has roots of such thinking in ancient china. It is safe to say that most systems are soft, especially those in which we involve humans with their emotions, motivations and imperfect perception. The area of soft system thinking covers organizations that has a collective goal and is linked to an external environment. Even computer programs become a subject of soft system thinking as a tool for human operator. The difference can be spot between fig. 3 and 4 that in soft systems thinking elements of the system cannot be easily determined. In hard system thinking there is assumption that system parts do not have any self-purposes. This assumption is wrong for systems composed of individual persons like organizations. Of course on some abstraction level we can model organization in a hard way i.e. in process notation like Business Process Modeling Notation 2.0 and there are business management approaches that focus on measurable hard indicators, but all refers to soft values like organizational culture, self improvement and innovation.

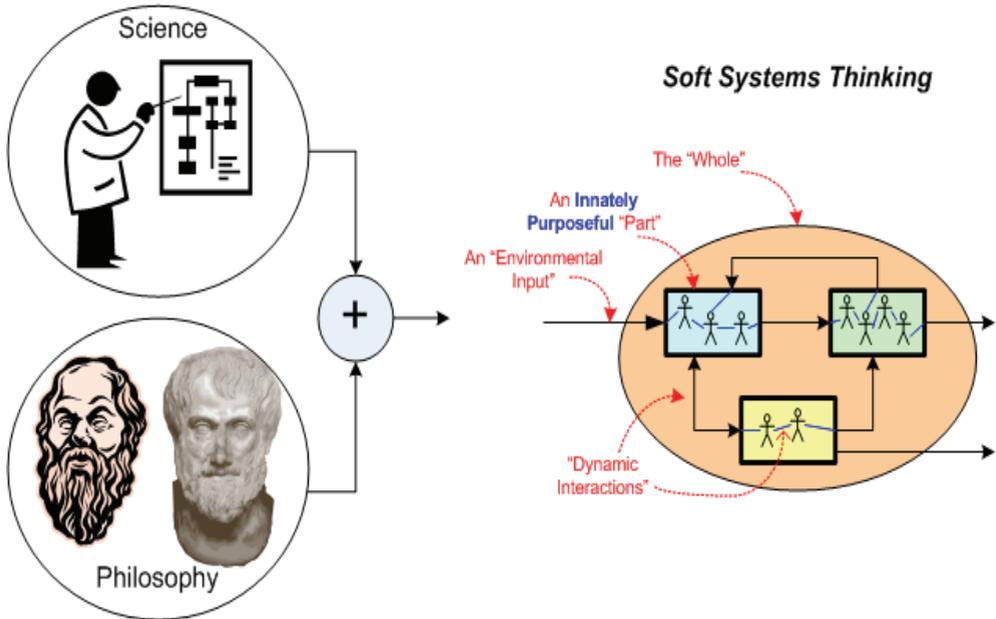


Fig. 4. Soft systems thinking [8]

If we want to model a learning organization we should use the soft systems approach and all learning will include human interaction, only data gathering and transformation can be automatic. If an organization wants to learn, there must be some knowledge sharing. The only kind of knowledge that a person can manage directly is called explicit. Tacit knowledge cannot be codified, but it could be transferred by some form of experience sharing [9]. From an organization's point of view, we can distinguish individual or collective knowledge. There are many ways of knowledge sharing in an organization, starting from lessons learned documentation via mental models to more focused specific aspects notations. In fact, any form of documentation can only store explicit knowledge, but a proper form can make the process of knowledge codification easier and more effective. For example, the Guideline Interchange Format (GLIF) was developed to share guidelines in medical and clinical procedures. GLIF is an example of how domain-specific notation that is quite similar to business rule notation with elements of process definition can be used in modeling medical document processing [10].

SOEKS is also a dedicated structure for capturing decision event experience in a human-readable format, and there is a chance that capturing decision events in this way we can learn more from them than we could using other formats.

### 3. KNOWLEDGE AND EXPERIENCE GATHERING LIMITATIONS

The knowledge spectrum (Figure 5) spans from a complex reality (the source of experimental data and information gathered from observations and measurements) to high-level abstractions (e.g., theories, hypotheses, beliefs, concepts, formulae etc). Therefore, it comprises increasingly lean modalities of knowledge and knowledge representations media and the relative boundaries and relationships between them [11].

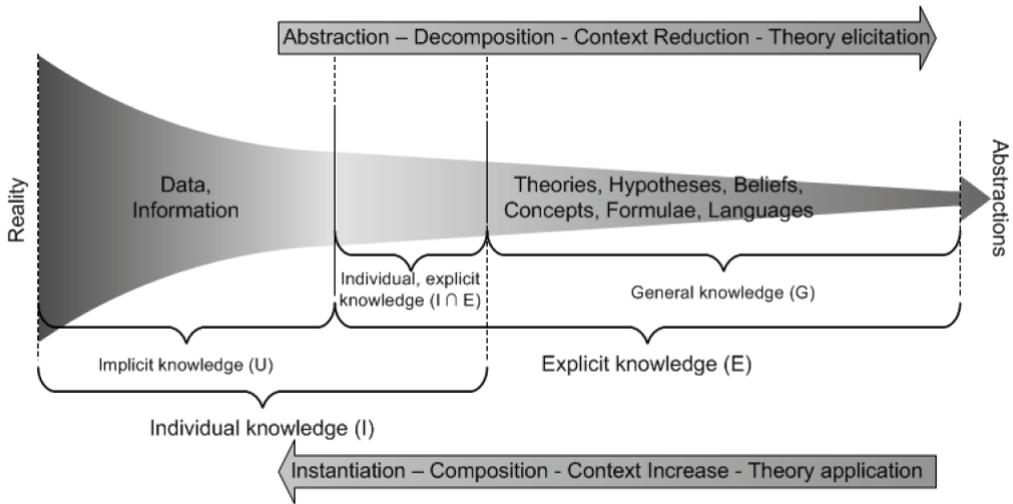


Fig. 5. The knowledge spectrum [11]

SOEKS is meant to work on some abstraction level, the rules, constrains must be defined, there must be explicit logic in functions and variables must be identified. From this perspective we will not be able to catch the whole decision context, but on another hand we gather experience record for specific reasons. If we really want to capture the most complete reality we do better using sensors similar to human senses like audio-video recording touch sensors etc. The abstraction is needed for understanding and evaluating atomic decisions. If gather a large quantity of those records we can try to elicit theories about decision process and decision factors on organizational level. In hard system thinking it will be easier to record a SOEKS for an atomic decision because most of rules, constrains, functions and variables are known and even process of recording could be automatic. It will be the case of automatic decisions made in low value loan approval process where the decision support mechanism in fact replaces a loan officer [12]. The value of such experience record will be limited to another form of information structure and can be even generated using simulation techniques.

On another hand in structured problem there are numeric methods and until problems are solvable in nondeterministic polynomial time. In hard system thinking approach that treat a human being as deterministic machine there is a little room for true learning or experience sharing it is more about information exchange. Hard system thinking could be effective for solving certain classes of problems especially where human role is secondary.

Soft system thinking is more context rich and closer to reality then hard system thinking. One of its key differences is that it assumes imperfection of human perception.

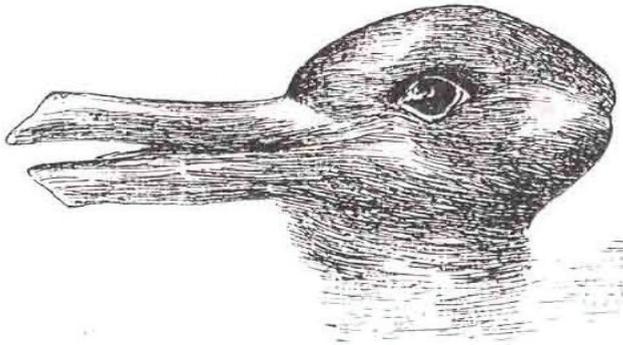


Fig. 6. Do you see a duck or a rabbit, or either ? [13]

The way we take decision is a matter how we see thing in a specific context. In an organization we will function in specific realm that has its own culture, regulations. Depending on organization we may take decisions in more structured way or not, for example we have to follow specific processes and principles, but in the end willingly or not we mix into decision process our internal believes, experience and legacy. In this case SOEKS will try to extract as many decision factors as possible and the decision maker would like to share. There are some decision factors that are we are not willing to share that affect the decision it could contain prejudices, first impressions, hidden motives, but also trust, loyalty and many more. Of course the organizational culture can affect the willingness to share one's motives, but it would be naive that it is possible to extract all even known to decision maker factors. The second problem is with interpretation of SOEKS because like in figure 6, same thing can mean different depending on a person. The problem of imprecise language can be mitigated by using formal classification or ontology for a domain, but subjective factors will remain uncovered. An individual SOEKS record is insufficient for any deeper reasoning, but when we can gather and cluster a larger number of records we can balance subjective

factors and extract the decision process on some collective level. This process of generalization will probably require human interpretation and judgment, but it could be supported by business intelligence tools. In some environments in SOEKS could be enriched by hard factors. For example when decision is facilitated in some information technology tool ale rules, constrains, variables and functions can be automatically populated to SOEKS.

#### 4. SUMMARY

SOEKS fits system thinking like a glove. It can be perceived as dedicated to decision mental model, but it can be achieved only after gathering and extracting collective knowledge. Of course it will require some effort and not all organizational cultures will encourage experience sharing, but it is technically possible to use SOEKS both in hard and soft system thinking. It is not likely that SOEKS will reveal all decision factors and overcome all human imperfections in perception, but as dedicated human friendly data structure for capturing experience on some abstraction level will help to understand how decision are made in an organization. This with soft system thinking approach could lead to proper diagnosis and treat the disease instead of symptomatic treatment. It may be not so immediate as a pain killer, but will help an organization to remain healthy.

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## **AGILE PRACTICES AS A TOOL SOLVING SOFTWARE DEVELOPMENT PROBLEMS**

The paper reports results of the survey participated by a group of software engineering specialists. The aim of the survey was to identify the role of the best practices in the software development process based on agile methodologies. The considered set of practices consisted of the quality assurance practices. The practices were considered in terms of their impact on supporting some selected problems encountered during software development process.

### 1. INTRODUCTION

Software development includes all that is involved between the requirement of the desired software through to the final software product. Software development process bases on a given methodology and uses different means like formal notations, methods, and supporting tools. The quality of the process, and consequently the quality of the final software product depends strongly on the way how these notations, methods and tools are applied, in other words, it depends on practices. There are many practices, some of which are referred to as best practices because of their positive evaluation in practical applications. Although the notion of the best practice is independent of the notion of a methodology, the best practices are strongly associated with agile methodologies since the definition of such a methodology is very often perceived through a set of recommended practices.

The subject of paper's interest is a subset of practices recommended by the most popular agile methodologies: *Extreme Programming, Crystal Clear, Feature Driven Development, Scrum, Dynamic Software Development Methodology, Agile Unified*

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*Process*, and *Agile Modeling*. There are several dozen known practices [1, 2]. Very often the practices are applied without direct justification. Such an approach does not enable to assess the usefulness of the practices.

In further, the set of considered practices is limited to selected practices that are associated with quality assurance [4]. It means that these practices may be applied in some of software life processes supporting quality assurance according to ISO/IEC 12207:2008 [6]. In this paper only a subset of 23 practices, that may be considered as quality assurance, are discussed. It should be underlined that quality assurance practices do not guarantee the quality of the final software product but their application conducive the quality, and conversely, their non-application lead to a low quality product.

If the practices are applied, obvious questions arise: when to use the practices, and what is usefulness of them? The main aim of the paper stems from these questions. We wanted to know how practitioners respond to the questions. As a sample of respondents the group of students with professional experience from the Faculty of Informatics and Management, Wrocław University of Technology, was selected. The students took part in a elaborated survey. The main aim of the survey was to elicit respondents' recommendation how the selected practices support solving of selected problems encountered in the software development process. The set of problems was fixed on the base of authors' experience as well as on the analysis of the problems contained in the descriptions of different software development methodologies. The problems embrace both engineering problems related to software development, and managerial problems related to the management of software development process.

Additionally, we wanted to know how the respondents assess the practices from the perspective of the cost effectiveness of their application, and how they propose to group the practices to achieve their synergy effect.

We found no survey of relevance focusing on quality oriented agile practices, their cost-effectiveness and problem solving support. The related works focus on ranking of the agile practices from other perspectives: importance for project [2], popularity of using [10, 11], essentiality for agility approach [9], difficulty in adoption [1]. Some other works focus only on adoption of agile practices in industry [7, 8].

The structure of the paper is as follows: the next section describes the elaborated survey, section 3 presents an analysis of the survey results, and finally, Section 4 concludes the paper.

## 2. SURVEY DESCRIPTION

The structure of the survey resulted from the stated research questions:

- How often selected quality assurance practices are used? Which of them are the most cost-effective if implemented?

- Which of the practices are recommended to be used together to achieve synergy effect?
- Which practices can be used to support solving selected problems appearing during the process of software development?

Respondents were asked a total of 15 questions (seven multi-choice and eight open questions) divided into four sections: demographics, practice cost-effectiveness, groups of practices with synergy effect, and practices supporting the solving of development problems.

In the beginning of the first part – demographics – respondents gave information about his/her professional experience, i.e. the period of work in software development, and the roles played in software development teams. Next, the respondents were asked about agile approaches and practices he/she ever applied in his/her team. The respondent was also asked to tick all from the list of 23 selected practices, which he/she used in the software development projects. The practices were as follows: *Informative workspace* (P1), *Pair programming* (P2), *Timeboxing/quarterly cycle* (P3), *Continuous integration* (P4), *Incremental development* (P5), *Root cause analysis* (P6), *Code and test* (P7), *Product backlog* (P8), *Requirement prioritization* (P9), *User stories* (P10), *Stand-up meetings* (P11), *Sprint burndown chart* (P12), *Frequent delivery* (P13), *Sprint demo* (P14), *Sprint review meeting* (P15), *Retrospectives* (P16), *Configuration management* (P17), *Architecture vision* (P18), *Product owner/on-site customer* (P19), *Modeling* (P20), *Executable specifications* (P21), *Refactoring* (P22), *Test-driven development* (P23).

The second part of the questionnaire concerned the cost-effectiveness of selected practices.

In the third part the respondent proposed groups of practices (clusters) which in his/her opinion should be applied together to bring synergy effect.

The fourth part concerned the respondent opinion on possibility to support solving of selected project problems by properly selected practices. A respondent having the list of 28 selected problems, structured according to the project phases and type of activities (development or management), was asked to point one or more of practices for each of these problems, which according to his/her experience, could be helpful in solving them.

The following problems were defined: *Identification of user needs* (R1), *Changing of requirements* (R2), *Inadequate requirement specification* (R3), *Incorrect interpretation of the requirements* (R4), *Lack of domain knowledge* (R5), *Variability of implementation environments* (R6), *Complexity of the domain* (R7), *Problems in code integration* (R8), *Duplicated code reduction* (R9), *Uncomplicated project* (R10), *Complex project* (R11), *Difficulty in code or database structure interpretation* (R12), *Varied code quality (depending on the developer)* (R13), *Verification of artifacts in the context of the specification* (R14), *Requirements for code quality* (R15), *Need for continuous product validation* (R16), *Requirements of extensive documentation* (R17), *The*

*elimination of software bugs (R18), Adaptive software maintenance (R19), Improving software maintenance (R20), Preventive software maintenance (R21), Access to current information on the status of the project (R22), Communication and information exchange rules (R23), Requirement for software implementation (R24), Deviations from plans (R25), Late detection of threats, eliminating or reducing the impact of their occurrences (R26), Participation of the team members in many projects at the same time (R27), Planning releases, iterations, tasks (R28).*

In the survey participated 65 students, both of B.Sc. and M.Sc. levels, in the field of informatics from the Institute of Informatics, Wrocław University of Technology. There were 30 full time students, and 35 part time students. Most of them had also professional experience in software development as a result of being employed in software companies, before study or concurrently with their study at the university. 33 participants have more than 6 months experience in IT. They work mainly as programmers and testers.

The survey was conducted at the end of the academic year, after completion by students team projects, in which they applied many agile practices, especially Scrum practices.

### 3. SURVEY RESULTS AND THEIR ANALYSIS

The survey aimed in brings evaluation of agile practices from three perspectives. We wanted to know which practices can be successfully applied for solving defined problems, which are perceived as cost effective, and how to group them.

We decided to analyze only responses from respondents who had minimum 6 months period of professional experience. Because of it the 22 responses were left out, analyzed 33 respondents had an average of 43 months experience in the software profession.

Table 1 presents the relationship between defined problems and practices as perceived by survey participants. An entry of the table contains the number of times a practice (P1, ..., P23) was selected to solve a specific problem (R1, ..., R28). The last column and the last row show the summaries. The cells containing a number greater than 5 were singled out with other filling.

The most often addressed problems are:

- R28, selected 62 times, and supported by following practices: P8, P9, P11, P12, P15
- R22, selected 59 times, and supported by following practices: P1, P8, P11
- R18, selected 58 times, and supported by following practices: P22, P23
- R23, selected 45 times, and supported by following practices: P1, P11, P16.

Problems weakly addressed are *Requirements of extensive documentation* and *Complex domain*, both received 16 votes. Modeling received relatively little votes, and we can conclude that it is not perceived as a typical agile practice.

The most universal practices (top 5), addressing many different problems, are:

- P19 (*On-site customer*), indicated 75 times, supporting all problems from requirements discipline,
- P23 (*Test driven development*), indicated 74 times, supporting testing and maintenance disciplines,
- P1 (*Informative workspace*) – indicated 68 times, supporting team work discipline,
- P4 (*Continuous integration*) – indicated 68 times, supporting problem solution from different areas,
- P22 (*Refactoring*) – indicated 68, supporting software construction, testing, and maintenance.

The results partially overlap with those reported in [9] (*continuous integration, test-driven development*), [10, 11] (*refactoring*), and [1] (*continuous integration, test driven development, refactoring*), although the assessments were done from different perspectives. The practices, resulting from our survey, and not belonging to the top 5 of others, are: P1 (*common information space*), and P19 (*customer on site*).

The least universal practices, selected only 16 times, are: P3-*Timeboxing/quarterly cycle*, P12-*Sprint breakdown chart*, and P17-*Configuration management*.

The second perspective of practices' evaluation was cost-effectiveness. Cost-effectiveness of a practice was estimated by the practice application cost in relation to the benefit of using the practice, with the assumption that the latter (benefit) is higher than the former (cost).

The respondents were asked to indicate (from the list P1, ..., P23 practices) all these practices which according to respondent's opinion influence on project efficiency (respondents were able to select multiple options).

The response count for this question was 32 out of 33 respondents (one respondent did not tick any practice). The responses to the question are provided in Fig. 1.

What is not surprising, the winners are: *Informative workspace*, *Sprint review meeting* and *Product owner/On-site customer* which were pointed out 20 times (60,61%). All these practices are not difficult to implement and cheap in adoption. It is worth to notice that these practices belongs to the management category. Next to them come six practices which were pointed out 19 times (57,58%). In this group we have two practices of the management category (*Timeboxing/quarterly cycle*, *Incremental development*) and four are of the software engineering category (*Code and test*, *Requirement prioritization*, *Product backlog*, *Test driven development*).

Table 1. Summarization of survey results

	Requirements					Softw. design		Software construction						Software testing				Software maintenance				Team work		Risk analysis					Pl.	Total
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28		
P1	3	2	2	2	3	2	1	3	3	0	0	1	0	3	0	0	4	1	0	2	1	18	10	2	1	0	3	1	68	
P2	0	1	0	1	0	2	1	4	3	2	0	2	10	1	2	0	0	5	0	1	0	3	4	1	0	1	1	1	46	
P3	0	1	0	0	0	0	1	0	2	1	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	1	0	5	16	
P4	1	0	1	0	0	5	2	17	0	3	1	1	1	4	1	8	1	6	4	3	2	0	0	2	0	4	0	1	68	
P5	1	0	1	0	0	1	1	1	1	0	3	0	1	1	1	2	0	1	7	2	2	1	0	3	1	3	0	4	38	
P6	1	1	0	1	1	0	0	1	0	0	0	1	0	1	1	0	0	5	0	0	0	0	0	1	1	4	0	1	20	
P7	0	1	0	0	0	2	0	2	0	6	1	1	2	7	3	3	0	10	3	2	0	0	0	0	0	2	0	0	45	
P8	3	2	3	2	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0	1	0	8	2	1	4	1	0	7	38	
P9	0	2	2	2	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	2	4	1	0	8	27	
P10	9	2	8	0	0	0	1	0	0	1	1	0	1	0	0	0	1	0	0	1	0	3	3	1	1	2	0	2	37	
P11	0	2	2	4	2	1	0	0	0	1	2	2	0	0	1	0	0	0	1	0	0	14	11	2	1	3	3	7	59	
P12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	1	0	4	0	2	6	16	
P13	2	6	3	3	1	1	0	0	0	2	0	0	0	1	0	2	0	2	0	1	0	0	0	1	1	3	1	2	32	
P14	1	1	2	6	1	0	0	0	0	0	0	0	0	3	2	3	0	1	0	0	0	2	1	0	2	1	1	1	28	
P15	0	1	0	0	0	0	0	0	1	0	2	0	1	0	1	0	0	2	0	0	1	4	4	2	0	2	2	5	28	
P16	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	3	8	0	0	1	3	4	22	
P17	0	0	0	0	1	6	0	2	1	0	0	1	0	0	2	0	0	1	1	1	0	0	0	0	0	0	0	0	16	
P18	1	1	2	0	0	3	2	0	1	0	9	1	0	0	1	1	1	0	0	1	0	0	0	0	0	2	1	0	27	
P19	13	9	6	12	11	0	3	0	1	1	1	0	0	2	1	1	1	1	1	3	0	0	1	0	2	2	0	3	75	
P20	2	1	2	0	1	3	2	0	0	0	6	5	0	1	1	0	3	0	1	0	0	0	0	2	0	0	3	2	35	
P21	0	1	1	1	1	0	0	0	0	0	2	1	0	4	1	1	1	1	2	1	0	0	0	2	0	0	1	2	23	
P22	0	0	1	0	0	1	0	6	12	3	1	2	5	2	5	1	0	9	2	9	7	0	0	1	0	1	0	0	68	
P23	0	1	0	0	2	2	2	3	2	4	4	2	4	9	7	2	12	4	4	3	0	0	0	1	0	3	1	0	74	
Total	37	35	36	34	25	29	16	39	28	22	39	22	23	34	34	30	16	58	26	34	16	59	45	25	23	37	22	62	906	

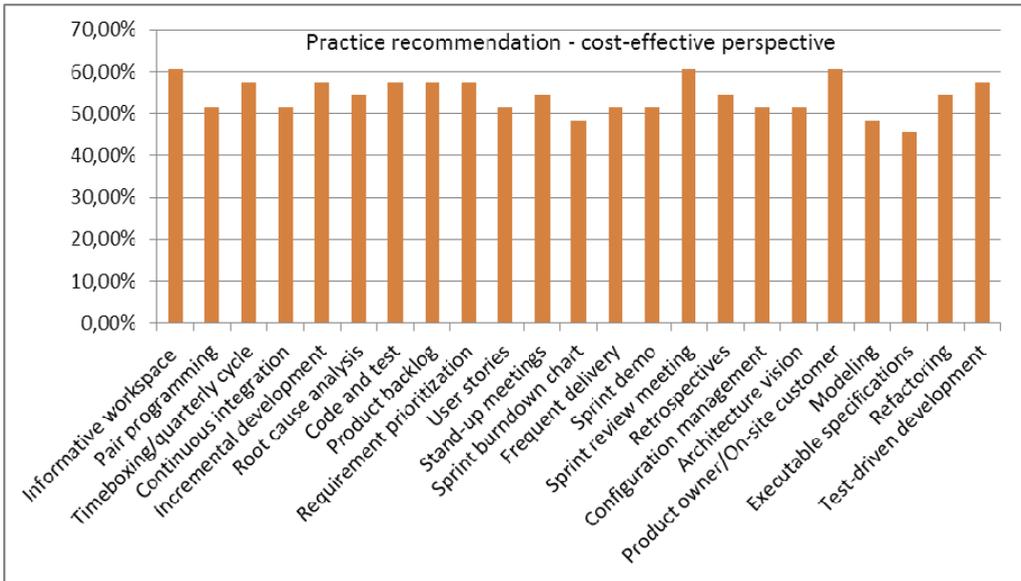


Fig. 1. The percentage of practices recommendation in the context of practices' cost-effectiveness

The resulted ranking is not very similar to the results one can find in other surveys, e.g. [1, 10,11]. But it is quite near to the results reported in [3].

Some surprising results are: high ranking of Test driven development which are mostly pointed out as too difficult to implement [1, 10] and relatively low ranking of (*Daily*) *Stand-up Meetings* and *Retrospectives* practices. The two latter seems to be inexpensive and easy to implement.

The last research question was about possible grouping of practices. Figure 2 presents group of practices proposed by respondents who have at least 6 months experience in IT.

We counted the number of votes for each pair, triple, ...,  $n$ -tuple of practices that were selected at least once, and after that eliminated those having less than 5 votes. Totally we had 1681  $n$ -tuples to be assessed ( $n \geq 2$  and  $n \leq 5$ ). Number 5 was selected as the reasonable minimum, which gives about 15% of people taking part in the questionnaire. It should be noticed that the maximal number of votes for a tuple was 7 (5 tuples); 6 votes were given for 1 tuple, 5 votes for 9 tuples, and 4 votes for 17 tuples. The maximal number of practices with at least 5 votes was 2. Three triples obtained 4 votes, i.e. {P7, P11, P15}, {P4, P22, P23}, {P7, P19, P22}, what is not reflected in Figure 2.

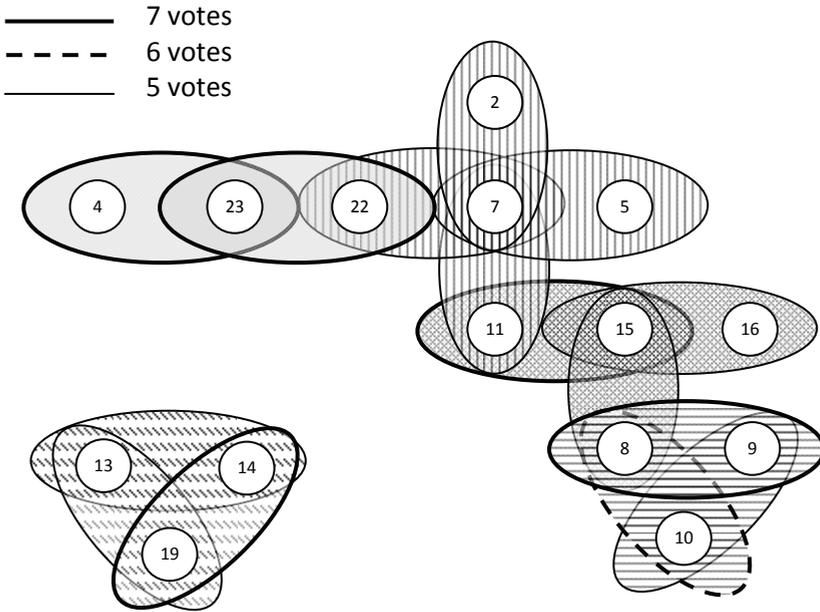


Fig. 2. Groups of practices

We tried to mark identified groups of practices, that – according to the questionnaire’s participants – should be used together. That are:

- {P4, P22, P23} – this selection was confirmed by additional 4 votes for this triple,
- {P2, P5, P7, P11, P22} – with the binding practice No. 7 (*Code and test*), partially confirmed by 4 votes for the triple {P7, P11, P15},
- {P8, P11, P15, P16} – with the binding practice P15 (*Sprint review meeting*),
- {P8, P9, P10} – three practices connected each other,
- {P13, P14, P19} – three practices connected each other.

The first two groups (a) and (b) are connected directly to the implementation besides practice P11 (*Stand-up meetings*), which is the border practice linking group (b) with (c). Group (c) is about process improvement (P15 – *Sprint review meeting*, P16 – *retrospectives*), and contains one linking practice (P8 – *Product backlog*) from group (d). Group (d) contains practices connected to user requirements. The last group (e) consists of practices mitigating the risk, e.g. practice P13 (*Frequent delivery*) or practice P14 (*Sprint demo*).

We followed the same approach for questionnaire’s participant with less than 6 months experience but almost without any valuable results. The votes were very dispersed. The maximal number of votes were 5 for one pair {P1, P7}. The same pair was selected 3 times by more experienced respondents). Three pairs obtained 4 votes:

{P11, P16}, {P3, P14}, {P8, P9}. Every pair belongs to a more complex group shown in Figure 2.

Identified group (clusters) of practices are different from those proposed by Elssamadysy [5]. But the group of practices he discussed were limited to technical practices only (i.e. development practices). Moreover his proposition was based on author's subjective opinion and theoretical analysis of practices' characteristics so it is not comparable with our results.

#### 4. CONCLUSIONS

The main stress in the survey was put on identification of the most influential quality assurance practices in supporting solution of software development problems. The intention was driven by the fact that the success of the project is contingent upon the use of pro-quality practices. This identification gave rise to the question about the groups of mutually supportive practices. The survey provided initial views of professionals on the subject. Due to the small number of participants, especially not confirmed until the end of their degree of competence, the results should be treated carefully enough. However, the survey clearly revealed the changing views of respondents resulting from the level of their experience. The changes of views were not shown in the presentation above. This part of the survey is the original and the most valuable. It needs some refinement and is required to be conducted with participation of more numerous respondents.

The question on cost effectiveness of practices in the survey was left to the experience and intuition of respondents. These recommendations compared to similar recommendations gained in other surveys, are not very diversified, which seems to prove that the respondents were not very experienced.

The results of the survey lead to some expected conclusions, for example:

- *On-site customer, Informative workspace* and *Test driven development* practices being three of the most universal practices (i.e. addressing many problems) were also viewed and indicated as the most cost effective.
- The practices *P3-Timeboxing/quarterly demo* (16 votes), *P12-Sprint burndown chart* (16 votes), *P17-Configuration management* (16 votes) were indicated as the least universal. The first one was indicated as the most effective. *Refactoring* was indicated as the weak effective what is in contrary to the opinion indicating it as the most influential.

There were also, to some extent, unexpected conclusions, for example:

- The least addressed problems are as follows: *Requirement of extensive documentation* and *Complex domain* (only 16 votes).
- Very few respondents pointed out *modeling* practice what can be interpreted that this practice is not viewed as agile practice.

The latter findings seem to stem from the fact that the proponents of agile methods do not see the problems that may arise after the first release of the software product. In particular, a broad range of issues related to the maintenance and development of software system should be taken into account. To solve these problems, modeling practice is just extremely useful.

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## **PART 2**

# **MODELS OF RISK MANAGEMENT IN DECISION MAKING PROCESS**



Michał J. KOWALSKI\*

## **VALUE-BASED CONTROLLING**

Value Based Management (VBM) sparked development of a wide spectrum of tools that support companies in their pursue to grow the value. All the attempts that can be found in literature gathering the knowledge of VBM have led to define VBM subsystems and created from them closed management cycles. In terms of this, VBM does not differ significantly from the management approach suggested by controlling. Thus, we can name the contemporary model of management as Value-Based Controlling (VBC). In this paper the author makes an attempt to define VBC, and describes the most important tasks of VBC. The analogy between the VBM cycle and Controlling cycle is presented and on this basis VBM studies and tools are classified. Exemplary VBC tools, applied in Polish companies were also presented.

### **1. INTRODUCTION**

Contemporary management science is aiming to maximize business value. It is only possible by meeting the expectations of all stakeholders, which in turn provides the long-term existence, survival and development of every organization. This belief is the basis of a trend in financial and business management known as Value Based Management (VBM) that has been developed since the 1980s. VBM is defined as a business management system, in which all decisions are taken by the managers - at the financial, investment and organizational level, and they aim to maximize the value of invested capital (IC) [3]. It is something more than simply a management concept. It is a kind of business philosophy where all the company's aspirations, analytical techniques and all processes are concentrated to maximize the value; the decision-making focuses on the key factors that influence the value [2]. VBM philosophy creates a management cycle that is to be a kind of recipe for good management. Throughout the years of research, VBM has inspired development of a system of tools that support

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value creation at each stage of the management cycle. Implementation of the system is to provide the company with the possibility to create value, and thus secure its survival and development.

The article aims to analyse the tools supporting Value Based Management, presents various VBM concepts and tries to classify them. The author also reveals analogies between the value management cycle and controlling business cycle and on the basis of this discussion defines the term of value-based controlling.

## 2. VALUE BASED CONTROLLING

### 1.1. DEFINITION

VBM philosophy encourages companies to implement a management cycle that can be called a self-improvement cycle in terms of value creation. It focuses on the value at each of the stages that make up the closed management cycle. The value is the basis of setting business goals and decides about courses of strategic actions. On their basis resources and investments are allocated to maximise the value of capital. Management science has been defining new value growth measures since the VBM concept was invented. Measured results not only include information about the financial results but also invested capital, cost of capital and the risk associated with the business. The growth of capital value is also the most important factor deciding about the managers' motivation system. The value constitute thus the basis for evaluation of management activities and at the same time a communication tool between the manager and the owner. The board of directors evaluates management activities thoroughly considering the value and then approves future courses of strategic actions. At this point the management cycle closes. Rappaport indicates that to fully implement VBM, we should accept the principle of 4M. According to the 4M principle value is the basis of thinking (Mindset), decision-making (Management), evaluation of results (Measurement) and remuneration (Motivation).

One can state that due to its complexity VBM redefines management system first suggested by the controlling concept, which takes its roots in the XV century, thus long before VBM concept was invented, although its development and proper organization is dated to the year 1931, when the Controller's Institute of America was set up (later renamed Financial Executive Institute) [16]. The variety of controlling definitions can be reduced by their classification, taking into account their common features. The literature treats the controlling as (1) management tool, (2) management subsystem or (3) management supporting method. The controlling concept is to support the basic functions of management because it partially takes over and partially supports planning and controlling processes and as a result coordinates the whole company. Con-

trolling, similarly to VBM, results from and integrates all areas of the company and permeates and integrates them as well. In light of requirements formulated by VBM, the growth of value should be the essence of this coordination. Value-based controlling is a system of business and process workflow management that coordinates various areas of the organization to achieve the growth of value of invested capital.

The literature mentions also controlling shareholders [1] understood as the relation between the quality of corporate governance and the change in business value. However, value-based controlling is wider-oriented than controlling shareholders, also to the inside of the company. Although value-based controlling undoubtedly bridges the management and the owner, the concept appears to include more than the controlling shareholders does.

Unrein [14] mentions the need to extend controlling. He turns our attention to the fact that the concept of controlling is expanding and that controlling is no longer restricted to cost management. Aspects, such as quality, cash management, payment management, resources management and investment management are included to the controlling as well. However, the author underlines the value, which is added to the organization by pure implementation of the controlling rather than controlling as a management system, which is oriented to grow the capital value.

## 1.2. THE CYCLE AND TOOLS OF VALUE-BASED CONTROLLING

Controlling, similarly to VBM, constitutes a closed management cycle that tries to present the nature of management as a system composed of subsequently realized steps closed in a self-improvement cycle. In this section, elements of value-based controlling cycle and its connections with VBM are presented. On the basis of the comparison classification of value-based tools is made.

Controlling is no longer perceived as simply control. The role of a controller as an official that is to support the management, through continuous feedback being a result of planning and comparison between the actual state of the company with the desired (reference) state was subjected to extensive criticism [16], [15]. Limiting the role of controlling to the budgeting and analysis of deviations can distort the controlling concept, which in any case should not restrict the organization. Controlling is to inspire companies, to constantly search for new paths, paths that create value. Therefore, the controlling cycle should begin definitely much earlier than budgeting.

The starting point for value-base controlling should be the explicitly-oriented company's mission, according to VBM, to build value for shareholders. This objective does not cut off from the interests of stakeholders other than the owners of the capital. The expectations of employees, customers, public and even the natural environment have to be satisfied if the company is to build value in the long-term. Violation of the balance between any of the stakeholders increases the investment risk in such a company, which automatically means for it a loss of the value.

The company's mission is decomposed into strategic challenges. The task for controlling is now to inspire the organization to think strategically. Stewart, the author of the Economic Value Added (EVA) concept (see section 4), clearly shows the process of value migration between industries or businesses [13]. Companies compete not only with their direct competitors operating on the same market but above all compete on a global scale for the capital or for the investor. In order to maintain the ability to grow capital value and achieve higher and higher return on investment, the company must be prepared for constant change and use tools to predict and verify the directions of the changes.

Strategic plans developed under value-based controlling, in addition to forecasting and analysis of the financial results, should take into account all the other value drivers, including above all the capital required for development and generated risk.

VBM concept suggests a number of value creation strategies. The growth strategy does not, however, always guarantee growth of value. Sometimes the withdrawal, reduction of certain activities, may be better from the point of view of value. When choosing a strategy, discount investment measures should be included as they allow to a look at projects exactly from that point of view.

According to the controlling cycle, strategic plans should be next transferred to operational plans. In this respect, value-base controlling faces the problem of measuring value at all the management levels. The challenge for the researchers is to look for tools to measure the value at the operational level of individual contracts, orders, manufactured products or rendered services. Value-based controlling permeates into the operational planning in trading calculations; there appear elements associated with the measurement of capital requirements. VBM changes the approach to trade negotiations, where along with the trading margin payment terms are negotiated and before the contract is signed a production cycle is analyzed as well as necessary investments to carry out the order to determine of the return on invested capital.

Value-based controlling requires proper management reporting. Measures are needed to report regularly the managers whether and to what extent their decisions have caused the growth of value. Profit centers and cost responsibility centers, known from classic thinking about controlling, are transformed into value creation centers. Classic effectiveness measures of responsibility centers are converted to or completed with measures that evaluate, most of all, the return on invested capital. Reporting systems have sought for value decomposition methods into factors, drivers, that will be able to identify for the managers the buffers of value that can be used.

The closing element of the classical reasoning about controlling is a feedback in the form of incentive systems. Controlling is to look for methods that will shape the behaviour of employees to achieve business objectives. Controlling places particular emphasis on this part of the cycle. There is no possibility of VBM implementation without making employees' salaries dependent on the value and even growth of value to which they contributed. Value-based controlling is to ensure consistency in the

expectations of the owners with the activities of the management through incentive schemes. At this point, the controlling cycle is closed. Incentive systems open new routes in strategic thinking, create new paths to build capital growth.

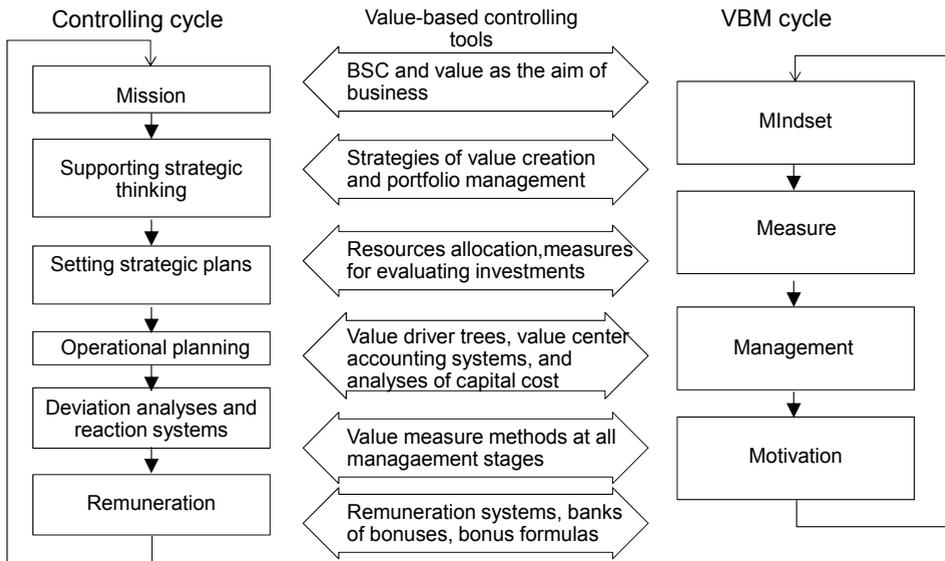


Fig. 1. Value-based controlling, cycle and tools

Fig. 1 presents a controlling cycle and VBM cycle. Both cycles are consistent with each other and complement each other as well. Value-based controlling is a system-based approach to management. The owners and managers receive a complete set of management and decision-making tools. Throughout many years of VBM research, many tools supporting the concept of value have been developed. Thinking in terms of value-based controlling permits to suggest classification of research and tools supporting value creation for each element of the cycle:

1. at the stage of setting business aims
  - research on BSC concept [4]
  - looking for quality and non-financial value measures, including research on intellectual capital [5]
2. at the stage of setting strategic plans
  - portfolio management tools, value creation matrixes indicating areas of strategic development [11]
  - investment evaluation tools, including discount methods based on CF and value measures like EVA [11]

3. at the stage of setting operational plans
  - value measure on operational levels of management
  - accounting tools and allocation of invested capital and its cost
  - processing approach to value management [7]
4. at the stage of result evaluation
  - looking for value measures, measure systems, adjusting accounting data to their economic sense
  - looking for financial and non-financial value drivers
  - value trees, decomposition of value drivers [9]
5. at the stage of motivation
  - a. remuneration systems, bonus formulas [10], [6]
  - b. management stock options
  - c. banks of bonuses
  - d. relation between measures and share prices [8].

### 3. APPLICATION OF VALUE-BASED CONTROLLING

In this section, chosen examples of value-base controlling are presented. These examples come from experience of Polish companies that implemented VBC tools.

The companies use BSC concept as the basis to communicate strategy. Their aim is to grow value of the invested capital. The basic measure used is Economic Value Added and its derivative  $\Delta$ EVA (delta). The aim in the strategy map and most of the taken initiatives assume to achieve grow in EVA in the next three years. The growth of capital value is also reflected in the mission of the company. The strategy map is decomposed into a matrix, i.e. into individual business units and products that are provided by the company and what is more into individual management sectors, personal sectors or financial sectors.

Although each product market strategy is different, they all share the same aim in the financial perspective, i.e. the value. Very interesting are the functional strategies decomposed in individual sectors. For example, the tax management strategy and risk management policy, where the BSC methodology decomposes important value drivers into strategic courses of action, which are to lead to the growth of value.

Strategic plans are prepared each time with the use of VBM measures, especially Economic Value Added. Separate internal procedures assume every quarter WACC measures for the company as a whole and for the individual business units as a tool to monitor risk and investors' expectations. Analysis of the profitability of projects is carried out by discounting of the future EVA. What is calculated is the factor influencing the level of invested capital and the risk of projects. The results are compared with the return on capital (ROIC) obtained from alternative forms of investment, for exam-

ple by comparing the returns obtained from investing in the development of organic businesses, such as internal investments to increase the market share with the return on investment obtained in the form of merge & acquisitions.

Up-to-date reporting is to communicate the obtained growth or drop in value including their decomposition into individual areas and drivers. An exemplary management reporting model in its most comprehensive form is presented in Tab. 1.

Table 1. Management reporting model in value-based controlling

Company name	Value centre 1	Value centre 2	...	Total
Revenues [mln PLN]				
Gross margin after incurring direct costs [mln PLN]				
<i>rate of gross margin [%]</i>				
Indirect costs [mln PLN]				
<i>Rate of indirect costs [%]</i>				
Earnings Before Interest and Tax [mln PLN]				
<i>Rate of EBIT [%]</i>				
Tax				
Cost of Capital [mln PLN]				
At average Invested Capital [mln PLN]				
EVA [mln PLN]				
<i>Rate of economic profit [%]</i>				
<i>Return of Invested Capital [%]</i>				

Source: my own

Value centre accounting system is not restricted to cost decomposition but also includes measures and factors of value. There are in the measures of the effectiveness of the centers new measure supporting efficiency measure in value creation. The Tab. 3 presents chosen measures evaluating the effectiveness of value creation centers that can complement the measures used for traditional profit centers.

Table 2. Chosen value measures for value centres

Capital productivity	$\frac{\text{Revenues (annual equivalent)}}{\text{Average invested capital}}$
Invested Capital Requirement	$\frac{\text{delta IC}}{\text{delta Revenues}}$
Tax management efficiency	$\text{NOPAT}$
<i>Rate of economic profit</i>	$\frac{\text{EVA}}{\text{NOPAT}}$

Source: my own

A separate reporting area constitute invested capital. Analytics in this area usually involve decomposing capital into perspectives:

- areas of management, taking into account individual value creation centers
- by type by source of capital invested, usually based on a formal arrangement of a balance sheet
- by type by source of capital invested indicating equity external and internal debt.

A particular challenge for value-based controlling is the allocation of capital to the value centers. The requirements in this area are no longer only a challenge for management accounting but they are also shared by the law. For example, according to the planned regulation of EU law, the compensation granted to the operators of passenger transport for carrying out economically inefficient but important from the social point of view objectives will be granted on the basis of the actually incurred costs, however, assuming the so-called “reasonable profit”. Calculation of the reasonable profit, in turn, results from the determination of capital required for the realization of the task and the expected return on this capital by the market. Hundreds of transport operators face therefore the task of developing algorithms for monitoring and allocation of capital employed in their regular operations and the remaining activities, and subsequently they have to indicate keys and algorithms to divide capital for individual transport tasks. Value-based controlling is to develop algorithms to calculate the profitability of contracts from the point of view of value. An example of such a calculation is presented in Tab. 3

Trading company employee who calculates the value of a contract, before it is signed, introduces to the calculation data that will allow to estimate the value of the contract that will be generated during its economic life. The data allow to evaluate the demand for capital that will be necessary to realize the contract, taking into account such elements as necessary fixed assets, stocks, money frozen in receivables. Value-based controlling is designed to support the organization at the operational level in such instruments.

Table 3. A fragment of contract profitability by Value-Based Controlling

Gross margin after direct costs		1 868,29 zł
Costs of direct supervision (as the rate %)	-3,16%	- 315,62 zł
Other indirect costs (as the rate %)	-12,50%	- 1 248,91 zł
expected EBIT of the contract		303,76 zł
Tax (as effective tax rate calculate by EBIT)	-3,3%	- 10,02 zł
Expected NOPAT of the contract		293,74 zł
Monthly average Invested Capital		2 376,23 zł
Expected cost of capital		- 285,15 zł
Expected EVA of the contract (monthly value)		8,59 zł
Expected ROIC of the contract		12,36%

Source: my own

The last part of the controlling cycle is motivation. Value-based controlling is to build a bridge between the owner and the manager. The tasks in this area concern, among other things, seeking for bonus systems that will ensure the long-term growth. An exemplary formula developed by VBC for one of the Polish companies is represented below by the equation:

$$\text{Bonus} = \text{BA} * (\text{I} + \text{A}) + \text{x1} * \text{MVBM}_{\text{DBU}} + \text{x2} * \text{MVBM}_{\text{SBU}}$$

Where: KB – bonus base amount; I, W – individual measures of achievements and initiatives correcting BA between [0, 150%]; x1, x2 – rates in %; MVBM<sub>DBU</sub> –VBM measure for direct Business Unit; MVBM<sub>SBU</sub> –VBM measure of superior Business Unit.

#### 4. CONCLUSION

VBM sparked development of a wide spectrum of tools that support companies in their pursue to grow the value. All the attempts that can be found in literature to gather the knowledge of VBM have led to define VBM subsystems and created from them closed cycles. In terms of this, VBM does not differ significantly from the management approach suggested by controlling. Such an approach allows to include VBM tools into a system solution, which can provide a management model aiming to grow value.

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## **APPLICATION OF FUZZY MEASURES TO FINANCIAL PORTFOLIO SELECTION PROBLEM**

Selecting an optimal financial portfolio can be seen as a multiple criteria decision making problem (MCDM). This is mainly due to the development of the theory of finance, which provides tools for synthetic evaluation of many aspects of business, in particular the ratio analysis and cash flow analysis. In this case, fuzzy integrals are convenient tools for criteria aggregation, especially the discrete Choquet integral. The use of Choquet integral as a non-additive approach allows us to model not only the relevance of the criteria, but also the interactions between them. The aim of this paper is to show how to address the problem of selecting an optimal financial portfolio using fuzzy measures and fuzzy integrals.

### **1. PORTFOLIO SELECTION AS A MULTIPLE CRITERIA DECISION PROBLEM**

Financial portfolio selection is an important and well studied area in computational intelligence. The most popular approaches such as neural networks, rule-based systems, genetic algorithms, or support vector machines have been used in this area many times. These methods provide good results but suffer from some common drawbacks such as neglecting of the dependence among characteristics of investment assets (criteria), ignorance of the interdependence among assets, and the assumption of precision and certainty of available data [4].

According to Cezary Dominiak [14], theoretical works on portfolio analysis, empirical studies of market efficiency and re-evaluations, which have experienced decision-making sciences, led to creation of a new direction, where portfolio analysis is considered as a multicriteria decision making problem. It is an evolution from the

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normative models, whose main objective is to identify the optimal portfolio, to the prescriptive models which are based on decision support methods and take into account the individual needs of investors (decision makers). A particularly important factor in this evolution was a discussion on the structure of investor preferences, which seems to be much more complex than the expected utility function using in the modern portfolio theory [1,7]. Moreover, when investors decide where to invest money, besides a selection of a suitable characteristics of an asset (share), it is also important to check if these characteristics are independent from each other. There is a number of examples when the chosen characteristics are not independent, for example higher *return* is usually accompanied by a higher *risk* [8], the stability of a company is also closely related to the *risk* [6], etc. In the finance analysis these dependences between characteristics are very common. This is due to complexity of economic links in the global economy, which can be compared to a communicating vessels. However, as will be shown later in this paper, many approaches ignores the existence of these relationships. In many works on application of multi-criteria decision analysis in portfolio selection problem, researchers divide the process into two parts [14]: selection of “the best” assets to portfolio and distribution of a capital among the selected assets. A similar approach is adopted in this paper, where multicriteria decision analysis is used first to reduce the set of considered assets, and next a global value of preferences of each asset allows us to create a weight structure in the final portfolio (several methods have been tested in this step). We propose to use a multicriteria decision analysis (MCDA) method, which is popular in the European scientific community [10]. However, it is also possible to use for this purpose a multi-attribute utility analysis (MAUT) which is used for example by Magoc [6] and, in general, is popular among American scholars [11].

### 1.1. PROBLEM FORMULATION

A multicriteria decision making problem can formally be defined as a triple  $(A, \mathcal{F}, (\succsim_k))$  where  $A = \{a_1, a_2, \dots, a_n\}$  is a finite set of *alternatives* (*investment options*);  $\mathcal{F} = \{f_1, f_2, \dots, f_m\}$  is a finite set of *criteria* with a finite set of possible values for each of them;  $\succsim_k, k = 1, \dots, m$ , is a *preference relation* over  $A$  under criterion  $f_k$ . In typical situations, decision makers are able to provide a numerical value  $f_k(a_i)$ , called an *evaluation of alternative*  $a_i$  under criterion  $f_k$ . These values should reflect the preference relation  $\succsim_k$ , i.e.  $f_k(a_i) \geq f_k(a_j) \Leftrightarrow a_i \succsim_k a_j$ . The most difficult task in multicriteria decision making problems is to find a way to aggregate the preferences  $\succsim_k$  into one global preference  $\succsim$  that should correspond to the actual preferences of the investor with respect to the possible investment options and all criteria, i.e.  $F(f_1(a_i), \dots, f_m(a_i)) \geq F(f_1(a_j), \dots, f_m(a_j)) \Leftrightarrow a_i \succ a_j$ , where  $F$  is an *aggregation operator*, which returns an aggregated numerical value for the vector of the evaluations of a given alternative  $a_i$ . A number of aggregation operators can be used

for this purpose. A well known aggregation operator, often used in decision making, is the *Ordered Weighted Averaging* aggregation operator (shortly OWA) proposed by Yager [17], which is defined as  $OWA_{w_1, \dots, w_m}(a_j) = \sum_{i=1}^m w_i f_{(i)}(a_j)$ , where  $w_1, \dots, w_m$  represent weights of importance of criteria which sum up to 1, i.e.  $\sum_{i=1}^m w_i = 1$ , and  $f_{(1)}(a_j) \leq f_{(2)}(a_j) \leq \dots \leq f_{(m)}(a_j)$ . The OWA operator includes a family of aggregation criteria as special cases. Namely, that *min* operator (resp. *max*) can be obtained by fixing all weights equal to 0 except for  $w_1 = 1$  (resp.  $w_m = 1$ ), the *Hurwicz criterion* can be obtain by setting all weights equal to 0 except  $w_1 = \alpha$  and  $w_m = 1 - \alpha$ , the *median* (resp. other *order statistics*) can be obtained by assuming all weights equal to 0 except for  $w_{(n+1)/2} = 1$  (resp.  $w_k = 1$ ). Finally, fixing all weights equal to  $1/m$  leads to the *arithmetic mean*. The main drawback of the OWA operator is the fact that it ignores the interactions between the criteria. In the next section we discuss a generalization of OWA which will allow us to take such interactions into account.

## 2. NON-ADDITIVE AGGREGATION OPERATOR

Since 1974, when Sugeno [12] introduced the concept of a fuzzy measure, in multicriteria decision making problems we can model not only the power of influence of each criterion, but also the interactions between the criteria. In this section, we present some basic definitions of fuzzy measures and integrals which will be used later in this paper. We refer the reader to [2,12,13,18] for more details on the presented concepts. Let  $X$  be a finite set and  $P(X)$  be the power set of  $X$ .

**Definition 1** A function  $\mu: P(X) \rightarrow [0, \infty)$  is a  $\sigma$ -additive measure if the following axioms are satisfied: (1)  $\mu(\emptyset) = 0$ , (2) if  $A_i, i = 1, 2, \dots, n$ , are disjoint subsets of  $X$  then  $\mu(\cup_{i=1}^n A_i) = \sum_{i=1}^n \mu(A_i)$ .

The additivity property is convenient in some applications, but in many real world reasonings, including portfolio selection, it might be inadequate. In the fuzzy measure concept, the additivity has been replaced with a weaker axiom of a monotonicity.

**Definition 2.** A fuzzy measure  $\mu$  on  $X$  is a function  $\mu: P(X) \rightarrow [0, 1]$ , satisfying the following axioms: (i)  $\mu(\emptyset) = 0$ , (ii)  $A \subseteq B \subseteq X$  implies  $\mu(A) \leq \mu(B)$ .

Property (ii) is called the *monotonicity* and is a weaker condition than the additivity. Sugeno assumed that  $\mu(X) = 1$ , and he expressed the scores on criteria on the  $[0,1]$  scale, so it is a normal measure, but in this paper we discard this assumption, and allow  $\mu(X)$  to take any value that will preserve the condition of monotonicity.

Notice that defining a fuzzy measure on a finite set of  $n$  elements requires specifying  $2^n$  numbers. So, it can be done efficiently only when the cardinality of the set  $X$  is not large. Determining a fuzzy measure  $\mu$  in the set of criteria  $\mathcal{F} = \{f_1, f_2, \dots, f_m\}$  is the first step in the aggregation of partial preferences of an investor. The main advantage of fuzzy measures is in their ability to model interactions among the criteria. It is possible, because a weight of importance is attributed to every subset of the criteria. A fuzzy measure is said to be *superadditive* (resp. *subadditive*) if  $\mu(A \cup B) \geq \mu(A) + \mu(B)$  (resp.  $\mu(A \cup B) \leq \mu(A) + \mu(B)$ ) whenever  $A \cap B = \emptyset$ , and it models a *synergy* (resp. *redundancy*) between criteria. A general description of main properties of fuzzy integrals for aggregation can be found in [5].

The next step is to use a discrete fuzzy integral to aggregate the preferences. In this paper we propose to use the *Choquet integral*, which leads to the following aggregation operator:

$$C_\mu(a_j) := \sum_{i=1}^m (f_{(i)}(a_j) - f_{(i-1)}(a_j)) \mu(A_{(i)}), \quad (1)$$

where  $0 \leq f_{(1)}(a_j) \leq \dots \leq f_{(m)}(a_j)$ ,  $A_{(i)} := \{f_{(i)}, \dots, f_{(m)}\}$ , and  $f_{(0)}(a_j) = 0$ . The Choquet integral as a fuzzy aggregation tool is a generalization of both the OWA operator and the weighted arithmetic mean. Notice that if a fuzzy measure is additive, then it is a simple weighted average, i.e.  $C_\mu(a_j) := \sum_{i=1}^m \mu(\{f_i\}) f_i(a_j)$ , and to define the measure it suffices to define only the  $m$  coefficients (weights)  $\mu(\{f_1\}), \dots, \mu(\{f_m\})$ , where  $\mu(\{f_i\})$  can be seen as an importance of the  $i$ th criterion. In general, however, the fuzzy measure allows us to model the interactions between the criteria and so the Choquet integral should be applied.

## 2.1. PRACTICAL IDENTIFICATION OF FUZZY MEASURES (CORRELATION-BASED APPROACH)

Identification of a fuzzy measure in the set of criteria is the crucial step in the described approach. In this paper we propose a method which can be used for three criteria. The extension of this method to larger criteria set is an interesting subject of further research. To define the fuzzy measure we used the past data and the correlation coefficients. For the singleton subsets, it is appropriate to use the correlation coefficient between the rate of return on assets and the value of the criterion, i.e.  $\mu(\{f_k\}) = \rho(r_i, f_k)$ , where  $r_i$  is the rate of return. We assume that all the criteria used in our analysis are positively correlated with the rate of return, and so  $\mu(\{f_k\}) \in [0,1]$  for each  $f_k$ .

Estimation of the coefficient measures of two element subsets is more complex. The monotonicity condition (see Definition 2) requires the value of measure of two

element subset  $\mu(\{f_k, f_l\})$  to be greater than or equal to the larger of the two values  $\mu(\{f_k\})$  and  $\mu(\{f_l\})$ . From the theory of fuzzy measures we also know that if  $\mu$  is superadditive, i.e.  $\mu(\{f_k, f_l\}) \geq \mu(\{f_k\}) + \mu(\{f_l\})$ , then the criteria  $f_k$  and  $f_l$  interfere in a negative way. Conversely, if  $\mu(\{f_k, f_l\})$  is a subadditive, i.e.  $\mu(\{f_k, f_l\}) \leq \mu(\{f_k\}) + \mu(\{f_l\})$ , then  $f_k$  and  $f_l$  interfere in a positive way [6]. The interactions between the criteria can also be described by using the correlation coefficients. The proposed relationships between the measure of two elements subset and the correlation coefficients between them is as follows: when  $\rho(f_k, f_l) < 0$  then  $\mu(\{f_k, f_l\})$  should be greater than the sum of  $\mu(\{f_k\})$  and  $\mu(\{f_l\})$ ; when  $\rho(f_k, f_l) = 0$  then  $\mu(\{f_k, f_l\})$  should be equal to the sum of  $\mu(\{f_k\})$  and  $\mu(\{f_l\})$ ; when  $\rho(f_k, f_l) > 0$  then  $\mu(\{f_k, f_l\})$  should be less than the sum of  $\mu(\{f_k\})$  and  $\mu(\{f_l\})$ . In the first condition the fuzzy measure acts as a subadditive measure, what is consistent with the intuition. When two criteria are negatively correlated, and both are positively correlated with the rate of return, then they represent different phenomena that positively affect on the level of return on investment, but usually the positive effects of growth of one of them is accompanied by a negative impact of the depreciation of the second one. For example, an increase in the value of return is usually accompanied by a decrease of a risk. The assets for which both criteria have a high value should pay particular attention to investors. In what follows, we propose to define the measure of two elements subsets in the following way:

$$\mu(\{f_k, f_l\}) = \mu(\{f_k\}) + \mu(\{f_l\}) - \rho(f_k, f_l) * \min[\mu(\{f_k\}), \mu(\{f_l\})] \quad (2)$$

In order to calculate the measure for the set of all criteria, we used a minimal squared error algorithm, so  $\mu(X) = G$ , where  $G$  is the value which guarantee the minimal total squared error defined as  $E^2 = \sum_{k=1}^l (C_\mu(z_{k1}, \dots, z_{kn}) - y_k)^2$ , where  $y_k$  is the total return rate for each of 3 years before the decision moment.

The main disadvantage of this approach is a limited number of criteria (only three). However, the concept of 2-additive fuzzy measure developed by Grabisch, allows us to extend this approach. A non-additive measure is called *2-additive* if the measure of subsets with 3 or more criteria is additive [3]. Observe that the 2-additive approach is much less complex (only quadratic with respect to the number of criteria) but still allows us to model the interactions between two criteria. Most advanced work on the use of 2-additivity measure in portfolio selection problem can be found in [6].

### 3. COMPUTATIONAL TESTS

The method proposed in this paper was tested on data from Warsaw stock market (GPW) over the years ranged from 2000 to 2013. Only the stocks from IT industry, which were listed at the time and were a part of WIG-INFO index, were considered in the test. We divided the available data into two periods: training set and test set. From

over 200 financial, economical, and management ratios only three, with the highest correlation coefficient with Market Value Added (MVA)<sup>1</sup>, were selected as a criteria in the multicriteria decision making model. These ratios are presented in Table 1.

The first two criteria are part of the financial analysis and are calculated in accordance with the method proposed in [16]. *Receivables Turnover Ratio (RT)* indicates how many times, on average, accounts receivables (AR) are collected in a year and it is an accounting measure usually used to quantify a firm's effectiveness in collecting debts as well as extending credit. The higher the value of *RT* is the better is the company in terms of collecting their AR. *Total Asset Turnover (AT)* is a financial ratio that measures the efficiency of a company's use of its total assets to product sales (the productivity of a company's assets). The third one (*Intellectual Capital per Book Value*) is derived from the group of intellectual capital indicators and was developed by Ujwary-Gil [15]. This ratio express a relation between the intellectual capital (very important type of resources in hight-tech companies) and the book value. The values of correlation coefficients between the ratios and MVA and between all pairs of the ratios are presented in Table 1.

Instead of the correlation index we can use a number of other methods to identify the importance of each criteria, for instance, we can use other statistic or econometric methods based on the same data of possible ratios. Fuzzy aggregation approach could be evaluated over intervals and would result in an interval value of the global assessment of an alternative assets [6]. Thus, identification of importance of criteria could be done by using the experience and knowledge of the decision maker, and it is especially useful when the selection criteria is qualitative. We can also find different methods of calculation. For example, in the multiattribute utility theory a concept of interaction index is used, which was proposed by Murofushi and Soneda as a tool to identifying the coefficient of fuzzy measures for subsets with more than one element. The interaction index  $I_{ij}$  is a kind of average value of the benefit given by putting  $i$  and  $j$  together [9]. However, we used the correlation coefficient because of its simplicity of calculation and interpretation.

Table. 1. Correlation coefficients

criteria ( $f_k$ )	No.	Correlation with MVA
RN	1	0,73
RA	2	0,71
IC/BV	3	0,87

	RN	RA	ICBV
RN		0,85	0,17
RA			0,16
IC/BV			

<sup>1</sup> Market Value Added (MVA) is the difference between the market value (MV) and the capital invested by both bondholders and shareholders - a high MVA indicates that substantial wealth for the shareholders has been created.

The fuzzy measure coefficients, calculated according to the approach proposed in this paper (see formula (2)) are as follows:  $\mu\{RN\}=0,73$ ;  $\mu\{RA\}=0,71$ ;  $\mu\{ICBV\}=0,87$ ;  $\mu\{RN, RA\}= 0,84$ ;  $\mu\{RN, ICBV\}=1,48$ ;  $\mu\{RA, ICBV\}=1,47$ ;  $\mu\{RA,RN, ICBV\}=2,68$ .

### 3.1. THE RESULTS

Table 2 shows the normalized values of the ratios defined as a evaluation criteria and values of the aggregation by Choquet Integral for 9 companies.

Table 2. The values of normalized financial ratios and aggregation by Choquet Integral

Ratios	MCL	TLX	CMR	WAS	ACP	ATM	SGN	SME	ELZ
Amount due turnover	0,00	0,11	0,38	0,45	0,96	1,00	0,57	0,06	0,13
Total Assets Turnover	0,07	0,00	0,11	0,01	1,00	0,28	0,15	0,08	0,13
Intellectual Capital/Book Value	0,73	1,00	0,42	0,92	0,00	0,20	0,43	0,82	0,45
$C_{\mu}(a_i)$	<b>0,67</b>	<b>0,94</b>	<b>0,72</b>	<b>1,09</b>	<b>0,84</b>	<b>1,13</b>	<b>0,91</b>	<b>0,83</b>	<b>0,28</b>

We now build a portfolio composed of the assets of these 9 companies in the following way. Let  $\mathbf{A}$  be the subset of the assets for which value  $C_{\mu}(a_i) \geq C_{\mu}^*$ . The weight for each asset in portfolio P1, with score grater or equal than a critical value ( $C_{\mu}(a_i) \geq C_{\mu}^*$ ), is calculated as follows:

$$w_{1i} = \frac{C_{\mu}(a_i)}{\sum_{i \in \mathbf{A}} C_{\mu}(a_i)} \quad (3)$$

We fix  $C_{\mu}^* = 0,98$  and  $C_{\mu}^*$  was estimated basing on historical data by maximizing the return on portfolios (across the learning periods) with weights calculated by formula (3). Depending on the level of the critical value, the portfolios were built of different sets of assets (only the assets with the value of Choquet integral greater than or equal to the critical value are considering as a component of portfolio) and comparison of all portfolios returns constructed for different critical values allowed us to choose the optimal level of the critical value.

In the second portfolio (P2) a weight for the  $i$ th asset is also defined by formula (3) with  $\mathbf{A}$  containing the assets of all nine companies. To test not only the forecast abilities of portfolios based on the proposed approach but also the effectiveness of proposed method to identification of a fuzzy measures, two portfolios based on alternative approaches were constructed. For each of these alternative fuzzy portfolios formula (3) was used to calculate the weights. The first alternative fuzzy portfolio,

based on minimization of the quadratic error, proposed by Grabisch and Roubens [5] and the second one based on fuzzy  $\lambda$ -measure with Shapley standard proposed by Takahagi and Eiichiro [13]. For more information about these methods we refer the reader to [5, 13]. Table 3 presents the structure of a portfolios built by using the methods proposed in this paper, and portfolios where fuzzy measure based on minimal squared error (portfolio MSE) and  $\lambda$  Fuzzy Measure approach with Shapley standard (Shapley standard portfolio):

Table 3. Structure of portfolios based on fuzzy measure

	P1		P2		LMS		Shapley standard portfolio	
	$C_{\mu}(a_i)$	$w_{2i}$	$C_{\mu}(a_i)$	$w_{1i}$	$C_{\mu}(a_i)$	$w_{3i}$	$C_{\mu}(a_i)$	$w_{4i}$
<b>MCL</b>	-	0	0,67	0,09	0,13	0,04	0,43	0,09
<b>TLX</b>	-	0	0,94	0,13	0,16	0,05	0,59	0,13
<b>CMR</b>	-	0	0,72	0,10	0,33	0,10	0,40	0,09
<b>WAS</b>	1,09	0,49	1,09	0,15	0,40	0,13	0,70	0,15
<b>ACP</b>	-	0	0,84	0,11	0,74	0,23	0,98	0,21
<b>ATM</b>	1,13	0,51	1,13	0,15	0,79	0,25	0,42	0,09
<b>SGN</b>	-	0	0,91	0,12	0,47	0,15	0,45	0,10
<b>SME</b>	-	0	0,83	0,11	0,14	0,04	0,48	0,10
<b>ELZ</b>	-	0	0,28	0,04	0,03	0,01	0,18	0,04
<b>sum</b>	<b>2,22</b>	<b>1,00</b>	<b>7,42</b>	<b>1,00</b>	<b>3,19</b>	<b>1,00</b>	<b>4,63</b>	<b>1,00</b>

The first group of tested portfolios (a,b,c,d in Table 4) are based on fuzzy approach. Portfolio P1 (a) is built according to the concept described in this paper. The construction of the second portfolio (b) covers all the nine assets, and is based on equation (3) as well as portfolios (c) and (d). Next group of portfolios contained a market benchmark, first of them (e) is the widest benchmark of the market namely it is a WIG index, benchmark (f) represent twenty biggest company on the GPW, and finally benchmark (g) that is the most reliable benchmark because it is a branch benchmark.

All portfolios based on fuzzy measure achieved higher average annual rate of return (AAR) and higher geometric mean return (GMR) than the branch benchmark (WIG-INFO). The highest return have a portfolio P1 composed of assets which met the criterion  $C_{\mu}(a_i) \geq C_{\mu}^*$ . The return of this portfolio is greater even than whole market benchmarks (WIG and WIG-20), and three times greater than the portfolio composed of all 9 analyzed assets with equal weights. Almost all effective annual rates were very high for portfolio P1 (even 60% in 2011), the exception is 2012, which saw the highest decline in portfolio value (-33%). The nominal value of portfolio P1 after 4 years was also higher then all benchmarks (194% of the initial value), what -

when the whole IT industry index offered only 5% more than the initial value – would mean that this approach is resistant to the negative impact of the market in long term.

Table 4. Comparison of effectiveness of portfolios based on fuzzy approach with market benchmarks and alternative portfolios

portfolio		Effective Annual Rate (EAR)				Nominal value of portfolio (2009 = 100)					Average Annual Return	Geometric Mean Return
		2010	2011	2012	2013*	2009	2010	2011	2012	2013*		
P1	a	0,2801	0,6054	-0,3341	0,4159	100	128	206	137	194	0,2418	0,1798
P2	b	0,2042	0,3488	-0,3323	0,2122	100	120	162	108	131	0,1082	0,0708
HLMS	c	0,1090	0,3282	-0,2649	0,1384	100	111	147	108	123	0,0777	0,0537
Shapley standard	d	0,1611	0,3150	-0,3140	0,1636	100	116	153	105	122	0,0814	0,0507
WIG	e	0,2942	0,2298	-0,1571	0,1355	100	129	159	134	152	0,1256	0,1110
WIG-20	f	0,2194	0,2338	-0,1880	0,0777	100	122	150	122	132	0,0857	0,0712
WIG-INFO	g	0,0542	0,0846	-0,0961	0,0114	100	105	114	103	105	0,0135	0,0112
equal weights for all 9 assets	h	0,2067	0,2823	-0,3326	0,2123	100	121	155	103	125	0,0922	0,0578
CAPM (standard model)	i	-0,2317	0,5588	-0,1233	0,0571	100	77	120	105	111	0,0652	0,0264
MPT (min coefficient of variation)	j	0,0013	0,1130	0,0100	0,0880	100	100	111	88	96	0,0531	0,0520
MAX geometric mean	k	0,1581	0,0424	-0,2738	0,0573	100	116	121	88	93	-0,0040	-0,0188

As we can see after the second year of investment , the portfolio P1 achieved a return equal 263% what formed a enormous gap (138%) between P1 (a) and WIG-INFO (g) which achieved a return rate equal to 125%. Next Year brought a revision and this gap was decreased but during all time of investment P1 bringing much more returns than branch of the selected stocks.

The results show a relatively high ability to identify unevaluated companies, which allows portfolios constructed by the fuzzy methods to achieve higher returns than the market. Large group of financial ratios was used in the process of selection of criteria, but the models were tested only on a selected group of IT companies. It is reasonable to extend the test to other industries or some developed markets.

#### 4. CONCLUSIONS

We can conclude that the proposed method of portfolio selection outperforms all market benchmark as well as the other benchmark methods. The new approach yield a higher return on almost every situation. From theoretical perspective the most important advantage of using fuzzy integrals in multicriteria decision making (especially in portfolio selection problem) is the ability to model interactions between criteria. But the fuzzy approach pays cost of this advantages by their high

complexity. However the method of identification of fuzzy measure, based on historical data as well as others work on this problem [5] simplify the application of this method.

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## **EXPECTED SHORTFALL IN INVESTMENT PROFITABILITY CALCULATION**

Methods of investment profitability calculation are based on forecasted discounted cash flows. There are a lot of factors that influence the level of cash flows. Hence, the important role plays implementation of risk and uncertainty in the process of investment profitability calculation. There are methods that include risk factor in direct or indirect way. Monte Carlo simulation is the example of the last group of methods. Application of simulation process and receiving probability distribution of NPV as a result is an attempt of risk presentation in investment project. In the paper risk tail measure is presented - namely Expected Shortfall (ES) in relation to Net Present Value (NPV). Expected Shortfall answers to the question: "What is the expected loss incurred in the worst  $\alpha$  cases?".

### **1. INTRODUCTION**

The superior goal of company's activity is maximization of its market value. The way of this goal realization is investing. Investments being driving force behind the development contribute to company's value growth. The decision to invest is crucial for every company. Investments cause that a company is much more competitive through increase of working capacity, improvement of product quality or starting new product production.

Investment undertaking is connected with incurring financial outlays. As a rule, investment process is a long-term one, marked with a significant dose of uncertainty. Because decision to incur investment outlays is taken at present and investment inflows will be received in the future, in the phase of investment planning investor has to consider a lot of factors that can appear and, at the same time, may have influence on the investment profitability. That is why so important role, in the process of investment profitability calculation, plays taking into account factors of risk and uncertainty. In the literature a lot of methods that include risk factors can be found f.e. Certainty Equivalent, Risk Adjusted

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Discount Rate Approach, Scenario Analysis, Sensitivity Analysis, Monte Carlo Simulation. Thanks to simulation process we can get the probability distribution of Net Present Value. NPV informs how much company market value grows if the project will be performed.

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+k)^t}, \quad (1)$$

where:

$CF_t$ - cash flow generated by the project during  $t$  – period,

$k$  – discount rate (hurdle rate, rate of return, opportunity cost of capital).

The idea behind NPV is to determine cash flows over the life of a project and discount them by the appropriate opportunity cost of capital. Discount rate specifies the minimum necessary rate of return required by the company's investors. It is also defined as a company's cost of capital.

Investment cash flows are presented as free cash flows and their formula is as follows [7]:

$FCF = EBIT \cdot (1 - \text{Tax rate}) + \text{Depreciation \& Amortization} - \text{Changes in Working Capital} - \text{Capital Expenditure}$

FCF is the amount of cash that is left with the firm, after the payment of all cash expenses and investments [6].

Cash flow forecasts are based on assumptions about future investment and operational strategy of a company. The planned investment project cash flows are characterized by high volatility. The main sources of uncertainty in the forecasting of cash flows include:

- the level of sales,
- the level and revenue collection,
- the level of liabilities,
- capital expenditures,
- changing conditions of the possibility of obtaining funds.

The correct assessment of FCF is the basic problem. The most sophisticated investment profitability method may lead to wrong decision when the future cash flows are forecasted inappropriately. There are a lot of factors that have the influence on the cash flow levels. Some of them are macroeconomic factors whose impact on the cash flows level is difficult to describe as a number [9]. These factors are sources of systematic (undiversifiable, market) risk. Investors are most interested in reducing the level of this kind of risk.

## 2. MONTE CARLO SIMULATION AND RISK MEASURES

In classical approach cash flows are forecasted as a single figure with no trace of uncertainty. The project risk is included in discount rate, exactly in the cost of equity that contains risk premium for company’s investors. Deterministic model does not consider all possible combinations of factors that have influence on cash flows simultaneously. It may lead to wrong investment decision. Monte Carlo simulation allows to model all potential combinations of scenarios for the uncertain variables. It is a tool for considering all possible combinations of variables giving the opportunity to inspect the entire distribution of project outcomes. The most important thing is developing a conceptual model of the problem under study and building the simulation model taking into consideration correlations between variables [10].

Having probability distribution we can read off risk measures like f.e. standard deviation and quantile value. Standard deviation shows how much variation or dispersion exists from the average (mean), or expected value [9]. Quantile value that represents Value at Risk shows that for the certain tolerance level (for example  $\alpha=0,05$ ) there is 5% chance that the received value of NPV will be lower than the value indicated by the quantile value. Value at Risk measure “provides no handle on the extent of losses that might be suffered beyond the threshold amount indicated by this measure. It is incapable of distinguishing between situations where losses that are worse may be deemed only a little-bit worse, and those where they could well be overwhelming.” [8, p. 1444]

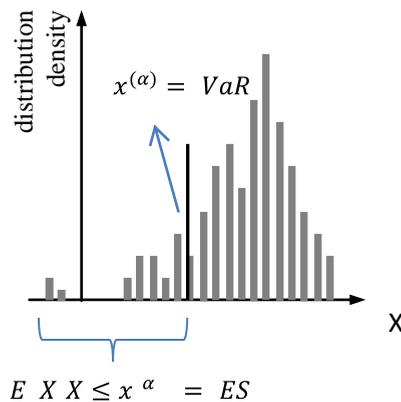


Fig. 1. Illustration of VaR and ES  
Source: own work based on [5]

Alternative measure that does quantify the losses that might be encountered in the tail is Expected Shortfall, Fig. 1.

### 3. EXPECTED SHORTFALL (ES)

In order to illustrate the concept of ES assumptions and basic definitions will be presented.

Let:

$X$  – real-valued random variable  $X$  on a probability space  $(\Omega, \mathcal{A}, P)$ ,

$E[\dots]$  – expectation with respect to  $P$ ,

$\alpha = (0,1)$  – tolerance level that presents the sample of the worst calculation results (the worst scenarios).

Indicator function:

$$\mathbf{1}_A(a) = \mathbf{1}_A = \begin{cases} 1, & a \in A, \\ 0, & a \notin A. \end{cases} \quad (2)$$

#### Definition 1 (Quantiles)

For random variable  $X$ :

$$x_{(\alpha)} = q_{\alpha}(X) = \inf \{x \in \mathbb{R}: P[X \leq x] \geq \alpha\} \text{ is the lower } \alpha\text{-quantile of } X, \quad (3)$$

$$x^{(\alpha)} = q^{(\alpha)}(X) = \inf \{x \in \mathbb{R}: P[X \leq x] > \alpha\} \text{ is the upper } \alpha\text{-quantile of } X.$$

The  $x$ -notation is used if the dependence on  $X$  is evident, otherwise the  $q$ -notation.

Note that

$$x^{(\alpha)} = \sup \{x \in \mathbb{R}: P[X \leq x] \leq \alpha\}.$$

From  $x \in \mathbb{R}: P[X \leq x] > \alpha \subset \{x \in \mathbb{R}: P[X \leq x] \geq \alpha\}$

it is clear that  $x_{(\alpha)} \leq x^{(\alpha)}$ .

Moreover

$$x_{(\alpha)} = x^{(\alpha)} \text{ if and only if } P[X \leq x] = \alpha \text{ for at most one } x \quad (4)$$

and in case  $x_{(\alpha)} < x^{(\alpha)}$

$$x \in \mathbb{R}: \alpha = P[X \leq x] = \begin{cases} x_{(\alpha)}, x^{(\alpha)}, & \text{gdy } P[X = x^{(\alpha)}] > 0, \\ x_{(\alpha)}, x^{(\alpha)}, & \text{gdy } P[X = x^{(\alpha)}] = 0. \end{cases} \quad (5)$$

$VaR^{(\alpha)}$  can be defined as the smallest value such that the probability of the absolute loss being at most this value is at least  $(1-\alpha)$  [4].

**Definition 2 (VaR)**

$VaR^{(\alpha)} = VaR^{(\alpha)} X = -x^{(\alpha)} = q_{(1-\alpha)}(-X)$  is the VaR at level  $\alpha$  of  $X$ , (6)  
 where:

$$\begin{aligned} x^{(\alpha)} X &= \sup \{x \in \mathbb{R} : P[X \leq x] \leq \alpha\} \\ q_{(1-\alpha)} Y &= \sup \{x \in \mathbb{R} : F_Y(x) \leq 1 - \alpha\} \\ F_Y(x) &= P[Y \leq x] \\ Y &= -X \end{aligned}$$

**Definition 3 (Expected Shortfall)**

Let  $X$  be a real integrable random variable on some probability space  $(\Omega, \mathcal{A}, P)$  and  $\alpha \in [0,1]$  be fixed. Then

$$ES^{(\alpha)} X = -\frac{1}{\alpha} (E[X 1_{X \leq x^{(\alpha)}}] - x^{(\alpha)} P[X \leq x^{(\alpha)} - \alpha]) \tag{7}$$

**Definition of Expected Shortfall at a given  $\alpha$  level is literal mathematical transcription of concept „average loss in the worst  $\alpha$  cases”.**

When  $X$  is a continuous and increasing cumulative distribution, then  $P[X \leq x^{(\alpha)}] = \alpha$  and  $ES^{(\alpha)}(X)$  is reduced to:

$$ES^{(\alpha)} X = -\frac{1}{\alpha} (E[X 1_{X \leq x^{(\alpha)}}] - x^{(\alpha)} \alpha) = -E[X | X \leq x^{(\alpha)}] = TCE^{(\alpha)} = TCE^{(\alpha)} X, \tag{8}$$

where TCE (*Tail Conditional Expectation*) is a notion introduced earlier by P. Artzner et al. [1].

To illustrate the concept of Expected Shortfall a few examples will be presented.

Let's assume that  $X$  has distribution  $N(\mu, \sigma)$ . Then  $Z = \frac{X-\mu}{\sigma}$  has a standard normal distribution  $N(0,1)$ . For given  $\alpha \in (0,1)$  we can find, using  $N(0,1)$  distribution tables, number  $z(\alpha)$  such that  $P[Z \leq z(\alpha)] = \alpha$ .

It can be noticed that  $P[X \leq x^{(\alpha)}] = \alpha = P[Z \leq z(\alpha)]$  and  $\frac{x^{(\alpha)} - \mu}{\sigma} = z(\alpha)$ .

Hence we get

$$x^{(\alpha)} = \sigma z(\alpha) + \mu. \tag{9}$$

For  $X$  like above we have

$$E[X 1_{X \leq x^{(\alpha)}}] = \int_{-\infty}^{x^{(\alpha)}} x f(x) dx, \tag{10}$$

where  $f(x)$  is density of distribution  $N(\mu, \sigma)$ , namely

$$f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}.$$

Using the conversion of the variable of integration  $t = \frac{x - \mu}{\sigma}$  we get  $x = \sigma t + \mu$ ,  $dx = \sigma dt$  and changing the upper limit of integration in the integral above from  $x^{(\alpha)}$  to  $z(\alpha) = \frac{x^{(\alpha)} - \mu}{\sigma}$  then

$$E[X1_{X \leq x^{(\alpha)}}] = \int_{-\infty}^{z(\alpha)} (\sigma t + \mu) \phi(t) dt, \quad (11)$$

where  $\phi$  is density of  $N(0,1)$  distribution, namely

$$\phi(t) = \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}}.$$

From (11) we get

$$E[X1_{X \leq x^{(\alpha)}}] = \sigma \int_{-\infty}^{z(\alpha)} t \phi(t) dt + \mu \int_{-\infty}^{z(\alpha)} \phi(t) dt. \quad (12)$$

The second integral is the value of the distribution function  $\Phi(z(\alpha))$  of the normal distribution  $N(0,1)$  at the point of  $z(\alpha)$ . It is  $\alpha$ . Thus, from (12) follows

$$E[X1_{X \leq x^{(\alpha)}}] = \sigma \int_{-\infty}^{z(\alpha)} t \phi(t) dt + \mu \alpha. \quad (13)$$

Calculating integral at the right side (13) we get

$$\int_{-\infty}^{z(\alpha)} t \phi(t) dt = -\frac{1}{\sqrt{2\pi}} e^{-\frac{z(\alpha)^2}{2}} = -0,103168,$$

where  $z(\alpha) = -1,6449$  for  $\alpha = 0,05$ .

We can write that:

$$E[X1_{X \leq x^{(\alpha)}}] = \sigma * (-0,103168) + \mu \alpha. \quad (14)$$

If  $ES^\alpha(X) = -\frac{1}{\alpha} E[X1_{X \leq x^{(\alpha)}}]$ ,

then  $ES^\alpha(X) = -\frac{1}{\alpha} E[X1_{X \leq x^{(\alpha)}}] = -ES$ .

We get  $E(X | X \leq x^{(\alpha)}) = -ES^{(\alpha)} X = \frac{0,103168\sigma}{\alpha} - \mu$ .

For  $\alpha = 0,05$  we have  $E(X | X \leq x^{(\alpha)}) = -ES^{(\alpha)} X = 2,06336\sigma - \mu$ .

Using equation (9) let's consider three cases:

- 1) For  $\mu = 1000$  and  $\sigma = 500$  we get  $x^{(\alpha)} = 177,5$ ,  $VaR = -177,5$ ,  $ES^{(\alpha)} X = -31,68$ ,  $E(X | X \leq x^{(\alpha)}) = 31,68$ , expected conditional value is positive, Fig. 2.

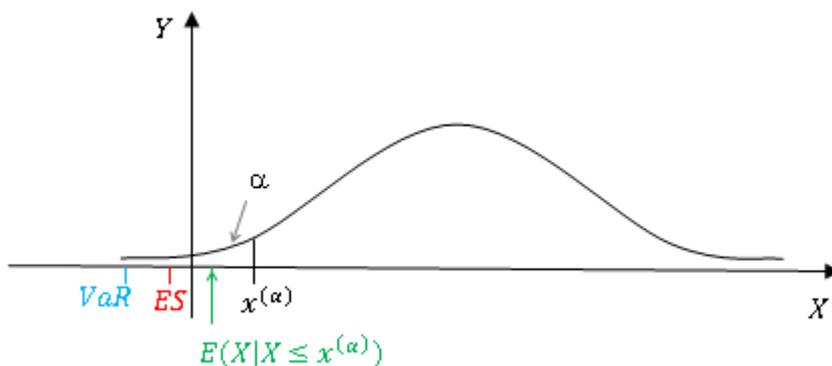


Fig. 2. Expected conditional value – case No. 1  
Source: own work

- 2) For  $\mu = 800$  and  $\sigma = 400$  we get  $x^{(\alpha)} = 142,04$ ,  $VaR = -142,04$ ,  $ES^{(\alpha)} X = 25,34$ ,  $E(X | X \leq x^{(\alpha)}) = -25,34$ , expected conditional value is negative, Fig. 3.

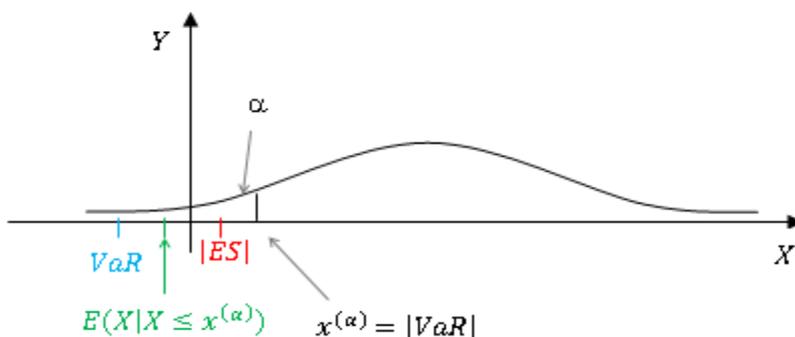


Fig. 3. Expected conditional value – case No. 2  
Source: own work

- 3) The most interesting case is when the quantile is negative, because then VaR is positive and indicates the absolute lower limit of losses.

Then situation  $X \leq x^{(\alpha)} < 0$  is incurring losses.

Let  $\mu = 500$  and  $\sigma = 400$ . Then  $x^\alpha = -157,96$ ,  $VaR = 157,96$ .

In this case, the conditional result is certainly negative, but

$ES^\alpha X = 325,34$ ,  $E(X | X \leq x^\alpha) = -325,34$

i.e., the expected result is significantly less than the positive VaR, Fig. 4.

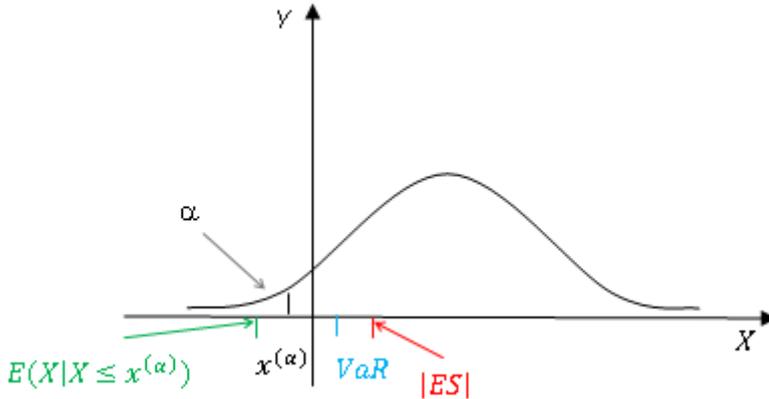


Fig. 4. Expected conditional value – case No. 3

Source: own work

To illustrate the issue further let's consider discrete case. Let's consider the four probable NPVs (in million zł) marked as  $X$  for simplicity.

The probability distribution is as follows:

$$\begin{aligned} P X = -2 &= 0.04, & P X = -1 &= 0.04, \\ P X = 0 &= 0.12, & P X = 1 &= 0.8. \end{aligned}$$

The probability of success is high, but also the loss of two types, although with small probabilities, are possible.

Assuming  $\alpha = 0,05$ , then by (3)  $x^{(\alpha)} = -1$ . Hence  $VaR^\alpha X = 1$ .

Moreover, we have

$$\begin{aligned} P X \leq x^\alpha &= P X \leq -1 = P X = -2 + P X = -1 = 0.04 + 0.04 \\ &= 0.08 \end{aligned}$$

$$\text{and } E X \mathbf{1}_{X \leq x^\alpha} = -2 * 0.04 - 1 * 0.04 = -0.12,$$

and

$$-x^\alpha (P X \leq x^\alpha - \alpha) = 1 * (0.08 - 0.05) = 0.03.$$

Substituting into equation (7), we obtain

$$ES^{\alpha}(X) = -\frac{1}{0.05} * (-0.12 + 0.03) = 1.8$$

However, substituting into equation (8), we get

$$TCE^{\alpha}(X) = -E[X | X \leq x^{\alpha}] = -\frac{1}{P[X \leq x^{\alpha}]} E[X | X \leq x^{\alpha}] = \frac{0.12}{0.08} = 1.5$$

This result reflects the situations that in bad cases we get equally likely negative NPV equal to -1 or -2. It can be noticed that ES more draws attention to the worse outcome NPV, i.e. NPV = -2 million zł than TCE.

To avoid mistakes in interpretation it is better to use definition of conditional expected value  $E(X | X \leq x^{\alpha})$  which is minus  $ES^{\alpha}(X)$ . Then there is no doubt that in the above example we get negative NPV in the amount of 1,8 mln zł when we use  $ES^{\alpha}(X)$  equation, or we get negative NPV in the amount of 1,5 mln zł when we use  $TCE^{\alpha}(X)$  equation.

#### 4. SUMMARY

Value at Risk seems to be inefficient risk measure in investment profitability calculation. It informs only that for the certain tolerance level there is  $\alpha$  chance that the received value of NPV will be lower than the value indicated by quantile value. It says nothing about the possible lower value, which may be little or a lot worse than the quantile value. "VaR, in other words, is a sort of *best of worst cases scenario* and it therefore systematically underestimates the potential losses associated with the specified level of probability" [2, p.4]. Expected Shortfall, unlike VaR, is in general subadditive and therefore it is a coherent risk measure in the sense of [1].

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## **CASH FLOW RISK**

The work reads about cash flow which are the foundation of investment profitability determination. Considering the importance of the element in the process of profitability assessment, the main problems, connected with the amount of cash flow assessment techniques and risk – which is crucial as well - are shown. The methods, which take risk at cash flow into account, are considered. It should be remembered that the accurately and precisely assessed investment benefits the company and allows to get an aim, which is the maximization of the company value.

### **INTRODUCTION**

Main aims of an economic activity are permanently determined by three factors which are profit, money and risk. Each economic entity board of directors should work in a way that the relations, different for short and long time horizon, eventually lead to the increase of entity market value. In this context, information about cash flow come into remarkable prominence [15]. The increase of assets value, connected with investments, is the direct result of the realization by the company the investments in fixed assets. In practice, it means the change of money into an asset what is characterized by long-lasting use or possession, which is long binding of the money. The comeback to the money form is a gradual process, lasting many years by the value loss or once, after long time, by assets sell off or loss. The exception is a short-term investments that can be sold or used in the present period [14].

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Dynamic methods are mostly used to measure fixed investment profitability. Considering money value change in time, they are found to be more reliable in the contrary to static methods. A feature of dynamic methods (also called discounted ones) is to set cash flow and then discount them into one comparable period. A cash flow calculation is a starting point of investment efficiency assessment. It means that the level of cash flow must be precisely assessed. Determining incomes and outcomes, generated by an investment, many problems can be found. One of them is the amount of techniques to determine cash flow; the next one is the risk of their creation.

## 1. CASH FLOW – BASIC INFORMATION

A cash flow statement is an element of a financial statement, which shows the full view of the company situation alongside with a balance, an income statement, a list of capital changes and an extra information. In the contrary to International Accounting Standards, Accounting Act lays a duty for all economic entities to make three parts of the financial statement: the balance, the income statement and the extra information. Other two elements are obliged only when the economic entity in a financial year, for which the financial statement is prepared, fulfils at least two conditions:

- annual average employment per full-time job was at least 50 people,
- total balance assets at the end of the financial year in Polish currency equals at least 2.5 million euro,
- the net revenues from goods and products sales as well as financial transactions for a financial year in Polish currency equal at least 5 million euro.

The cash flow statement informs about activities which make changes of money status and their equivalents in an economic entity. Thanks to the statement, the money level and the source of origin are set. The amount of outcomes and the use direction of these kind of resources are set as well. The cash flow statement is divided into the areas of company activity i.e.:

- transactions area – connected with the essential kind of company activity,
- investment area – concerning acquisition and disposal of the financial assets elements as well as profits and costs connected with them,
- financial area – concerning the sources of company funding.

The first area of cash flow presentation can be prepared with indirect or direct method, but it should be remembered that there is continuity of accounting principle use. In the direct method, the groups of incomes and outcomes are presented and classified with regard for the source of acquisition and the aim of expenditure. However, the indirect method lies in correcting the result of financial event, which had no financial character.

The cash flow statement considering cash dimension of presented data is a precious and reliable source of information about the financial condition of the company and it is the foundation of future cash flow projections [13].

### 1.1. THE IMPORTANCE OF CASH FLOW ASSESSMENT

According to the literature on the subject, profit is the aim of each company. The profit is to make company development and consequently lead to the increase of its value. The company development is possible by investing. The indispensable resource to make an investment is inter alia money. So the ability to generate positive cash flow is the key element in the process of realization the most important aims of a company.

Investing is *risk-adjusted use, expending accumulated or received capital assets in order to obtain the expected effects in the future, which can be: the increase of incomes, the development of a company, the gaining of material possession, the increase of growth rate and profitability of a company*. Investments in a company can concern the financial part, tangible and intangible area and the area connected with human capital. There is one common feature; investments are relatively long-term binding of relatively huge assets for the determined purpose. What is more, the consequences are reversible in a certain degree. Relativity means, in this sense, the amount bound in term longer than one production or service cycle, one act of consumption or the time unit set by mutual agreement [1]. Tangible investments concern the purchase of fixed assets or the reconstruction, modernization of the assets in order to grow the capability used by a company that generates profits [5]. Making the accurate investing decision should consider the efficiency criteria which is the foundation of assessing the tangible investment profitability. Generally known dynamic methods are used to value an investment. One of these methods advantages is taking into consideration money value change in time with discount process. The base of discount methods is to set incomes and outcomes (determined as a cash flow), generated by considered venture. Cash streams are identified with cash flow which could have been generated by considered investing venture.

As it was mentioned before, the characteristic of setting cash flow refers to cash basis which determines incomes and outcomes of money. Financial assessment of economical profits is reasonable because of distinguishing between expense and born cost (an expense does not have to be a cost at the same time) and incurred capital expenditures are directly connected with money expenses [18]. So it is important to assess cash flow precisely.

The problem, that occurs during the assessment of tangible investment profitability, is the time factor because it causes the problem with values from different periods. It is connected with pegging assets as final results, which means the need to

wait for reimbursement. The moment we obtain incomes is not unimportant because it influences on both our consumer intentions and investing ones. From an investor point of view, more profitable is to obtain a profit earlier in the income form. Postponing, deferring the profit in time causes immediate creation of so called costs of lost possibilities (in the form of delayed consumption or non-received income which could be gained if the profit would have happened earlier). The relation between costs of lost possibilities and incomes arrangement in time is defined as a money value in time. The same capital value or cash flow today has got a different value than the same capital value or another value of cash flow in the future. The value accompanying with lengthening time diminishes and is connected with the money value, which is identified as an interest rate. The interest rate is a profit rate which can be obtained by money or capital administration in the determined time range. It is also a measure of money value in time. Considering time factor, it allows to have the possibility of comparing the greatness of money stream in any point of time. Using the accurate interest rate  $r$ , which is called the discount rate in the account of efficiency, allows to put money streams into any moment. It also means the cost that should be born for having “foreign” money.

The task of discount rate is considering time preferences and the costs of lost chance i.e. showing the prospective profits by investing the capital into alternative investments. Discount rate set, which will fulfill its task, is not easy. Usually to indicate the level of discount rate, we use interest rate increased of venture risk premium and expected inflation rate [4]. Dynamic methods taking money value in time into account and pay attention to the fact that the value itself does not decide about net profit value but also the moment of obtaining the value [12]. Among the dynamic methods, it can be distinguished:

- the method of valuate the discounted return period of incurred expenditures;
- the method of net present value (NPV);
- the method based on profitability index;
- the method of final assets;
- the method of internal rate of return;
- Baldwin method.

## 1.2. TECHNIQUES OF CASH FLOW ASSESSMENT

In the methods of cash flow assessment, the problems of gaining reliable data and probabilities of future periods occur. The division of cash flow assessment methods is shown in the literature from the beneficiary point of view. There are methods that are used [2, 7, 8, 10, 17]:

- 1) Free cash flow belonging to different financial party – considered from the company point of view (the name Free Cash Flow to Firm – FCFF – is also

used). Cash flow set with this method base on operating income which is enlarged with amortization (the amortization is a cost that is not the expenditure at the same time) and diminished with extra capital expenditure as well as corrected with the value of net current assets (working capital) which includes the change of supplies, receivables, payables and money [7,9]. Debt charges are not taken into consideration because they should be included in the required investment rate of return. Unconsidered interest of foreign capital would lead to inflated value of income tax so the tax shield should be taken into account in the discount rate [3, 8].

- 2) Free Cash Flow to Equity (FCFE) – as the name indicates, FCFE reflects measures belonged directly to owners. In the cash flow calculation with FCFE method we count in outcomes, connected with the starting investment expenditures, only those expenditures which comes from investor own resources. Other expenditures (which come from creditors' measures) are considered in the method only after accomplishing the bank loan pay-off. What is more, the FCFE construction includes also interest of foreign capital [8, 17].
- 3) Free Cash Flow to Debetholders (FCFD) – concerns money streams which correspond with interest payment, bank loan installments and inflows in relation to a new debt [18].
- 4) Free Cash Flow to Capital (FCFC) – they are flows for all capital purveyors [3, 18]. Cash flow, set with this method, are discounted with discount rate which does not include tax shield because the value of tax shields in directly added to free cash flow. It prevents from double considering the effect of tax shield [9].
- 5) In the literature, the method of Adjusted Present Value (APV) is mentioned and two stages are separated. The first one concerns cash flow investment calculations, where all capital expenditures are taken into account but foreign sources of finance are not taken into consideration (those cash flow are discounted with the discount rate which reflects costs of equity). In the second stage, a correction, connected with capital foundation with foreign sources of the project include tax savings (interest costs in relation to investments founding with foreign capital diminish the base to tax). This part of cash flow is discounted with rate, bases on cost of the foreign capital. APV value includes the sum of indicated previously discounted cash flow [3, 17].

The general scheme of indicating cash flow is shown in the Table.

Calculation Method	Cash Flow
FCFF	$FCFF_t = NOPAT_t + A_t \pm \Delta NWC_t - I_t$
FCFE	$FCFE_t = PAT_t + A_t \pm \Delta NWC_t - I_t + \Delta D_t$
FCFD	$FCFD_t = Int - \Delta D_n$
FCFC	$FCFC_t = NOPAT_t + A_t \pm \Delta NWC_t - I_t + Int * T$
APV	$FCFF_t = NOPAT_t + A_t \pm \Delta NWC_t - I_t$ $TS_t = Int * T$

Source: Study on the basis of: [3, 8, 9, 18]

#### Explanations:

*NOPAT* (Net Operating Profit After Tax) – operating profit after taxing on the basis of *EBIT* (Earnings Before deducting Interest and Taxes), *A* – Amortization,  $\Delta NWC$  (Net Working Capital) – the change of working capital, *I* – capital expenditures,  $\Delta D$  – the change of indebtedness value (+ drawing a new bank loan, - the payoff of a bank loan installment),  $D_n$  – a new drawn bank loan, *Int* (interest) – interests payment from a debt, *T* – tax, *TS* – tax shield, *PAT* (Profit After Tax) – net profit.

Each method of cash flow calculation implies the accurate choice of discount rate. Considering free cash flow to firm, the discount rate - based on weighted average cost of capital - is used. But in the next method of cash flow calculation (FCFE), with regard to its appurtenance to an owner, equity cost is used with taking indebtedness influence into account. The easiest method of determining cash flow is FCFD and discount rate setting means to determine cost of foreign capital which, in practice, turns out to be the market interest rate. That rate determines the whole payment due to the capital owner, which is expressed as a percentage of the capital market value. This is the price for making the capital available and the most popular source of capital availability is a bank loan. So, the cost of foreign capital can be identified with credit cost. For determined cash flow with FCFC method, the discount rate, which equals WACC before taxing, is used (author's note: tax shield is directly added to free cash flow). In the last method, the APV one – regarding its two steps, two discount rates are used to make calculations. In the first part, the discount rate equals capital cost of company which is free of debt and agrees with expected assets refund. However, in the second part, discount rate as cost of foreign capital is taking into consideration.

The most common are two models of flow assessment which differ from each other because of conceiving the changes in financial activity. FCFE considers both changes in the basic company activity and changes in the financial activity, so net profit is created – financial costs diminish EBIT causing gross profit which is diminishes because of income tax. However, with FCFF, the tax counted from EBIT (without con-

sidering financial costs) does not equal the tax that is really paid by a company which realizes investments [8, 18].

## 2. TAKING RISK AT CASH FLOW INTO ACCOUNT

Risk is an indispensable phenomenon accompanying economic activity. Investments realized by a company are made with a bit of uncertainty concerning future conditions. So, risk is an important element because the success of the investment is the most important for an entrepreneur. In relation to investing decisions, risk means no certainty about reaching the desired income from the investment, with reference to the planned one, at the stage of decision making process [13].

The method that considers risk element in cash flow is certainty equivalent method (CE). The certainty equivalent of cash flow is a certainly obtained part of a cash flow value. Flows called certainty equivalents are discounted with risk-free discount rate. Certainty equivalent of net cash flow is determined as a product of the flow and certainty equivalent factors in the consecutive calculating periods [13, 18]. The factors are determined by a following formula:

$$e_t = \frac{(1 + r_f)^t}{(1 + r_f + r_{pr})^t} \quad (1)$$

Certainty equivalent factor [13, p. 391]

where:

$e_t$  – CE factor in the consecutive year  $t$ ,

$r_f$  – risk-free rate of return,

$r_{pr}$  – risk premium,

$t = 0, 1, \dots, n$  – consecutive year of calculation term .

The dependence between net risk-adjusted cash flow and certainty equivalent can be described with a formula:

$$e_t = \frac{NCF_{tPEW}}{NCF_{tNIEP}} \quad (2)$$

Certainty equivalent factor II [18 p. 224]

where:

$e_t$  – CE factor,

$NCF_{tPEW}$  – risk-free flow called certainty equivalents,

$NCF_{tNPEW}$  – uncertain cash flow.

A factor of certainty equivalent can get the values from the range  $0 \leq e_t \leq 1$  and the level of the factor's value decreases when the risk increases.

Corrected net present value with certainty equivalent gets the following form:

$$NPVc = \sum_{t=0}^n e_t NCF_{tNPEW} a_t = \sum_{t=0}^n NCF_{tPEW} a_t \quad (3)$$

Corrected NPV [18 p. 224]

where:

$NPVc$  – corrected NPV,

$e_t$  – CE factor in year  $t$ ,

$a_t$  – discount ratio calculated for risk-free rate of return,

$NCF_{tPEW}$  – risk-free flow called certainty equivalents,

$NCF_{tNPEW}$  – uncertain cash flow.

## 2.1. CASH-FLOW-AT-RISK

Cash-Flow-at-Risk (CFaR) is a measure that bases on the Value-at-Risk (VaR) methodology, proposed by RiskMetrics Group. Using VaR methodology, economic entities can determine the prospective market risk influence on financial results. The base of calculations is making simulations for each scenario of economic changes and convert an accurate, chosen measure. Among measures, there are: Earning-at-Risk (EaR), Earnings-per-Share-at-Risk (EPSaR) and Cash-Flow-at-Risk (CFaR). Cash-Flow-at-Risk is a measure that allows to set a maximum decrease of cash flow, with reference to the determined value. It can happen as a result of market risk influence on determined variables in the determined period of time and level of certainty [16]. The determined level of relevance is perceived as a level of probability ( $\alpha$ ). So, there are  $(1-\alpha)$  chances that the cash flow value deviates about value smaller than calculated CFaR from established cash flow [11]. In the literature, CFaR is defined as a top value about which cash flow can be diminished, comparing with planned value in the con-

sidered time [6, p. 383]. VaR type of methodology is regarded as a measure of danger, so CFaR is the measure of planned cash flow value.

## SUMMARY

Cash flow is a crucial element of investment efficiency calculus. It is a base of methods to assess the profitability. So, above all, it is important to set cash flow correctly and, what is the most important, to take risk factor into consideration. Uncertainty about future conditions diminishes the precision and reliability of determined cash flow. So the methods, that deserve attention, are those which consider risk during valuation. In the work, the attempt to deliberation on the subject was made. The analysis proves that the problem is important, both in the literature and in practice. The work should be treated as the beginning of further discussion.

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Wojciech SIBILSKI\*

## **A NEW 10-FACTOR DU PONT MODEL FOR POLISH CORPORATIONS**

Financial decisions should be supported by financial analysis. The vital issue in the financial analysis of corporations is the issue of profitability. Often used and historically well known model of profitability is the so called Du Pont model and related to it well known profitability ratios. However, this model seems to be in many cases too general and hiding important specific factors that influence ultimate profitability of a corporation, understood as a return on its equity. In the paper the discussion of historical development of Du Pont model was initially presented, and then its limitations indicated. On this basis a new model, specific for Polish corporations, has been proposed and discussed. The model has been then applied to two exemplary Polish corporations income statements. The merits of the model were discussed. The model may be applied, after adjusting, to international corporations on the basis of their specific income statement formats.

### 1. INTRODUCTION

As it is usually assumed that ultimate goal of a corporation is to increase its value for its owners, mainly through profitable operations, the problem of profitability and its analysis appears to be of the great importance. There exist various well known ratios measuring different types of profitability, usually named as “returns on” – to mention at least: “return on sales”, “return on assets” or “return on equity”. It is important not only to calculate a specific return, but to identify factors that have impact on the specific value of the ratio. The most popular model used for presentation of these factors is the Du Pont model. The brief history of the model was presented in [1] and is shortly recapitulated here, since it forms a basis for the development of the new extended 10-factor model, specific for Polish corporations.

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The basic notation used in further discussion is well known for financial and management professionals, but to avoid misunderstandings for other readers, it is shortly reported here:

*S* – revenues from sales, or simply sales,

*E* – equity capital,

*TA* – total assets,

*EBIT* – earnings before interest and taxes, reported often as operating profit or operating income,

*EBT* – earnings before taxes, reported often as gross profit or gross income,

*EAT* – earnings after taxes, reported often as net profit or net income,

*ROS*, *ROA*, *ROE* denote return on sales, on assets and on equity correspondingly, understood as a quotient of EAT divided by sales, assets and equity correspondingly. Notation used further in the paper will be introduced when needed.

## 2. BRIEF HISTORY OF THE DU PONT MODEL AND THE PURPOSE OF RESEARCH

Original Du Pont model was created in 1918 and it presented return on assets as a product of return on sales and total assets turnover (being actually a 2-factor model):

$$ROA = ROS * TAT, \quad (1)$$

that is: (net income / total assets) = (net income / sales) \* (sales / total assets). This model was used until 1970s, when return on equity became more important than return on assets only, and the model was extended to a 3-factor model of the form:

$$ROE = ROS * TAT * (TA / E), \quad (2)$$

where return on assets (net income / total assets) was impacted by so called equity multiplier (total assets / equity). This model seems to be still the most popular in financial analysis. It has two important drawbacks, namely it hides the total impact of financial leverage on ROE, since equity multiplier is only one factor in financial leverage impact (second factor of financial leverage – interest costs are hidden in nominator of ROS – net income), and it hides the impact of income taxes – of the same reason – there is net income in the nominator of ROS. These drawbacks were eliminated in 1999, about 80 years after first model was created. Hawawini and Viallet [2] proposed a modification of the model introducing to the model three levels of income (or earnings) instead of single “net income”, namely earnings before interest and taxes EBIT, earnings before taxes EBT, and earnings after taxes EAT. Additionally they transformed a traditional balance sheet into a “managerial balance sheet”, but this trans-

formation is skipped in this paper to avoid unnecessary complications. In this way the following 5-factor model was created. After adjusting for skipping the above mentioned “managerial” transformation, it takes the following form:

$$ROE = OPM * TAT * FCR * (TA / E) * TR, \quad (3)$$

where OPM stands for “operating profit margin” defined as (EBIT / sales), FCR stands for “financial cost ratio” defined as (EBT / EBIT), and TR stands for “tax ratio” defined as (EAT / EBT). The developed form is then:

$$ROE = \frac{EBIT}{Sales} * \frac{Sales}{TA} * \frac{EBT}{EBIT} * \frac{TA}{Equity} * \frac{EAT}{EBT}. \quad (4)$$

The above 5-factor model separates operational efficiency of assets represented here by OPM\*TAT (kind of “operational return on assets” – OpROA), from financial leverage impact on ROE represented by FCR\*(TA/E) (kind of “compound leverage factor” – CLF), and from income tax impact represented by TR. The compound form of this model would then be:

$$ROE = OpROA * CLF * TR. \quad (5)$$

The 5-factors model resolves problems with initial 3-factors model, by extracting and showing (disclosing) the impact of financial leverage and impact of income taxes on ROE, but it stops at OPM (at EBIT actually) in the process of identifying reasons of – observed in financial statements analyses – increases or decreases of ROE in subsequent years. The limitations of 5-factors model are especially visible in situations when ROE drops, and at the same time increases of Compound Leverage Factor, Total Assets Turnover and Sales are observed (an example of such situation will be discussed further on a basis of PKN ORLEN financial statement for a year 2011). The answer for reasons of such situation on the basis of 5-factor Du Pont model is limited to the statement, that it is the decrease of Operating Profit Margin that is “guilty”, and that’s all.

The purpose of this research is to move forward in extracting and showing the impact of other factors on ROE in the Du Pont type of model, on the basis of polish income statement format. The reasonable limit in number of factors specified is 10, so a 10-factors model is proposed, but skipping impacts of some factors, any n-factors model in a range of n from 6 to 10 may be constructed, depending on the available information provided in the assumed income statement format (not only for Polish corporations) and current needs of analysis.

### 3. MODIFICATIONS OF POLISH INCOME STATEMENT FOR 10-FACTOR DU PONT MODEL BUILDING

As a basis of further discussion a functional (calculation) form of Polish Income Statement is assumed. The following modifications are introduced:

#### Modification 1

After subtracting Selling Expenses from Earnings on Goods Sold (EGS), Earnings on Sales (ESL) is introduced. After subtracting from ESL General Management Expenses, Earnings on Sales&Management – ESM appears.

#### Modification 2

Interest is extracted from Financial Costs and presented separately, and consequently Earnings Before Interest, Extraordinary Items and Taxes (EBIXT) is introduced as Earnings on Operations (EOP) plus Financial Revenues minus Financial Costs but Interest.

#### Modification 3

To keep widely used EBIT, EBT and EAT in such a sequence, it was necessary to move Extraordinary Events before Interest in the format of Polish Income Statement.

Table 1. PKN Orlen modified Consolidated Income Statement

<b>PKN ORLEN Consolidated Income Statement ( in '000 PLN)</b>	<b>2011</b>	<b>2010</b>
A. Net Sales - S	106 973 074	83 547 432
B. Cost of Goods Sold - CGS	98 397 811	75 566 961
C. Earnings on Goods Sold - EGS (A-B)	8 575 263	7 980 471
D. Selling Expenses	3 660 256	3 394 612
E. Earnings on Sales - ESL (C-D)	4 915 007	4 585 859
F. General Management Expenses	1 468 298	1 365 195
G. Earnings on Sales & Mgmt - ESM (E-F)	3 446 709	3 220 664
H. Miscellaneous Operational Revenues	1 006 655	771 321
I. Miscellaneous Operational Costs	2 386 892	869 336
J. Earnings on Operations - EOP (G+H-I)	2 066 472	3 122 649
K. Financial Revenues	2 968 444	698 766
L. Financial Costs but Interest	1 873 956	364 551
M. Earnings Before Interest, Extraordinary Events and Taxes - EBIXT (J+K-L)	3 160 960	3 456 864
N. Extraordinary Events Balance	-	-
O. Earnings Before Interest and Taxes - EBIT (M+-N)	3 160 960	3 456 864
P. Interest Expense	369 219	386 697
Q. Earnings Before Taxes - EBT (O-P)	2 791 741	3 070 167
R. Taxes	776 738	614 700
S. Earnings After Taxes (net profit) - EAT (Q-R)	2 015 003	2 455 467

As a result the modified format of Income Statement is presented in Table 1, together with the data for PKN Orlen for years 2010 and 2011 [3].

#### 4. 10-FACTOR DU PONT MODEL BUILDING

On the basis of modified Income Statement it is possible to define extra ratios that will be further used to build a new model. The purpose is to identify and present impacts of those factors on ROE, that were hidden in 5-factors model, actually within its first factor, that is operating profit margin ratio – OPM, that related Earnings Before Interest and Taxes - EBIT, to Sales. But EBIT appears only close to the end of Income Statement, so 5-factors model actually skips all previous factors that shape EBIT!

To take them into account, starting from the top of the above Income Statement the following ratios are defined:

Return on Goods Sold:

$$RGS = \frac{EGS}{S} = \frac{\text{Earnings on Goods Sold}}{\text{Sales}},$$

Selling Expenses ratio:

$$SEX = \frac{ESL}{EGS} = \frac{\text{Earnings on Sales}}{\text{Earnings on Goods Sold}},$$

General Management Expenses ratio:

$$GME = \frac{ESM}{ESL} = \frac{\text{Earnings on Sales \& Management}}{\text{Earnings on Sales}},$$

Miscellaneous Operational Items ratio:

$$MOI = \frac{EOP}{ESM} = \frac{\text{Earnings on Operations}}{\text{Earnings on Sales \& Management}},$$

Financial Items (but Interest) ratio:

$$FIT = \frac{EBIXT}{EOP} = \frac{\text{Earnings Before Extraordinary Events, Interest and Taxes}}{\text{Earnings on Operations}}$$

Extraordinary Events ratio:

$$EXE = \frac{EBIT}{EBIXT} = \frac{\text{Earnings Before Interest and Taxes}}{\text{Earnings Before Extraordinary Events, Interest and Taxes}}$$

On the basis of the above ratios the OPM ratio is built as follows:

$$OPM = RGS * SEX * GME * MOI * FIT * EXE , \quad (6)$$

being expressed explicit as:

$$OPM = \frac{EGS}{S} * \frac{ESL}{EGS} * \frac{ESM}{ESL} * \frac{EOP}{ESM} * \frac{EBIXT}{EOP} * \frac{EBIT}{EBIXT} = \frac{EBIT}{S} . \quad (7)$$

Finally, substituting (6) to (3), the 10-factors Du Pont model is created, taking the following form:

$$ROE = RGS * SEX * GME * MOI * FIT * EXE * TAT * FCR * (TA/E) * TR . \quad (8)$$

## 5. EXEMPLARY APPLICATION OF THE TRADITIONAL AND A NEW MODEL FOR SINGLE FIRM ROE ANALYSIS

To show usefulness of the 10-factors Du Pont model, it is applied to analysis of ROE of PKN ORLEN in years 2010 and 2011. For this purpose the lacking information about equity and total assets is supplemented to the information provided in PKN ORLEN Income Statement presented in Table 1.

Table 2. PKN ORLEN Consolidated Balance Sheet selected items

<b>PKN ORLEN Consolidated Balance Sheet selected items (in '000 PLN)</b>	<b>2011</b>	<b>2010</b>
Equity for the end of the year - E	26 798 683	24 239 953
Total assets for the end of the year - TA	58 731 478	51 149 792

The return on equity ROE of PKN ORLEN, computed directly as earnings after tax EAT (from Income Statement at Table 1.) divided by equity E (from Balance Sheet at Table 2.) dropped from 10,13% in 2010 to 7,52% in 2011. To analyze the reasons of this decrease, the calculations of factors of the traditional 5-factors model were performed and the results are presented in Table 3.

Table 3. PKN ORLEN ROE factors in traditional Du Pont model

Year	OPM	TAT	FCR	TA/E	TR	ROE	ROE for TR=0,80	GROE	OpROA
2010	4,14%	1,63	0,89	2,11	0,80	10,13%		12,67%	6,76%
2011	2,95%	1,82	0,88	2,19	0,72	7,52%	8,33%	10,42%	5,38%
	Year	CLF=FCR*TA/E							
	2010	1,87							
	2011	1,94							

First obvious reason of ROE decrease is the decrease of Tax Ratio from 0,80 to 0,72 (meaning that effective income tax rate rose from 20% to 28%), but even if the TR was still on the level of 0,80; ROE would be 8,33% - much lower than 10,13%. Going back step by step in search for reasons of ROE drop, let's check Gross ROE. It diminished from 12,67% to 10,42%. Why? Applying formula (5) there could be two reasons: decrease of Compound Leverage Factor CLF or Operational Return on Assets OpROA. CLF increased in 2011 to 1,94 compared to 1,87 in 2010, so financial leverage worked better in 2011 than in 2010 for PKN ORLEN ROE. So, the OpROA seems to be responsible, and it really dropped from 6,76% to 5,38%. OpROA is a product of OPM and TAT, but Table 3. shows that TAT improved in 2011 to 1,82 compared to 1,63 in 2010, meaning that total assets were better applied in 2011 to generate sales for PKN ORLEN than in 2010. Finally it comes that the second factor "guilty" for drop of ROE, is Operational Profit Margin OPM (TR was the first). And that is everything, what 5-factors Du Pont model is able to reveal.

To identify what actually caused OPM to drop, its development to 6 factors according to formula (6) is applied. The results of computations are presented in the following Table 4.

Table 4. PKN ORLEN OPM factors for a new Du Pont model

Year	RGS	SEX	GME	MOI	FIT	EXE	OPM
2010	9,55%	0,57	0,70	0,97	1,11	1,00	4,14%
2011	8,02%	0,57	0,70	0,60	1,53	1,00	2,95%

First of all it can be easily noticed that 3 factors had no impact on decrease of ROE, since they stayed the same (in two digits precision of presentation) in 2011 compared to 2010. These are Selling Expenses ratio – SEX, General Management Expenses ratio – GME, and Extraordinary Events ratio – EXE (this last, because of no extraordinary events reported). If it concerns SEX and GME it's of course not a rule, but simply the case of years 2010 and 2011 for PKN ORLEN. Main reasons of OPM drop from 4,14% in 2010 to 2,95% in 2011 (so for about 29%!) are a decrease of Return on Goods Sold – RGS from 9,55% to 8,02%, caused either by decrease of prices or higher costs of goods sold, and a decrease of Miscellaneous Operational Items ratio – MOI

from 0,97 in 2010 to 0,60 in 2011. This last drop was partially regained by the increase of Financial Items ratio – FIT, that increased from 1,11 to 1,53. The product MOI\*FIT was 1,07 in 2010 and 0,92 in 2011. Situation with MOI ratio, dependent on miscellaneous operational revenues and costs, may be accidental and may hopefully does not repeat in future, but a substantial drop of return on goods sold – RGS seems to be requiring a careful attention of corporation management.

## 6. EXEMPLARY APPLICATION OF 5-FACTOR AND 10-FACTOR DU PONT MODELS TO COMPARATIVE ANALYSIS OF FIRMS

A 10-factor model, as it was shown in preceding section, may reveal areas requiring special attention of managers, when applying it to subsequent financial statements of a single corporation. In this section its usefulness for comparing financial data of two firms is going to be shown. For this purpose the PKN ORLEN competitor was chosen – GK Lotos [4]. Its modified income statement is presented in Table 5., and necessary for ratios computation balance sheet items in Table 6.

Table 5. GK Lotos modified Consolidated Income Statement

<b>GK Lotos Consolidated Income Statement ( in '000 PLN)</b>	2011	2010
A. Net Sales - S	29 259 586	19 662 804
B. Cost of Goods Sold - CGS	26 572 381	17 269 213
C. Earnings on Goods Sold - EGS (A-B)	2 687 205	2 393 591
D. Selling Expenses	1 000 366	872 382
E. Earnings on Sales - ESL (C-D)	1 686 839	1 521 209
F. General Management Expenses	432 269	377 118
G. Earnings on Sales & Mgmt - ESM (E-F)	1 254 570	1 144 091
H. Miscellaneous Operational Revenues	168 098	56 959
I. Miscellaneous Operational Costs	337 874	139 696
J. Earnings on Operations - EOP (G+H-I)	1 084 794	1 061 354
K. Financial Revenues	25 847	42 077
L. Financial Costs but Interest	351 737	196 850
M. Earnings Before Interest, Extraordinary Events and Taxes - EBIXT (J+K-L)	758 904	906 581
N. Extraordinary Events Balance	-	-
O. Earnings Before Interest and Taxes - EBIT (M+-N)	758 904	906 581
P. Interest Expense	207 525	184 642
Q. Earnings Before Taxes - EBT (O-P)	551 379	721 939
R. Taxes	- 97 943	40 586
S. Earnings After Taxes (net profit) - EAT (Q-R)	649 322	681 353

Table 6. GK Lotos Consolidated Balance Sheet selected items

<b>GK Lotos Consolidated Balance Sheet selected items</b>		
<b>(in '000 PLN)</b>	2011	2010
Equity for the end of the year - E	7 782 383	7 513 477
Total assets for the end of the year - TA	20 432 220	17 727 364

Subsequently, Table 7. presents the traditional 5-factor model ratios, together with extra GROE, OpROA, and CLF calculated.

Table 7. GK Lotos ROE factors in traditional Du Pont model

Year	OPM	TAT	FCR	TA/E	TR	ROE	ROE for	GROE	OpROA
2010	4,61%	1,11	0,80	2,36	0,94	9,07%	<b>TR=0,94</b>	9,61%	5,11%
2011	2,59%	1,43	0,73	2,63	1,18	8,34%	6,69%	7,08%	3,71%
	Year	CLF=FCR*TA/E							
	2010	1,88							
	2011	1,91							

Based on the traditional 5-factor model (Table 3. and Table 7.), and limiting the comparative analysis of both corporations to the most general observations and conclusions it can be stated that:

- ROE of PKN ORLEN was higher in 2010 by about 1 percentage point (p.p.) than that of GK Lotos, and situation was approximately just opposite a year later, but because of higher than 1 effective tax rate of GK Lotos in 2011 (actually a return of tax). Without that, assuming for GK Lotos the same effective tax rate as in 2010, it's ROE would be on the level of 6,69%, about 1p.p. lower than PKN Orlen, as in 2010. Fundamental reasons of this situation is the PKN ORLEN advantage of about 3p.p. on a gross level GROE (and of 1,5p.p. on operational level OpROA);
- Effective tax rates of PKN ORLEN are much higher (20%–28%) than those of GK Lotos: TR ratio is 0,80 in 2010 and 0,72 in 2011, compared to low 6% in 2010 or even a tax return in 2011 of GK Lotos;
- Compound Leverages Factors CLF were for both corporations on the similar high levels of about 1,9;
- Total Assets Turnovers TAT were higher in PKN ORLEN (1,6–1,8), than in GK Lotos (1,1–1,4);
- Operating Profit Margins OPM were on similar levels, in 2010 GK Lotos was better, in 2011 it was PKN ORLEN.

On the basis of the above listed observations it becomes finally clear (check with formulas (3) and (5)), that since OPMs are similar and TATs are higher for PKN ORLEN, so it makes it's OpROAs higher, and since CLFs are both on a level of 1,9,

they magnify the difference between OpROAs of two corporations (1,5p.p) almost twice, making a difference in GROEs to be about 3p.p. Then it is reduced to about 1p.p. by differences in tax rates. As conclusion it may be reasonably recommended for PKN ORLEN to review its income tax polices, and for GK Lotos to improve its TAT (to review it's assets and to better apply them to generate sales).

The above made type of analysis and possible conclusions are of vital importance and it's not a purpose of this paper to diminish the importance and power of 5-factor Du Pont model. However it is clearly seen, that 5-factor model takes Operating Profit Margin as granted (as input to the analysis), so without developing OPM to its component factors nothing more on the basis of traditional model can be detected (revealed). OPMs were for both exemplary corporations on approximately the same level. The OPM factors for GK Lotos are computed in Table 8.

Table 8. GK Lotos OPM factors for a new Du Pont model

Year	RGS	SEX	GME	MOI	FIT	EXE	OPM
2010	12,17%	0,64	0,75	0,93	0,85	1,00	4,61%
2011	9,18%	0,63	0,74	0,86	0,70	1,00	2,59%

Developing OPM to 6 factors, that is actually extending 5-factor Du Pont model to 10-factor Du Pont model allows, in comparative analysis of these corporations, for easy noticing that:

- a) Returns on Goods Sold of GK Lotos were higher than those of PKN ORLEN by 2,5p.p. in 2010 and by 1p.p. next year;
- b) Selling Expenses ratios and General Management Expenses ratios were both consistently higher in GK Lotos than in PKN ORLEN (GK Lotos selling and management efforts are much more efficient than PKN ORLEN efforts);
- c) The above a) and b) "good news" for GK Lotos were subsequently damaged by Miscellaneous Operating Items and Financial Items that are much lower than in PKN ORLEN, so it makes finally OPMs to be on similar levels.

The above observations made on the basis of additional ratios proposed as extra factors to be included into the Du Pont model, entitle to form a hypothesis of a possible hidden potential for ROE improvement existing in GK Lotos compared to PKN ORLEN , because of its sound fundamental features, such as better RGS, SEX and GME factors, that if kept, and assuming low MOI and FIT being accidental or temporary, allow for growth of ROE in future. On the other side, based on the same observations, it may be recommended for PKN ORLEN management to investigate possibilities of improving RGS, SEX and GME, that were worse than those in GK Lotos, in purpose of increasing ROE.

## 7. SOME FINAL REMARKS

The above analysis and conclusions were made to show on the examples, how extended 10-factor Du Pont model facilitates the analysis of profitability of a single firm as well as comparative analysis of firms.

The new model, similarly to the traditional models, forms a kind of “a multilayer filter” that transforms original return on goods sold through subsequent stages, either reducing its volume or increasing (amplifying) it. It allows for various “what-if” or sensitivity analyzes. The best would be, if all layers (ratios) were as big as possible, but some of them are smaller than unity by its nature, like for example selling expenses ratio SEX or general management expenses ratio GME (unless management would be required to pay for a privilege to manage a corporation). Main advantage of the 10-factor model compared to 5-factor one, is in revealing important factors of profitability that were not clearly visible in the earlier model. It is obvious that a very careful direct analysis of an income statement and a balance sheet of a corporation, without applying of any special models could possibly generate similar observations and conclusions, but the purpose of such tools as Du Pont model is to make it not only faster, but mainly to clearly identify important factors, separate their impacts on final result, present them in a consistent and systematic manner and facilitate and concentrate in this way attention of analysts and managers on adequate actions.

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**PART 3**

**DECISION SUPPORT SYSTEMS**



Dorota KUCHTA, Joseph SUKPEN\*

## **THE ROLE OF FINANCIAL AND MANAGEMENT ACCOUNTING IN DECISION MAKING**

One of the most indispensable actions in an enterprise is continuous decision making. Over the years enterprises have acknowledged the key nature of this function and have therefore created a structure in which senior level management are responsible for these decision making processes. This function is so significant because, organizations are founded on decisions, the businesses of organizations are based on decisions and above all, the conscious efforts made to add value to the investments of shareholders are also based on decisions. Decision making therefore cuts across every segment of an enterprise. For decision making to be successful, the information on which these decisions are based should be reliable and accurate. One of the most reliable sources for information in every business is from accounting. This article will examine the role of accounting information in the decision making process as well as the relevance of the information that is generated from accounting practice. This in other words will be based on information from financial and management accounting processes.

### 1. INTRODUCTION

Decisions have to be made by every individual on a daily basis in different context and circumstances. The necessity for decision making is basically due to the fact that Individuals are faced a number of alternatives at a time between which a choice has to be made. Decisions are made between these choices because they all present different opportunities as well as challenges and depending on the realities of the situation and the individual involved, the choice is made. This phenomenon is not different for enterprises. While the decision making process for the individual might seem informal and not following specific procedures, the processes for decision making in organizations follow set out procedures and for the most part are not informal in nature.

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In the fast changing world of business, it is not just enough to make decisions but making the right and accurate decisions. Enterprises need to be able to analyze their environment and competitors to be able to have competitive advantage and this to a large extent depend on the decisions it makes. The best decisions are made on accurate and relevant information and the source of this information in every enterprise is accounting. Accounting is believed to be the language of business; it processes all documents of the financial information of an enterprise from costs to revenues. All the information about the volume of sales, the amount of cost incurred, the amount of money paid to employees as well as all other information about the shareholders, clients and every other stakeholder are recorded in accounting reports. This makes the function of accounting the most reliable source of information about the operations and performance of every enterprise. Accounting is sometimes referred to as the means to an end, with the end being the decision that is helped by the availability of accounting information (Arneld and Hope 1990).

There are two basic sources of accounting information used in the decision making process of organizations. The first is information from financial accounting while the second is information from management accounting. Though related, the two have different perspectives. Financial accounting provides historical information of enterprises; it presents information about the performance of an enterprise for the past periods as well as the status of its assets and liabilities. This information amongst others include; the profit and loss account, the balance sheet as well as the income flow statement. These statements helps the enterprise to tell how well or poorly it performed in a particular financial year, how much profits it made, what resources were used in achieving those profits, the amount of money which came in and went out of the enterprises as well as how much cash it has available at the end of the period. This information gives a perspective of the past performance allowing for improvement in the years ahead.

Management accounting on the other hand concentrates on the use of financial accounting information and other non financial information, interpreting them into useful decisions for persons within an enterprise. The information from management accounting is not historical in nature but rather based on historical information with recommendations of what could be done for better performance in the financial years ahead. This information is basically for decision making by the management of enterprises (Melissa Bushman 2007).

The next part of this article will therefore be looking at the nature of information generated from financial and management accounting. It will also consider the relevance of these data in decision making in enterprises as well as the processes and procedures involved in providing both financial and management accounting information. Additionally, the financial decision making process in an enterprise will be looked at paying specific attention to the usefulness of financial and management accounting in this process and a conclusion arrived at as to what improvements could be put in place to enhance the decision making process in enterprises.

## 2. OBJECTIVE

The overall objective of this paper is to justify the relevance of financial and management accounting information in the decision making processes of enterprises and to make the statement that no useful decisions in enterprises can ever be made without taking the information from these sources into consideration. This seeks to justify the importance of the complementary roles that financial and management accounting play.

The paper will thus discuss the nature of the information generated from financial accounting as well as that generated from management accounting. It will also identify the characteristics and relevance of the information from both sources by paying particular attention to what roles these information could play in the decision making process of enterprises.

The paper will equally examine the procedures through which enterprises collect financial and management accounting data and how this data can be interpreted into meaningful information for decision making.

## 3. FINANCIAL ACCOUNTING

Financial accounting is generally described as a field that treats money as a means of measuring economic performance instead of as a factor of production. This encompasses the entire system of monitoring and control of money as it flows in and out of an organization as assets and liabilities, revenues and expenses.

Accountants all over the globe have defined accounting as a system which gathers and summarizes financial data to prepare financial reports such as balance sheets and income statements for the organization's management, investors, lenders, suppliers, tax authorities and many other stakeholders.

Investopedia defines financial accounting as "the process of recording, summarizing and reporting the myriad of transactions from a business, so as to provide an accurate picture of its financial position and performance". This medium goes further to indicate that the objective of financial accounting is the preparation of financial statements that is; balance sheet, income statements and cash flow statements. These statements are prepared according to certain practices and principles especially those of the Generally Accepted Accounting Principles (GAAP). Accounting as a discipline records, classifies, summarizes and interprets financial information about the activities of a concern so that intelligent decisions can be made about the concern.

The American Institute of Certified Public Accountants has defined the Financial Accounting as "the art of recording, classifying and summarizing in as significant manner and in terms of money transactions and events which in part, at least of a financial character, and interpreting the results thereof".

American Accounting Association defines accounting as "the process of identifying, measuring, and communicating economic information to permit informed judgments and decisions by users of the information".

The various definitions of accounting all point to the fact that financial accounting is basically about recording all business transactions and their monetary values for the use of stakeholders. This information may vary depending on who it is meant for but generally there are certain accepted principles and requirements which have to be met.

According to Katarina Zager and Lajos Zager (2006), the financial accounting process starts with collecting data about business events, analysis of business events, recording entries in business books, preparing the trial balance and eventually preparing the financial statements.

The financial statements prepared include; the balance sheet, the income statement (profit and loss account), cash flow statement and the changes in the ownership of the enterprise. Each of these statements has exclusive information from certain business processes in the enterprise.

The income statement is sometimes referred to as the profit and loss statement (P&L), statement of operations, or statement of income. This statement is understood as a financial report which depicts the operating performance of a company, that is, revenues less expenses generated, over a specific period of time. This financial statement measures an enterprise's financial performance over a specific accounting period. It gives a summary of how the enterprise incurs expenses and revenues through its operating and non-operating activities. This portrays what is actually happening in the company to persons outside of it. By extension this statement also shows how certain kind of decisions taken in the past affect the business operations. This statement is so important because it facilitates the analysis of a company's growth prospects, cost structure and profitability as well as helping analysts to identify the components and sources of net earnings.

Danny Klinefelter (2008) defines a balance sheet as "a statement of the financial condition of a business at a specific time. It is one of the principal reports provided by a good accounting system. The balance sheet shows what is owned by a business, what is owed, and the owner's equity (or net worth) of the business". He proceeds with more information that it is possible to determine the growth and decline of assets, liability and net worth by comparing past and present balance sheets. The balance sheet also shows the amount of funds the owner has in the business. To determine this amount, the assets owned are listed and a value is placed on them. Liabilities and their values also are listed. The difference between assets and liabilities is equal to the net worth, or the owner's equity in the business. The balance sheet is often called a net worth statement. The net worth is the value that would be left if all of the business's debt obligations were paid in full.

Different view the balance sheet differently. According to Rodney Christopher (2011), "One way to think of the balance sheet is that it can inform us about the kinds and degrees of financial risk an organization faces as it delivers on its artistic mission.

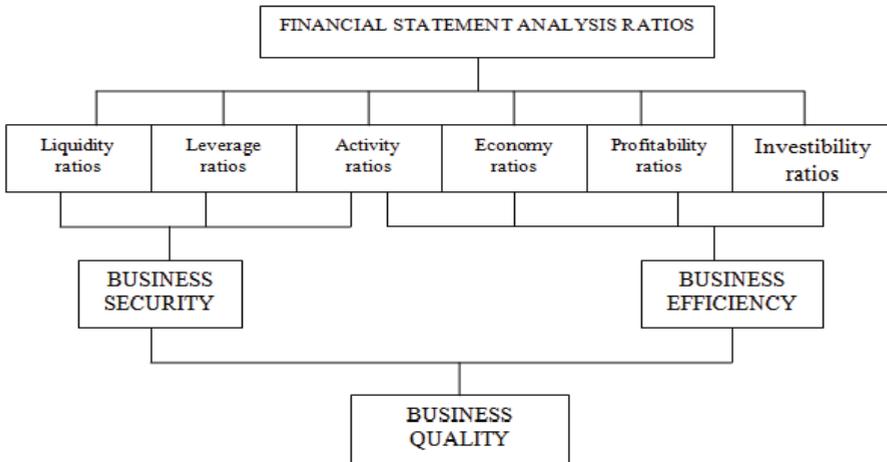
In this context, risk – and its converse, opportunity - has three distinct levels: liquidity, adaptability, durability”. The IMF Working paper (2002) on the other hand sees an economy as a balance sheet, “A stylized economy can be viewed as a system of the balance sheets of all its Agents ... a balance sheet analysis looks at stocks of assets and liabilities at a certain point in time - such as debt, foreign reserves, loans outstanding, inventory at the end of the year.

The cash flow statement provides aggregate data regarding all cash inflows a company receives from both its ongoing operations and external investment sources, as well as all cash outflows that pay for business activities and investments during a given quarter. Public companies tend to use accrual accounting and as such the income statements they release each quarter may not necessarily reflect changes in their cash positions.

The cash flow statement explains the change during the period in cash and cash equivalents. Cash includes currency on hand and demand deposits. Cash equivalents are short-term, highly liquid investments that are readily convertible to cash. These statements are important because they can be used to assess the timing, amount and predictability of future cash flows and as a basis for budgeting. It also provides information as to where money comes from and where it goes.

Financial statements generally contain very useful information about the performance of an enterprise but in the context of decision making, these statements are not very useful until they have undergone some kind of analysis. The nature of the analyses will depend on the recipient of the information. The main objective for analyzing financial statements is to recognize the achievements as well as identifying the opportunities which the enterprise could convert into profits. These analyses however go beyond the positive aspects of the enterprise, it also exposes the weak links in the enterprise for which corrective measures and improvements are needed. In the case of the analysis of financial statements, the most effective method is through ratio analysis.

Considering the time dimension, financial ratios can be basically divided into two groups. One group of financial ratios includes company's business within the particular time period (usually a year). This group is based on the data from profit and loss account and cash flow statement. The other group of financial ratios refers to the exactly defined moment which corresponds with the balance sheet date and talks about company's financial position in that moment. Ratios contain concentrated information that is needed for business quality measurement and decision making process as well (Katarina Zager, Lajos Zager; 2006). Ratios measure the quality level of particular economic phenomena which are included in financial statements. It is well known that the realized profit does not mean that the company has enough money to pay different liabilities; on the other side, loss does not mean that the company does not have any money at all. Therefore, when measuring business quality, we should examine classical ratios, based on balance sheet and profit and loss account, in correlation with cash flow statement and ratios based on cash flow statement.



Source: Katarina Zager and Lajos Zager (2006)

Fig. 1. Correlation between financial statement analysis ratios and basic criterion of good business

#### 4. MANAGEMENT ACCOUNTING

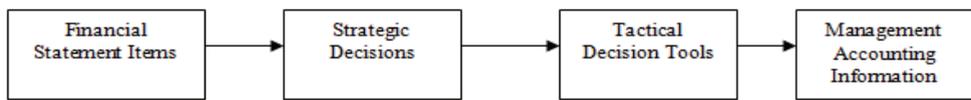
Kaplan and Atkinson (1989) stated that ‘Management accounting is the process of collecting, classifying, processing, analysing and reporting information to managers to allow them to take efficient and effective management decisions’. This in other words means that management accounting could be referred as internal accounting which is concerned with the provision of information to those internal users within the organization, like managers to help them make better decisions and improve the efficiency and effectiveness of existing operations (Drury 2006). In its most simple form, management accounting can be defined as collecting and recording useful accounting and statistical data as well as reporting them to decision makers (Crossman 1958; Singer 1961; Feltham 1968; Bruns and McKinnon 1993; Horngren et al. 2005).

An understanding of financial statements is critical to the ability of management to make good decisions. Financial statements, although prepared by accountants, are actually created by management through the implementation of decisions. The historical data from which accountants prepare financial statements result from actual management decisions. The reader and user of financial statements are not primarily the accountant but management. From a management accounting point of view, it is management rather than accountants that needs to have a greater understanding of financial statements.

Arguments by Byrne and Pierce (2007) posit that management accounting is supposed to provide information to support decision making and planning. It is equally supposed to provide information about periodic performances, analyses, support oper-

ational managers, business as well as project management. The multiplicity of the scope of management accounting is shared by Kelly and Pratt (1992) as well. Depending on the business and the purpose for which management accounting tasks are performed, the scope of these task could vary. In the investigation carried out by Cooper and Dart (2009) the top five activities associated with management accounting are the preparation and interpretation of management accounting information, the communication and presentation of financial information, leadership, development and implementation of management accounting systems and managing staff.

From the various views presented above, there is a clear concession that most of the information provided as well as decisions taken, are based on the data from financial accounting. While this is true, it is important to note also that management accounting goes beyond just financial accounting data but seeks to analyze and give meaning to the data. The task of management accounting starts from financial statement item and ends with management accounting information. This is represented in the diagram below;



Source: Kenneth R. Goosen (2008)

Fig. 2. Elements of Management Accounting

From a management accounting point of view the primary purpose of management is to make decisions that may be classified as marketing, production, and financial. The tactical decisions which must be preceded by strategic decisions provide the historical data from which the accountant prepares financial statements. In addition to being statements summarizing historical transactions, financial statements may be regarded as a descriptive model for decision making. Every item or element on the financial statements is the result of a decision or decisions. For each decision, there exists a management accounting tool that may be used to make a good decision. Management accounting can be subdivided into cost accounting systems and capital planning and budgeting systems.

## 5. DECISION MAKING

This is a comprehensive process made up of identifying the problem and decision criteria, allocating weights to those criteria, moves to developing, analyzing and selecting an alternative that can resolve the problem, implementing the alternative and ending with the evaluating the decision's effectiveness (Yeshmin & Hossan, 2011). Management accounting is concerned with the use of information in facilitating managers to make informed business decisions effectively. Management accounting is not

required to conform to national accounting standards thus allowing business owners to customize the management accounting techniques according to the demands of the company. Decision making is a process required for the execution of any business related function. Accountants in management accounting are mainly responsible for the provision of information to managers to assist them in making of the following decisions.

Apart from the fact that decisions can be made based on ratio analysis from financial statements, several other decisions can be made based on analyzed financial statements paying particular attention to management accounting decision models. These decisions are important because they shape the future of the organization as well as its operation so that they may conform to the organizational goals and mission. The following table introduces a management accounting decision making model based on the balance sheet.

Table. 1. Management Accounting Decision-Making Model- Balance Sheet Mode

	<b>Strategic Decisions</b>	<b>Tactical Decisions</b>	<b>Management Accounting Tool</b>	<b>Required Information</b>
<b>Assets</b>				
Cash	Risk	Minimum balance Amount needed	Cash budget	Cash inflows Cash outflows
Accounts receivable	Credit	Credit terms	Incremental analysis	Additional sales Additional expenses
Inventory Materials Finished Goods	Risk Quality Risk	Order size, no. of orders Supplier Safety stock	EOQ model Safety models	Purchasing cost Carrying cost Demand Probability distributions
Fixed Assets	Capacity Purchase/ lease	Depreciation methods Rate of return	Capital budgeting	Cash inflows/outflows Present value tables
Investments	Risk/ diversification	Number of shares	Capital budgeting	Potential dividends / earnings
<b>Liabilities</b>				
Accounts payable	Leverage	Amount to pay/ not pay	Cost analysis	Interest rate Terms of credit
Notes payable	Leverage Short-term vs. long-term	Amount borrow/ repay Interest rate/ lender	ROI analysis Incremental analysis	Interest rate Cost of capital
Bonds payable	Leverage Short-term versus long-term	Shares to issue Shares to retire	ROI analysis Incremental analysis Cost of capital analysis	Interest rate Cost of capital ROI data
<b>Stockholders' Equity</b>				
Common stock	Leverage / risk	Shares to issue Amount needed	ROI analysis Incremental analysis Cost of capital analysis	Cost of capital Cost of issuing ROI data
Retained earnings	Internal financing Risk	Amount of dividend Type of dividend	Incremental analysis Cost of capital analysis	ROI data Cost of capital

Source: Kenneth R. Goosen (2008)

From table 1, it is clear that there is a close relationship between the raw information provided by financial accounting and the interpreted meanings that management accounting provides. In the opinion of many researchers, these accounting systems are complimentary in the sense that, the analyses of management accounting are based on financial accounting; and the figures of financial accounting are determined by decisions taken by management accounting.

The following diagram presents the scheme of a business decision making procedure.

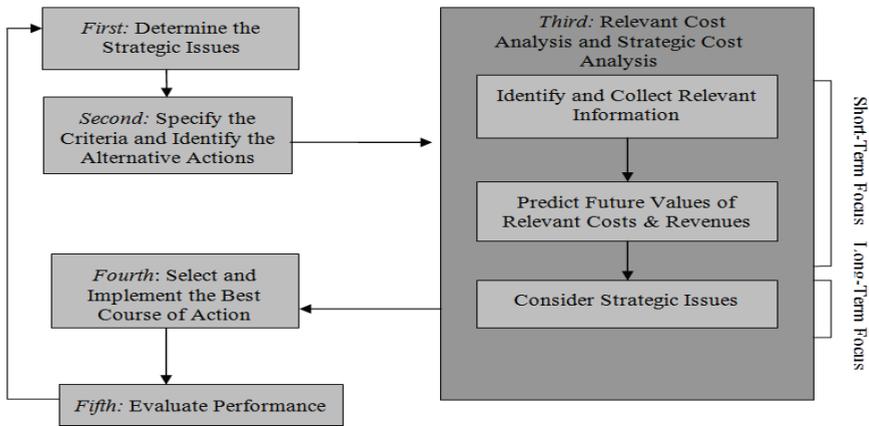


Fig. 3. The process of making business decisions

From the diagram above, it is clear that the role of accounting information cannot be underestimated in the decision making process. This is emphasized in the third stage of the decision making process – the analysis of relevant and strategic cost. This stage involves identifying and collecting relevant information, predicting future values of relevant costs and revenues and eventually considering the strategic issues. Financial accounting identifies what information is relevant and how to record that information thus playing an important role in the process. Management account on the other hand based on the financial information collected is able to predict the future values of costs and revenues as well as proposing the best strategic options available. Eventually the fifth stage of the decision making process is performed as part of the accounting functions – evaluating performance.

**Recommendation**

**Institutional**

Following the strong arguments for the significant roles which financial and management accounting information play in decision making, the following institutional recommendations are proposed:

- Just like in the case of financial accounting, statutes should be proposed for management accounting. It is important that governments and account-

ing standards made it compulsory for all enterprises to have standard management accounting reports considering the magnitude of contribution they could make. These statutes should replace the usual indifferent posture of enterprises to this system.

- Enterprises should pay more attention to management accounting as they do to financial accounting. A set of standard management accounting statements should be proposed and upheld by companies to help in the efficiency of their decision making.
- The processes through which decisions are made in enterprises should be published just like financial accounting statements so as to assure investors and stakeholders that the right information and processes are taken into consideration before significant decisions are made.

### Research

Apart from what institutions could do to improve the lot of financial and management accounting in decision making, researchers could also help in the process by concentrating on the following;

- Conduct further investigations by way of case studies to quantify how much financial and management accounting information is used in decision making in particular enterprises.
- Investigate to see if there could be other more useful information sources apart from financial and management accounting information in the decision making process in organizations. That is whether different sources of information could be useful for certain type of decisions in enterprises.
- Apart from revenues and expenses, other parameters that are key in the decision making process could be incorporated into the management decision making module. Researchers in industry could carry out further investigations into this to propose novel methods in decision making.

### Conclusion

Recognizing decision making as one of the most common but significant functions which management has to perform on a daily basis, it is important that organizations strive to improve in the processes and efficiency of the decisions made. Accounting as the language of business presents an opportunity for the improvement of decision making both through the information generated from financial analyses as well as the analyses derived from management accounting. From the discussions above, it is clear that not only is it important to get accurate information; it is equally important to make sure that this information reflects the visions and objectives of the enterprise which is where management accounting comes in handy. Irrespective of the nature of decisions made, management needs a good understanding of these systems to make the most beneficial decisions for the enterprise.

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## **LIMITED POSSIBILITIES OF USE OF FOREIGN FINANCIAL STRUCTURE MODELS IN CONDITIONS OF POLISH CAPITAL MARKET**

Contemporary existing models of companies financial structure mainly are planted in the reality of economies of developed states (i.e. UK, the USA, Canada and Japan) and their capital markets. Although these models have relatively great verifiability in market conditions of countries, in which they were created, it isn't possible to say it, that to the same degree they will be verifiable in case of Polish enterprises. This issue is connected with the completely different specificity of the domestic capital market. Besides financial structures of enterprises from various countries, considerably differ from themselves. This aspect had been already indicated in 2001 by Booth L., Aivazian V., Demirguc-Kunt A., and Maksimovic V. To similar conclusions had come in 2012 Fan J. P. H., Titman S. and Twite G., who showed, that the policy of financing economic activity of companies on developed markets is completely different than in the case of the developing ones.

The aim of this article is to show the originality of Polish capital market and the specificity of Polish enterprises' financial structure. Conducted analyses, on the need of this article, show whether exist the relation of structure of company's financial resources and their market value and how complex is this observed interrelation.

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## INTRODUCTION

In theory and practice of companies finance management we can find more often a statement according to which it is possible to increase a value of a firm thanks to clever management of financial structure resources [4]. Common idea in this field is as follows: it is possible to optimize evaluation of a firm thanks to rational creation of its debt level (in the same time using positive effects of tax shield and reducing negative influence of costs of excessive indebtedness) [6, p. 125 – 128]. Accordingly to mentioned it was prepared many models of financial structure of companies, where most of them are planted in economies of developed countries, such as the USA, Great Britain, Japan and their capital markets.

Although mentioned issue of management of financial structure has been undertaken by many economists from different developed countries, there still exist whole area of problems, which should be solved and especially verified in relation with specificity of domestic economies of certain countries. **It is worth to mention here traditional models:** Modigliani's and Miller's, bankruptcy costs (Stiglitz's, Baxter's, Kraus' and others), agency costs (M. Jensen's and W. Meckling's, Harris', Raviv's), signals (S.C. Myers' and N. Majluf's), financing order (ex. G. Donaldson's), competition on fight of control of companies (M. Harris's and A. Raviv's in.) **and more current dynamic models of capital structure:** (of Goldstein R., Ju Nengjiu, Leland H. E., Hennessy, Whited i Titman and others). Although this models are characterized with great verifiability<sup>1</sup> in conditions of countries, in which they has been created, it can't be said that in the same way they will be useful and practical in case of Polish companies. It is related with completely different specificity of domestic capital market.

### 1. AN ISSUE OF NOT DIRECT INFLUENCE OF FINANCIAL STRUCTURE ON ENTERPRISE VALUE

Although in many economic models (both traditional and modern, especially in mentioned in this article) it is stated, that financial structure has influence on com-

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<sup>1</sup> For example, for verifiability of traditional models (theory of Modigliani and Miller [9, p. 261–297]) argue results of Marsh (1982), Auerbach (1985), Jalilvand and Harris (1984) and also Opler and Titman (1994) [10, p. 219-244], but for verifiability of dynamical models argue research of H. DeAngelo, L. DeAngelo i T.M. Whiteda [2, p. 235–261].

pany's market value, in the same time there exist some empirical evidences, which shows that this influence is not direct and doesn't occur in every market conditions.

In details this issue showed Kayhan Ayla and Titman Sheridan in work entitled *Firms' histories and their capital structures* [8, p. 87–130]. They in their analysis mentioned, that essentiality of creation of optimal financial structure can be not so high, as it is commonly believed. Especially, when substitution between costs and benefits of financing with debt can create optimal financial structure, which causes weak relation between level of indebtedness and companies market value, which can be observed, when costs varying from optimum (of debt) are relatively low. In this case financial structure can be strongly dependent from transactional costs and market expectation, which temporarily can influence on existing relative higher costs of debt usage instead of equity. In the same it makes idea of coming to optimal indebtedness level much more insignificant. Especially, when more debt in financial structure couldn't be influential on company's market value (when we speak of optimal use of debt and its potential power of increasing firms value).

## 2. THE SPECIFICITY OF FINANCIAL STRUCTURE OF COMPANIES FROM DIFFERENT MARKETS

Except of mentioned in part 1. issue of potential independence of company's market value and its financial structure also important is matter of dissimilarity of capital structure conception, dependent on market condition of certain country and its economy.

In 2001 Booth L., Aivazian V., Demirguc-Kunt A. and Maksimovic V. [1, p. 87–130] showed significant differences between capital structures of companies from different countries. They proved, that permanent differences in a degree of financial leverage exist between many foreign countries (mainly developing ones). To similar conclusions came in 2012 Joseph P. H. Fan, Sheridan Titman and Garry Twite [3, p. 34-37], which proved, that idea of financing companies economic activity in grooving markets differ significantly from the one existing in developed countries. Their conclusions was based on analyses performed on a sample of different companies from 39 countries. Their achieved results showed that, in case of developed economies (i.e. New Zealand, Australia, Sweden, Canada and the USA) companies use more of long term debt instead of short term one. Especially, when, this source of foreign capital is more safety (for example in case of market and investment shocks). According to mentioned authors long term debt financing is related with

smaller corruption, higher stability of capital market and usage of not codified law (less formal). And in the same time in developing countries law and economic activities systems are mainly much more complicated and that's why they are factors of lowering the amount of long term debt in a term debt structure of native companies.

### 3. TERM STRUCTURE OF FINANCIAL RESOURCES OF POLISH COMPANIES

Presented in section 2 results of foreign economists are showing also stated on beginning of this article issue, that financial structure for companies from different markets could be tremendous different. In relation to mentioned in section 2 outcomes, there has been performed further analysis within this article. Exactly for a sample of 250 both stock and non-stock Polish companies, there has been done research, which goal was to verify whether financial structure of domestic firms differ significantly from those of foreign ones (especially foreign firms, that runs their businesses on developed countries capital markets). Performed (by author of this article) study was done in division of an original sample into 2 subsamples:

- first for 92 companies listed on basic stock market ,
- second for 158 companies not-listed on stock market.

All companies gathered to subsamples comes from 10 different groups of industries (for example metal, light, trade, services, electrical and electromechanical etc.), that was running their businesses constantly during the period of years: 2001 - 2010. To subsamples there weren't taken firms from financial industry (for example banks, financial institution etc.).

On the beginning of this section there will be presented results of research performed for stock companies. The aggregated results are shown in Figure no. 1.

YEAR	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	average
<b>The number of companies using long term debt in proportion higher than short term debt</b>	33	30	25	22	26	21	23	16	15	11	22,2
<b>The number of companies using long term debt in <u>proportion lower than short term debt</u></b>	59	62	67	70	66	71	69	76	77	81	69,8
percentage of companies which uses more short term debt	64%	67%	73%	76%	72%	77%	75%	83%	84%	88%	76%
change of number of companies using more long term debt	10%	20%	14%	-15%	24%	-9%	44%	7%	36%	0%	X

Fig. 1. Usage of long and short term debt in case of 92 companies listed on Polish stock market

As show it results, gathered in Figure 1. practically during whole period of analysis in case of stock companies main source of indebtedness is short time debt. But in the same time the highest number of those firms, which was using short term debt appeared in 2001. Further from year to year was growing a group of companies, which was using more long term debt instead short time one and the highest participation of those firms was identified in 2010.

Achieved results allow us to think, that in case of stock companies there appears processes and management behaviours similar to those one characteristic for organisations from developed countries. Because higher usage of long term debt (as shown in section 2) is typical for companies from states with stable economies and strong capital market, which economic units rather rely on safe and stable long term financing, forecasting, that their activity would be also long term. This observations seems to be proper, especially when analysed 92 stock companies belong to group of most stable and strong economic organisations on Polish capital market, which exist constantly from 2001 on stock market, where run more companies, exactly 329 [13], and rest doesn't have so long financial and market history.

In the same time it is worth to mention, that shown tendency in changes of financial structure of analyzed stock companies was changeful in whole period years 2001–2010.

Wherein in analysis we can observe also influences of current financial crisis on behavior of mentioned companies. Especially in year 2008 there appeared another wave of transition of short term debt to long term one, after ended in 2007 tendency of escaping from safer kind of indebtedness.

Similar and in the same time in some part different observations was noticed in case of usage of debt in case of 158 non-stock companies. Results of research performed for the second subsample presents Figure 2.

YEAR	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	average
<b>The number of companies using long term debt in proportion higher than short term debt</b>	24	25	25	27	23	29	30	25	27	29	26,4
<b>The number of companies using long term debt in proportion lower than short term debt</b>	134	133	133	131	135	129	128	133	131	129	131,6
which percentage uses more short term debt	85%	84%	84%	83%	85%	82%	81%	84%	83%	82%	83%

Fig. 2. Usage of long and short term debt in case of 158 companies not listed on Polish stock market

In case of non-stock companies also predominates usage of short term debt. Wherein in whole period of analysis is observed relatively constant level of participation of this kind of financing in indebtedness of analyzed firms. Where in years 2006-2010 this level of short term debt was even higher than in case of stock companies. What is most interesting, in further years, in comparison to 2001 there appeared decline in the share of entities using long term liabilities. It means there here occurred reverse tendency than existing in case of characteristic for companies from developed economies. Besides achieved results seem to show something different than should be forced by observed conditions of economical crisis (of years from 2008). Mentioned results could in fact prove difficulties that meet non-stock companies, when they try to secure long term debt financing. It might be identified simply, when we bring to consideration specific positions of these firms. Non-stock companies don't have stock market ratings and they have only ability to borrow from banks and other financial institutions (which standards and procedures are sometimes difficult and crucial for them) and they don't have relevant easy option to issue commercial obligations to secure their long term debt needs.

### 3. SPECYFIC INTERRELETION BETWEEN FINANCIAL STRUCTURE AND POLISH COMPANY'S VALUE

In correspondence to showed specificity of term debt structure of Polish companies it is also worth to underline and to describe an issue of characteristic influence of financial structure of those firms on their market value. First of all simple analysing only one indicator of financial resources shows, that mentioned influence is not so strong, to prove observations pointed out by most of modern capital structure theories and models. Only multi-dimensional analysis let us fully identify this impact. Such analysis has been done on a need of this article and in next subsection it will be presented.

#### 3.1. POLISH COMPANIES - RESEARCH SAMPLE

Research was performed for 2 subsamples (the same as mentioned in previous section): 92 stock companies and 158 non-stock companies, which were running constantly from 2001 till 2010.

#### 3.2. CHOSEN INDICATORS OF THE FINANCIAL STRUCTURE AND THE MARKET VALUE OF ANALYZED COMPANIES

With use of shown data was prepared a numerical representation of both the financial structure and the market value of analyzed companies. Thanks to broad analysis of the current literature in the field of capital structure theory and basing on Individual in-Depth Interview method (targeted to more than 80 companies from Lower Silesia market) the following indicators of financial structure was chosen to final analysis [11, pp. 89–93]:

- ratio No. 1 (wsk.1): equity to assets ratio,
- ratio No. 2 (wsk.2): ratio of covering liabilities with cash flow,
- ratio No. 3 (wsk.3): debt to assets ratio,
- ratio No. 4 (wsk.4): long-term debt to equity ratio,
- ratio No. 5 (wsk.5): fixed assets to constant capitals ratio,
- ratio No. 6 (wsk.6): interest coverage ratio of foreign capital (TIE),
- ratio No. 7 (wsk.7): debt coverage ratio,
- ratio No. 8 (6) (wsk.8 {6}): time structure of debt ratio,
- ratio No. 9 (7) (wsk.9 {7}): debt to equity ratio.

In order to describe the market value of analyzed companies a parametric measure, basing on the Q Tobina ratio was used, define with the following pattern<sup>2</sup>:

$$P_1 = \frac{MVA_E}{A} = \frac{MV_E - IE}{A} = \frac{pN - IE}{A} \quad (1)$$

$$P_2 = \frac{EVA_E}{A} = \frac{NOPAT - IC * WACC}{A} \quad (2)$$

where:,  $MVA_E$  – Market Value Added (for shareholders),  $A$  – book value of assets,  $MV_E$  – Market Value of Equity,  $IE$  – value of equity invested in a company,  $p$  – current shares price,  $N$  – amount of shares,  $EVA_E$  – Economic Value Added (for owners),  $NOPAT$  – economic profit before taxation (with CIT),  $IC$  – invested capital in a company,  $WACC$  – weighted average cost of capital.

Exactly parametric measure  $P_1$ , basing on Market Value Added indicator ( $MVA_E$ ) was used for 92 companies from basic stock market. And finally measure  $P_2$ , using Economic Value Added ( $EVA_E$ ) indicator was used for 158 firms out from stock market. This usage of two different “drivers” of firms market value have been used in research because of differences between financial standards of stock and non-stock companies (simply non stock ones don’t have capital ratings of their shares and it is not possible to calculate for them Market Value Added measure).

### 3.3. OBSERVED INTERRELATION OF THE COMPANY’S FINANCIAL STRUCTURE AND THEIR MARKET VALUE

Thanks to mentioned indicators correlation analysis was performed for the population of the 250 companies. For every firm, functioning nonstop in period 2001 – 2010 was calculated indicators of correlation between every 9 (in case of 92 stock companies) and 7 (in case of 158 non-stock companies) financial structure indicators and their parametrical measure of their market value (properly using  $MVA_E$  in case of stock companies and  $EVA_E$  in case of non-stock companies).

As essential level of correlation was taken correlation lower than -0,55 and higher than 0,55. This level was verified thanks to use of t-Student test, where, as amount of observa-

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<sup>2</sup> Own elaboration on the basis of the literature of the subject: [5, p. 6] and [12, p. 156., p. 156].

tions was taken the number of companies in period: 2001-2010, in which every company from the analyzed sample has been running its business. As a level of essentiality was used  $\alpha = 0,05$ .

In a result of analysis it was identified, that:

- in case of 75 from 92 stock companies (81,52%) there appears significant level of correlation for at least one from 9 financial structure indicators and parametric measure  $P_1 = MVA/A$  calculated for those firms;
- in case of 135 from 158 stock companies (85,44%) there appears significant level of correlation for at least one from 7 financial structure indicators and parametric measure  $P_2 = EVA/A$  calculated for those firms.

Achieved outcomes show, that in case of Polish both stock and non-stock companies we can observe significant interrelation between their financial structure and their market value. Of course, as seen, this relation is not straight and simple and doesn't exist for the same measures for every firm (in this case from the analyzed sample).

## CONCLUSIONS

Performed analysis are in some part in favor with mentioned in part 2. outcomes of foreign researchers and economists. Achieved (by an author of this article) results show, what observed Joseph P. H. Fan, Sheridan Titman i Garry Twite [3, p. 34-37], that in case of companies from developing economies long term debt is non-preferred source of their liabilities. This can be especially found in case of companies from outside of stock market.

Basing on mentioned outcome further and complex analysis was performed. With use of 9 financial indicators and 2 market value parametrical measures was verified the existence of influence of capital structure on market value of Polish companies. For a big sample, of 250 firms this influence was identified. Of course observed impact is not straight and so simple, as static trade-of theory suggests. This influence is rather multidimensional and can't be identified with use of only one previous chosen financial indicator. Achieved results are showing that in case of Polish companies rational management of their financial structure is possible, sensible and it can be performed in rather dynamic than static way. But, as show previous results of analysis of debt's term structure, existing and foreign dynamic models of capital structure

couldn't be used in simple way in case of Polish companies. Those models should be changed, for use them in case of Polish companies. They should be rather prepared to national market conditions, which of course could be quite difficult. That's why it would be easier or even more sensible to prepare exact models on a basis of data from Polish companies and their domestic economy. Such models, directed to Polish market conditions has been successfully prepared by author of this article. Their numerical representation and possible use will be presented in next article.

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## **ESTIMATION OF ECONOMIC EFFICIENCY OF USE OF INFORMATION RESOURCES**

The general criterion of expediency of use of information resources, information technologies at management of the enterprises is increase of efficiency of the basic manufacture achievable at it by perfection of managerial processes. Decrease in expenses for information service is not dominating, however it is necessary to take into account, that these expenses enter into production costs, and the they will be lower, the above general efficiency at the same qualitative and quantitative characteristics of the information.

General efficiency of use of information resources, information technologies at management of the enterprises is in direct dependence on expenses for management and used thus of information resources and from achievable results in sphere of primary activity. Develops of the efficiency determined through change of parameters of primary activity and through decrease, sometimes - increase, expenses for management.

### **1. PARAMETERS OF ECONOMIC EFFICIENCY OF USE OF INFORMATION RESOURCES**

At an estimation of efficiency absolute and relative parameters are used. An absolute parameter of efficiency of operation of information resources is annual economic benefit. Settlement profitableness and a time of recovery of outlay of capital investments concern to relative parameters.

Basis for definition of quantitative values of absolute and relative parameters are sizes of expenses and results from their use. Expenses divide on operational and capital. Results from use information resources can give in to quantitative

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measurement and cannot give in to quantitative measurement. Qualitative characteristics of information resources in this case mean.

Capital expenses ( $To_i$ ) on information resources are connected to designing or purchase of all kinds of maintenance (program, information, and technical, organizational) and introduction information resources in a control system of the enterprise. They have single character and develop of the following components:

$$To_i = K_{проект} + K_{ПО} + K_{техн} + K_{связь} + K_{ИБ} + K_{проч} \quad (1)$$

where  $K_{проект}$  – expenses for designing;  $K_{ПО}$  – expenses for the software;  $K_{техн}$  – expenses for means;  $K_{связь}$  – expenses for systems of communication;  $K_{ИБ}$  – expenses for creation of information base;  $K_{проч}$  – other expenses, including expenses for training of the personnel.

When designing and introduction last for a long time enough, at calculation of a total sum of capital expenses there is a necessity of reduction of occurring at different times expenses by the uniform moment of time (discounting), is usual by the moment of introduction:

$$K_{привед} = \sum_t K_t (1+i)^{-t} \quad (2)$$

where  $t = [0, T]$  – the period of occurrence of the capital expenses, counted from the moment of introduction information resources;  $T$  – quantity of the periods of occurrence of expenses;  $K_t$  – the sum of capital expenses in  $t$ - $1/4$  the period;  $i$  – factor of inflation.

At calculation of the general expenses on information resources there is a necessity of the account of capital expenses not in full, and with reference to the certain period of time, is usual by one year. It is carried out by means of effectiveness ratio of capital investments ( $E$ ).

Product ( $K * E$ ) characterizes that sum of capital expenses on information resources which will be returned to the enterprise within one year. Thus, capital expenses are not lost during use information resources, and capitalized.

Operation information resources is connected to expenses which are operational expenses.

Operational expenses are taken into account for a year and will consist from:

$$C_{эспл} = C_{з/н} + C_{тех. обл.} + C_{связь} + C_{проч} \quad (3)$$

where  $C_{з/н}$  – wages serving information resources the personnel with all necessary deductions;  $C_{тех. обл.}$  – cost of service of means;  $C_{связь}$  – cost of payment of services of communication;  $C_{проч}$  – other operational expenses (rent of premises, the electric power, materials).

Efficiency of use of system of information resources. It is defined by a degree of its conformity to the purpose. Distinguish economic and functional efficiency. The estimation of economic efficiency is based on comparison of expenses and results. The basic parameter of economic efficiency is annual economic benefit (economic profit):

$$\mathcal{E}_i = \mathcal{E}_{zod} - E \cdot K \quad (4)$$

where  $\mathcal{E}_{zod}$  – the annual economy (profit) caused by operation of information resources.

On market terminology is an economic or accounting profit. Represents a difference between proceeds and obvious expenses. Obvious expenses - all this monetary costs of the enterprise, including amortization;  $To$  – the lumpsum expenses connected to creation information resources;  $E$  – rate of return (normative profitableness).

From the point of view of the economic maintenance size  $E$  will consist of norm of feedback on the capital and norm of the enterprise income.

Product ( $E \cdot K$ ) on market terminology refers to as implicit expenses of business (Implicit Costs) as characterizes feedback of the capital which could be in other sphere, for example, at his premise in bank. Size  $E$  in market conditions should not be less than the annual bank interest rate. Usually size  $E$  is established a little bit above the interest rate as the profit can be received not only from the capital, but also from enterprise of the owner.

In each sphere of business the size of rate of return of  $E_{sli}$  any field of activity is established becomes by more profitable, new capitals and on the contrary there direct. Size  $E$  is factor of reduction of lump sum expenses to annual charges.

The sum of annual operational and capital expenses on ИП name the resulted expenses ( $\Pi$ ):

$$\Pi = C_{\text{кcn.л}} + K \cdot E \quad (5)$$

where  $E$  – the normalized profitableness.

This parameter is used in calculations of size of economic benefit, as result of use of information resources. Besides results of use of information resources can have social, ecological character.

As it was spoken earlier, results of use of information resources can give in to quantitative - cost measurement and not give in to a quantitative estimation. The first group of results develops of economy of means in sphere of operation of business and in sphere of his primary activity.

The size of economy in sphere of management ( $\mathcal{E}_{\text{en}}$ ) is defined as a difference of the resulted expenses by existing and offered variants of operation of information resources. She frequently appears negative, that is connected to high cost of modern

systems of information service. Therefore the basic source of effect from use of information resources are the results arising at change of a lot of parameters of industrial - financial activity which are reached in connection with application in operation of business of better, full and duly information ( $\mathcal{E}_{\text{new}}$ ).

For revealing these parameters it is necessary to execute the detailed financial and economic analysis, however almost always the basic sources of effect are:

1. Economy on the cost price of production and services;
2. Increase in proceeds from realization of production and services;
3. Economy owing to reduction of penalties and penalties;
4. Reduction of size of turnaround means.

Besides listed, in each concrete case of use of information resources at the enterprise there can be other sources of efficiency dependent on specialization of the enterprise and the purpose of use of information resources. In a result all calculations can be shown to definition of an annual gain of the profit.

Results of use of the information resources, not giving in to quantitative - cost measurement, are connected to increase of satisfaction of the administrative personnel, culture of management, change of technology of business dealing, improvement of a social climate at the enterprise. They are important and can play not last role at the decision of a question on expediency and necessity of use of information resources.

Absolute parameter of economic efficiency is annual economic benefit ( $\mathcal{E}_{\text{год}}$ ). This value pays off as follows:

$$\mathcal{E}_{\text{год}} = \mathcal{E}_{\text{внешн}} + \mathcal{E}_{\text{вн}} \quad (6)$$

$$\Pi = C_{\text{экупл}} + K * E \quad (7)$$

where  $E$  – the normalized profitableness.

Operation of information resources is considered effective, if

$$\mathcal{E}_{\text{год}} > 0 \quad (8)$$

Relative parameters of efficiency of information resources characterize profitableness of capital investments in them. With this purpose values of settlement profitableness ( $E_p$ ) and a time of recovery of outlay of capital investments ( $T$ ) are defined:

$$E_p = \mathcal{E} / T_o \quad (9)$$

$$\Pi = 1/E_p = T_o / \Theta \quad (10)$$

where  $\Theta$  - annual results (profit) on use of the information resources, determined as a difference between proceeds from realization of production and operational expenses.

Besides the above-stated parameters of efficiency, designers expect also a parameter of a time of recovery of outlay of capital expenses representing the attitude of capital expenses to economy of cost expenses:

$$T_{OK} = \frac{K_j - K_o}{\Delta C} \quad (11)$$

Settlement effectiveness ratio  $E_p$  is return size to a time of recovery of outlay and pay off under the formula:

$$E_p = 1 / T_{OK} \quad (12)$$

Onset of the above-stated parameters designers of information resources choose the most effective variant of technological process of processing of the information.

In the beginning works «Definition of structure of the basic operations » and «Specification of structure of means of performance of operations » are carried out. As entrance documents for performance of these work materials of inspection, « Statement of a problem », “Technical project” and set of preliminary chosen means for operations of technological process serve.

As a result of performance of these works designers receive the list of the basic operations, the description of technical and operational characteristics of the chosen information resources and methods of work with them, which act as the initial data.

The decision of a problem of calculation of economic efficiency of information resources should carry out after detailed research of a problem and definition of the purposes of estimation. Proceeding from the designed values of economic efficiency of information resources, of the decision on a choice of the most preferable variant of their use at the enterprise make. In most cases the basic criterion of such choice is the minimum of the resulted expenses, as results frequently not essentially differ from application of various variants of information resources from each other.

## 2. ESTIMATION OF EFFICIENCY OF ACTIVITY OF THE PERSONNEL OF THE ENTERPRISE

Effective enough method of revealing of business qualities, abilities of the applicant for a post is application of business games. The essence of business games

will be, that the situation close to real, and search of the best variant of its sanction is set to applicants for a post depends on their abilities.

Business games are used at selection of experts and heads more often. It is necessary to note, that it is expensive enough method. Therefore the expediency of his application in each concrete case should be justified. Besides business games can be used in system of preparation and improvement of professional skill of the staff of management.

Trial period – it is wide the form of finding-out of abilities of the applicant for a vacant post as, working during a trial period, it shows the professional skills and knowledge. This method allows to lower an opportunity of a mistake to a minimum because enables a management of the organization to dismiss the applicant at discrepancy of his professional level.

The reference in the centers of an estimation of the personnel is the method demanding significant financial expenses, but good result giving, as a rule, as in such centers applicants carry out a number of tasks in which modeling concrete working situations is used. Therefore the head of the enterprise organization receives exact enough characteristic of business qualities of the applicant.

To avoid mistakes at selection of the staff and to receive more objective estimations, it is possible to recommend to personnel services of the organizations to use not one, and simultaneously some methods of an estimation of candidates. With special carefulness it is necessary to select and prepare for those employees who communicate with clients as image of the organization depends on their activity as a whole, they represent the organization to clients, possible partners and the state bodies.

It is necessary to note also necessity of maintenance of training of separate workers in case they have not enough professional knowledge. As whole expenses for additional training can appear fewer expenses on search and selection of new employees. Besides for the organization it is more preferable to make lump sum expenses for training of the personnel, than in the further activity to collide with losses from personnel risks [4].

In the decision of personnel problems at the enterprise all versions of industrial adaptation have great value. So, at formation of collective it is necessary to take into account, that resolvability of the staff or a return parameter - workers on workplaces - in many respects depends on results of adaptation. Insufficiency its results in unreasonably high fluidity, to the raised disease, by other negative moments, including economic character.

Adaptation of new employees in collective - one of the important problems who should be solved to service on work with the personnel in the organization. It is necessary to notice, that necessity for the formalized procedure of adaptation exists at the enterprises of average and large business. For small structures, this problem is not so actual.

The insufficient attention of service on work with the personnel to this function, absence of precisely regulated procedures on adaptation of new employees entails the new employee in collective, his leaving or dismissal under the initiative of administration. Accordingly efficiency of actions on acquisition of the organization by the personnel is reduced, and efficiency of activity of the organization as a whole, falls.

Certainly, development, introduction and maintenance of system of adaptation of the personnel demand significant expenses and efforts. But all this is quite justified - in fact competently built system of adaptation gives conclusive advantages. First of all, she reduces costs on search of the new personnel. In fact as frequently we leave the new employee, and not having understood during a trial period, it approaches for this or that work whether or not, and again we waste time on numerous interviews.

Other important advantage of adaptable circuits - system of preceptor ship included in them. She not only helps new people to adapt quickly and easily, but also allows their skilled colleagues to get experience of a management that is for them motivating factor.

But the most important advantage making the strongest impression on heads, - the given system accelerates process of introduction of new employees in the company and raises efficiency of their work for minimally short time. From the problems of training character traditionally being destiny of beginners during a trial period, they quickly pass to the decision of the real problems worth before by the company.

Consequences of absence of the program of vocational guidance and adaptation of new employees can be their leaving or dismissal. What the formal reason this fact spoke, it inevitably results in decrease in an overall performance of the company. The impression of the employee about the company in this case remains negative, more likely, and often recurrence of such cases will lead to loss of reputation of the company in the market as employer [3].

For the characteristic of the separate parties of adaptation of the staff the system of parameters is used. In particular, it is possible to allocate:

- objective parameters - a level and stability of quantity indicators of work (regular performance of norms, qualitative manufacturing of production, absence of infringements in beat works, professional stability, growth of qualification, a level of a labor discipline);
- subjective parameters - a level of satisfaction the trade, working conditions, collective.

Other approach to an estimation of industrial adaptation proceeds from the characteristic and results of each of its parties.

So, for the characteristic and adaptations, it is especial on works with the big physical pressure parameters of development and power inputs, and also parameters of a condition of cardiovascular system, function of blood circulation, breath, speed of

restoration, a level of monotony of work, sanitary-and-hygienic norms of industrial conditions, a rhythm of work, convenience of a workplace, external factors of influence (noise, light exposure, vibration) are used.

Professional adaptation, as full and successful mastering by a trade, such parameters, as characterize a degree of development of norms of time (their performance, achievement of the average percent developed in collective), an output on an average level of a marriage of production on fault of the worker.

To the parameters describing social - psychological adaptation, concern a level of psychological satisfaction the industrial environment new to the person in the whole and its most important for him components, character of mutual relations with comrades, administration, satisfaction the position in collective, a level of satisfaction of vital aspirations [1].

Perfection of practice of selection and placement of personnel, stimulation of their work, promotion of workers, increases of their qualification is connected to the objective, business estimation of workers constructed on a scientific basis. The estimation of the worker represents the procedure spent with the purpose of revealing of a degree of conformity of personal qualities of the worker, quantitative and qualitative results of his activity to the certain requirements.

The problem of a business estimation of the worker will consist in revealing his labor potential, a degree of use of this potential, conformity of the worker of a post or his readiness to hold a concrete post, in characterizing efficiency of his labor activity, and, hence, and value of the worker for the enterprise.

Necessity of a business estimation arises and in other situations: at reception of the person for work, after the termination of a trial period by him, at formation of a reserve on promotion, at selection of the worker from a reserve for purpose for a post.

The estimation of business qualities of the worker at his reception for work is complicated and in essence also is reduced to studying his potential. For these purposes are used: studying of documents from a former place of work, participation of the applicant in analysis of industrial situations, an estimation of situational behavior at interview, in necessary cases are involved results of work during a trial period.

The basic requirement to a set of personal qualities for the subsequent estimation - to choose from the big number what can directly or indirectly influence effective performance by the worker of the official duties. Therefore the estimation of the new worker is expedient for carrying out in a cut of factors of productivity of work, bringing to a focus on:

- Knowledge (that the worker should know and that it knows);
- Skill (that it should do and that is able to make);
- Properties of character (what requirements to the person of the worker and what it).

The estimation of the worker after the certain period of work opens the big opportunities in a choice of directions of the analysis which should be to the full realized. If at employment serious enough check of a degree of presence at the worker of those or other qualities follow an estimation of personal qualities, business qualities and results of activity has been resulted. If at selection of the worker his potential after the certain period of work in a post it is necessary to reveal as these opportunities have been realized by him was estimated.

### 3. THE BUSINESS ESTIMATION OF EFFICIENCY OF ACTIVITY OF THE PERSONNEL OF THE ENTERPRISE

The business estimation of the worker passes in the form of certification more often. Certification is widely widespread form of work with the staff, actively used by the enterprises. Object of certification are the workers of the certain categories consisting in labor agreements with the given enterprise.

Efficiency of certification grows, if the certain legal consequences are connected to it: encouragement, translation into higher post, dismissal.

The major direction of personnel planning is planning career of the worker, his promotion on qualifying or service levels (steps) under the certain circuit (model).

Planning of labor career as the component of personnel selection represents criterion function of management by the personnel at the enterprise as pursues the purpose to provide the most rational use of labor potential of the worker, to create conditions for his self-realization as persons.

Vocational promotion of workers can be:

- Intraprofessional: increase of professional skill within the limits of the trade and the category due to development of adjacent operations and functions, increase in zones of service and development of the advanced receptions and methods of work; increase of the qualifying category; development of one or several adjacent trades;
- Interprofessional: change of a trade with the purpose of development new, more complex; transition to work by other trade of approximately equal complexity with the purpose of improvement of working conditions and preservation of health of the worker; formation of the worker of a wide structure:
  - o Linear - functional: elections and purpose as the foreman;
  - o Social: transition to no production work.

Promotion of experts and employees can be:

- Horizontal when the worker grows as the expert, consistently raising and deepening knowledge on the elected specialty and moving ahead from one qualifying category in another, from one post, with reference to the given trade, to higher;

- Vertical – promotion on hierarchy of posts of linear production managers;
- In the beginning horizontal, and then vertical: the generated expert or the employee at the certain step of professional work is switched to a vertical way of promotion – becomes the head of corresponding functional division.

The organization of qualifying promotion of experts and employees puts problems of duly maintenance of workplaces experts and heads of the necessary skill level and possessing corresponding personal qualities and an operational experience, fastenings of experts and heads, increases of efficiency of use of potential of the worker, opening road for his qualifying growth.

Three basic kinds of preparation of workers are usually allocated: preparation new working (earlier not having trades), retraining and training of workers to the second trades (in case of their liberation, expansion of their structure or needs of manufacture) and improvement of professional skill (consecutive perfection of a professional knowledge and skills by an available trade).

The organization of work is a system of scientifically proved actions directed on maintenance of conditions for optimum performance of a labor during manufacture, promoting achievement of the best productivity of labor activity, development of manufacture by intensive way.

To elements of the organization of work in collective concern:

- Division and labor co-operation – isolation of kinds of labor activity and system of industrial interrelations of workers;
- Rational receptions and methods of work due to which the most economical performance of operations (from a position of expenses of time and efforts of the worker) is provided;
- The organization of a workplace, that is equipment by his necessary means of production and their rational accommodation on the areas (lay-out);
- The organization of service of a workplace – kinds of service, the form of his granting, a choice of the executor.

In a broad sense the maintenance of the organization of work includes also normalization of work, creation of favorable working conditions, education at the worker of discipline of work, labor activity and the creative initiative.

Through the organization of work the idea work - maintenance of the fullest adaptation of material base of manufacture to the person, the high maintenance of work, conformity of his qualification, change in career, active participation of workers in the decision of industrial problems is realized.

Favorably affects industrial results and considerably raises quality of a labor life, bringing additional economic and social effect, use of collective forms of the organization of work and democratization of management.

The great value for use of labor potential has an establishment of norms of time for performance of work. Normalization of work not only provides economy of expenses of work as component of industrial costs, but also promotes higher level of production management. On the basis of norms of expenses of work planning, the organization of manufacture and management are under construction, the motivation of work, function of the account of expenses of alive work, the control over loading of the personnel are provided.

Normalization of work plays the important role in development of stimulation of the worker on achievement of those or other quantitative or qualitative results. Excess of norm is the basis for payment of the premium for the premium represents additional payment for additional work.

In formation of motivation of workers, increase of his self-feedback in industrial activity the special place is allocated to social policy of the enterprise. At the enterprise privileges and guarantees are realized within the framework of social protection of workers (social insurance on an old age, on a case of illness, in case of unemployment), established on a higher level. Besides the enterprises give the workers and members of their families side benefits due to the means allocated on these purpose earned by collective of the enterprise.

Social policy of the enterprise as a component of management represents the purposes and the actions, to the workers of side benefits connected to granting, services and payments of social character.

Socially focused personnel selection of the enterprise and the social services connected to it should promote, that:

- The worker identified itself with the enterprise;
- Desires of workers corresponded to the purposes of the enterprise;
- Labor productivity and readiness of workers for work grew;
- Workers have been socially protected, given in the lawful order or under the tariff agreement social services were if necessary supplemented;
- Own initiative of the worker was encouraged at the decision of his problems;
- The atmosphere at the enterprise improved, the favorable social - psychological climate was formed;
- At workers, and at the public positive representation about the enterprise was created.

#### 4. SUMMATION

The integrated list of payments, privileges and the services of social character given in various forms is offered:

## a) Monetary:

- Payments of the enterprise on purchase of the property and property (for example, purchase of actions of the enterprise for a reduced price);
- Paid clearing of work (at the introduction into a marriage, heavy illness of members of family, death of parents);
- Additional holiday money;
- Indemnification of the short working day of elderly workers;
- Grants and grants on the invalidity, paid by hospital cash department;
- The monetary compensation given in connection with personal celebrations or holidays, Christmas compensation (sums of money or gifts);
- Granting in using the service automobile;
- Payment of crossing while translating the worker in other structural division.

## b) In the form of maintenance of the worker in an old age (in addition to the state pension and private insurances of the worker):

- An additional provision of pensions within the framework of the enterprise;
- Lump sum compensation of pensioners on the part of the enterprise.

## c) In the form of using social establishments of the enterprise:

- Privileges in using dining rooms;
- The lowered rent in service habitation;
- The loan under construction of habitation under especially low interests;
- Using rest houses, sanatoria;
- Granting on favorable terms places in children's preschool establishments.

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## **MANAGING VIRTUAL TEAMS: THE THREE DIMENSIONS SCOPE**

Due to globalisation and economic reasons the number of people working as a team in a virtual environment is increasing. Although virtual team can outperform teams working in a traditional environment still many managers face difficulties in achieving this goal. This article describes the idea of a system that would support knowledge management in virtual teams focusing on three dimensions of virtual work: location, organisation, time.

### **1. INTRODUCTION**

#### **1.1. BACKGROUND**

The speed of evolution and access to the information and communication technology (ICT) has changed the way majority of people work worldwide. Also the pace in which communication media that have been introduced successively one after another are being popularized is becoming faster with every new media. It took 75 years for the telephone to reach 50 million users worldwide. For radio, television and personal computer it was respectively 38, 17 and 11 years. Yet it took only 3 years for the Internet to achieve the same goal (see figure 1)[1],[2].

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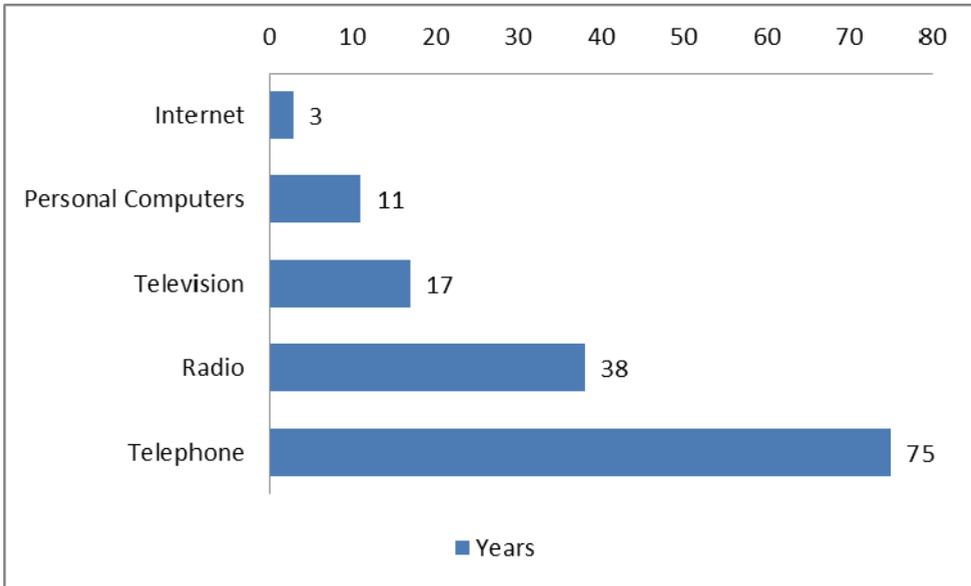


Fig. 1. Time needed to reach 50 million (US) users of each medium

With such fast evolution and wide access to the communication technology, the number of people managing their work remotely has dramatically increased [1].

## 1.2. VIRTUAL TEAMS

The use of ICT (in particular Internet) combined with distributed workforce gives a chance for creation virtual organisations, which may profit on advantages of different locations, time zones, culture and knowledge. The other advantage may be the possibility of virtualization in an *ad hoc* manner [3]. There is a number of forms of virtual organisation, where the most effective of them are:

*“singularly focused on creating, nurturing, and deploying key intellectual and knowledge assets while sourcing tangible, physical assets in a complex network relationships”*[4].

It is also more popular for the regular organisations to build virtual teams. Virtual team “is a team brought together with no consideration for physical location”. This type of virtual work may apply to long-lasting as well as short-term based teams [5]. This means that some team members do not meet in person on a daily basis. Very often they might be internationally placed. The term virtual team also presented as distributed virtual workforce has been recognized as a solution that gives a great potential of flexibility, responsiveness, and diversity of perspectives comparing to regular teams [6]. This term is used for groups where independent members cooperate with

each other using computer-mediated communication (CMC), as defined by Walther and Bunz [7].

In this paper we would like to focus on virtual teams, no matter of the organisation they are part of.

### 1.3. DISPERSION IN VIRTUAL TEAMS

In other words virtual team may be called a dispersed team. We can see dispersion in the scope of a degree and the scope of a kind.

Degree of dispersion can vary from low to high and would mean how much the team is dispersed. For instance low dispersion may describe a team where for every ten team members only one works in a different location. High dispersion would describe the team where every team member works in a different location. Examples above however show extreme situations and are not that often observed. More common are teams where the structure of the team can be divided into smaller groups where that groups are dispersed into few locations and often time zones while working on the same project.

Apart from the degree, the kind of dispersion is also important. There are few dimensions that should be taken into account. Spatial separation where team members may be located in different offices around the globe. Research show that even a small degree of spatial separation like working on different floors of the same building may affect the quality of collaboration [8]. Next is temporal separation when team members work in different time zones or on different shifts.

Teams also may have uneven configuration where majority of the team work at one location, while only small groups work somewhere else. And finally there is cultural diversity. The later aspect of diversity will not be a part of our research. However we strongly suggest that the person who is responsible for the team should have aspect of culture diversity in mind.

In general most teams are dispersed on some level and it has an influence on the team's efficiency [9].

### 1.4. DIMENSIONS OF VIRTUAL TEAMS

A different definition by Ware (2003) also uses the term distributed workforce and presents virtual team as a superposition of three dimensions [10]. This approach is based on the Johanson's (1991) framework for categorizing information that has it base on two dimensions: time and space (see figure 2).

Ware (2005) in his definition to the already mentioned dimensions adds another one which is organization. Altogether forms three conditions that need to be fulfilled in order to speak about distributed workforce. These three conditions are: individual

workers are in different physical locations (space); most of the communication is performed in an asynchronous way; individual workers are not employed by the same organization, or are working within distinctively different parts of the same organization. Figure 3 shows all three required dimensions.

<b>Time</b>	Same	Conference rooms, flip charts, white boards.	Audio, Video and web conferencing
	Different	Flip charts, Post-It notes, etc.	email, blogs, wiki's, social networking, collaborative workspaces
		Same	Different

**Place**

Fig. 2. Communication across time and place

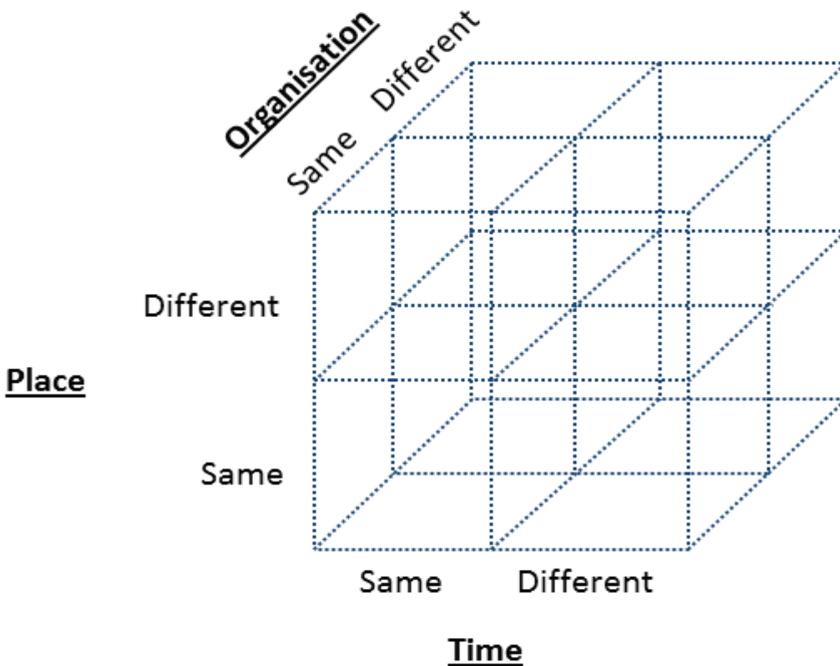


Fig. 3. Dimensions of a distributed workforce [10]

Any team member can be located in the space defined by these three dimensions. The distance between members may vary. The scales of any of these dimensions can be different. It is relatively easy to define the overlapping time scope of two persons working in the same team. But on the other hand it may be more difficult to define organisational adherence when tasks of two persons overlap. When we try to be more precise and mark the set of points in the Location-Organisation-Time space (LOT space) we will have a view of dispersion of the team. Highly dispersed teams often encounter problems in communication and are more difficult to coordinate. The level and kind of dispersion just defines a team and is not a problem as such. Dispersed teams may very well outperform collocated ones [9]. But LOT space can be used by the manager as a tool to create the best setup of team members by choosing the best possible values of each of the given dimensions for certain team members. Doing so gives increased opportunities for interaction between two or more parties. This in opinion of authors is one of the factors responsible for sharing the knowledge.

## 2. IDEA OF A MODEL

Sometimes managers do not realise how knowledge is distributed among team members. This is mostly due to big dispersion of a managed team. Uneven distribution of knowledge may be a potential risk in case when such a cluster of knowledge, in particular single team member for some reason leave the team. Authors suggest a model that would support manager of a virtual group to track knowledge concentration in a team and suggest when an action should be taken.

This model consists of two main modules that will generate data which when combined will be the base to the final decision.

### 2.1. LOT SPACE

Previously described LOT space can easily reflect current working structure of a virtual team in terms of dispersion. And the dispersion of a team has an impact to the number of interactions between team members. The level of interactions is crucial especially at the beginning stage of a project when team members are not yet well aligned to their new roles and responsibilities as well as roles and responsibilities of their colleagues.

After describing every team member by using location, organisation and time dimensions it is then possible to allocate all team members within LOT space. See figure 4 for an example of allocating team members.

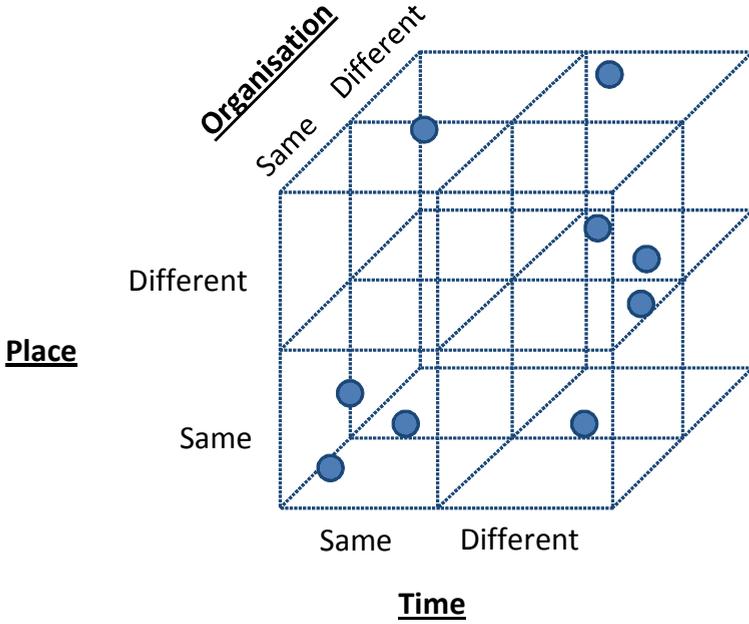


Fig. 4. Dimensions of a distributed workforce

Then a distance between every member can be calculated easily and team’s structure reflecting distances between every team member can be shown in two dimensional space. See figure 5 for an example of a team that has been allocated in two dimensional space. Dashed line shows the distance between two team members.

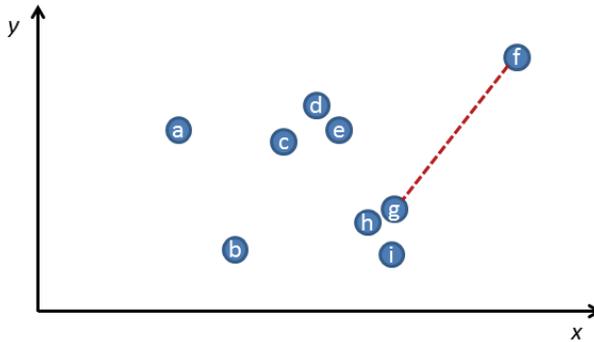


Fig. 5. Distance between team members in two dimensional space

The two dimensional space presented in figure 5 presents only the distance between any team members presented as dots with letters from *a* to *i*. This data is something that a manager can have an impact on. By changing the value of any of these dimensions, manager can change the overall distance between particular team members. What in fact can have an impact on communication and overall interaction between team members and can increase the level of knowledge flow.

In the example shown in figure 5, member *f* is relatively far away from any of the other. This might be because that member works in a different country, where the time zone is different and/or the scope of his/her work is much more different than the others' even though they all are participants of the same team working on the same project. In this case the flow of the knowledge may be disrupted because of the big distance.

What also can be noticed in the example above is that some team members are relatively close to each other and form a sort of small sub-groups. This might be because they share the same office space, are sitting one next to each other, share the same work hours, the scope of their work is similar or all above. It is more likely for these sub-groups to share the knowledge as they have an opportunity of live person-to-person interaction.

All above still only show dispersion of a team in terms of distance between team members. As this may suggest some levels of interaction does not actually reveal them to the manager.

## 2.2. INTERACTION STATISTICS

As it was mentioned before one of the factors that lead to creation of virtual teams was the fact of an overall evolution and wide access to ICT technologies. Today many workers cannot imagine work without using any of these communication technologies including telephone, e-mail or internet communicators. So do members of virtual teams. Today it is easier than ever to use mentioned media for communicating with other people in situations when face to face communication is not possible.

Many organisations use systems that integrate many of communication tools e.g. e-mail or internet communicators. Thanks to that it is easier to track the statistics of interaction between people using these tools. These basic statistics can be useful in generating information about how people among the team communicate with each other.

Taking into consideration three main communication media: e-mail, telephone, and internet communicator administrators of the systems are able to gather the following information:

- Number of interactions,
- Sender,
- Recipient or recipients,
- Chain or route of a message,
- Lapse of time.

Any contents of any type of communications is not expected to be processed or gathered. Only data mentioned above will be relevant.

Based on this data, especially on the number of interactions and on the information who initiate the interaction we would be able to suggest valuable people or groups of people in our team in terms of knowledge. In that case people who initiate a conversation would be seen as ones that potentially seek help of their recipients. In other words it may suggest that recipient(s) have information that sender is missing.

Interaction data could be added to the previous two dimensional distance chart (see figure 5). As a result we get a two dimensional chart with information about distance and the level of interactions. It may be presented as a network, where dots represent team members and may be called nodes. The size of the single node would represent the level of knowledge in that node. The lines between them may be called branches and would carry information about the distance. Also there might be additional lines between nodes that may represent the level of interaction as well as the direction. Information coded in this way would be very easy to interpret for managers. Consider figure 6 as an example.

In this case it is visible that nodes *g*, *h*, *i* form a sub-group with the high level of knowledge. This suggests that they are probably the core of a team. Also it is visible that node *a* is of a significant value and also may be crucial for this team, that is why manager should pay more attention to encourage more interaction between this node and others in order to increase knowledge flow and decrease its value. This could be made by managing the dispersion of the team discussed earlier (e.g. decrease the distance between this member and some other members). On the other hand node *f* may also draw attention of a manager. This can be a person who is working in the opposite of the rest of the team in different hours what is required for the project. In this case manager will know that this person may not cumulate knowledge but is still crucial in the project. In this case the manager can monitor the situation and take relevant action in time.

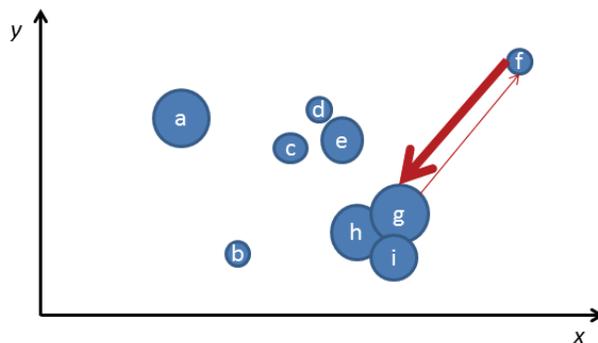


Fig. 6. Interaction chart

However this data must be supported with the clear understanding of processes within the team. As an example we can give a team leader to whom every team member sends a report on a daily basis. Based on gathered data this would be seen as the team leader has the biggest resources of knowledge. As it might be true it is responsibility of the manager to understand the processes and structure in the team and only on this basis take an action [11].

### 3. SUMMARY

#### 3.1. CONCLUSIONS

Contemporary workforce is very often spread among the organisation in terms of time, space and roles (scope of work). It is very hard task for a manager of such dispersed team to be able to follow all possible interactions and monitor the distribution of knowledge. That is why some tools that would support managers in monitoring the state of a virtual team are needed.

Proposed model is aimed to work only as an additional source of information for a manager and would not make any decisions instead of a person. This is due to the complex aspects of many projects that often involve many people where relations between them change constantly thus are very difficult to describe if not impossible. However if successful this model might be a base for more complex solutions that would support managers' decisions.

The general idea of proposed solution is to gather data about dispersion of the team and statistics of interactions between team members. Based on this data the system should be able to build a visual model of the team (compare with figure 6) suggesting distribution of knowledge.

As for now information generated by the system would be of the best value only if combined with the knowledge about processes run in the project.

#### 3.2. FURTHER WORK

It is not yet clear what types of mathematical calculations to use when analysing the data about the distance and interaction statistics. There has been some suggestions however that using fuzzy logics should be appropriate and sufficient for this type of the model.

The next steps would be further design of the model in the areas of gathering and analysing the data for output.

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## **THE ASSESMENT OF INVESTMENT RISK MANAGEMENT IN KNOWLEDGE TRANSFER PROCESS – A LITERATURE REVIEW**

This work presents the need to monitor the risk during the process of knowledge transfer. The authors discuss the concept of knowledge transfer, risk assessment and its classification, show what negative consequences of crossing the main parameters of the project are. The paper attempts to identify suitable risk assessment methodology to define the risk during technology transfer.

All processes managed by a human being are connected with risk. To find a relevant definition of that phenomenon we need to specify what kind of process we are thinking about. This paper is about risk in technology transfer– a process where university meets industry. To find a method of risk assessment in this case we need to define what risk is, how we can measure it and what its place in technology transfer is.

### 1. RISK DEFINITIONS

A word “risk” is used every day. When we look at its etymology, we can find different meanings, for example a Latin verb *riscare* expresses avoiding something, in Spanish language, as well as in French, *ar-risco* expresses courage and danger. The most popular is Italian translation, where risk is danger that threatens sea vessels at seas and oceans[5]. Risk can give two types of results: financial and material. According to Business Dictionary risk in finance is the probability that an actual return on investment will be lower than expected [13].

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What is important – we need to distinguish between two terms – risk and uncertainty. F. Knight assumed that uncertainty is a much broader concept than risk. In the situation of uncertainty it is possible to identify the source of potential failure, but it is not possible to determine the likelihood of its fulfillment whereas risk is uncertainty that can be characterized by numbers. Risk is a part of the future, and each move made at specific time creates a new reality. That is why we want to analyze the investment risk. Whatever we do, even if we try to protect ourselves from it, we are exposed to random factors.

When we want to define risk, we should start with identifying a sector. There will be different risks for financiers, firefighters or doctors. For the first group it will be connected with profits from investments, second – a possibility of fire. Doctors see possibilities of different disease or death [11]. This paper is about the investment risk in the process of technology transfer.

As it has been already told – everything is risky - including investments. Whether it is a company or an individual investor, they are not completely sure of the size and duration of future cash flows associated with their decisions. They can get great profits or horrible loss. But does it mean that we should give up on investments? No – we should specify our own level of risk tolerance in terms of investment in order to avoid unpleasant surprises.

There is one basic rule in investing: the higher expected rate of return on investment, the greater the risk of loss. Investments of high risk may indeed lead to significant losses but, on the other hand, they can be a source of extraordinary profits. We are choosing a risky investment, only if we are satisfied with the risk premium. In the process of investment, we specify the expected rate of return on investment and create portfolio in such a way that the risk premium meets our individual requirements [5, 6, 12]. In deciding how much to invest in a risky asset, individuals weigh up the costs and benefits referring to their preferences [1]. Some may say that there is no risk in bank savings. It is not true and this was proved in 2008 when the crisis reached the investment stage. Here we should consider methods of the risk assessment [10].

## 2. RISK ASSESSMENT

Investment efficiency in general is measured by the rate of return, risk and time horizon. Different investors have their own preferences about the scenario of an investment project. An aspiration to limitation of the investment risk is connected with minimization of loss or maximization of income. The basis for an optimal investment decision is the assessment of the profit rate relative to the investment risk. Professional risk management of investment projects requires a proper qualitative and quantitative

risk assessment. The qualitative method can be identified with risk assessment prepared by specialized institutions and it assigns risk classes to individual investment projects.. Usually the qualitative method is used to describe political and economic risk in micro scale. In quantitative method it is necessary to determine its metrics, e.g. certainty equivalent rate or variance of profit rates [8].

There are a lot of methods of risk assessment and its classification. Accurate distribution seems to be classification in view of risk treatment in the decision making process (Table 1).

Table 1. Treatment of risk in decision making process

Indirect methods based on the risk	Direct methods based on the risk
sensitivity analysis scenario analysis statistical analysis (probabilistic methods) simulation analysis	risk discount rate certainty equivalent limit payback

Source: [6]

Direct methods treat risk directly in decision criteria related to a specific method of cost evaluation, so they allow to take an investment decision including the investment risk. Indirect methods allow to obtain additional information about investment risk and they reduce uncertainty.

### 2.1. INDIRECT METHODS BASED ON THE RISK

A sensitivity analysis (*if what analysis*) test verifies changes in the research results generated by the model, which have occurred after the adoption of a different level of variables than original assumed.. The effect is the identification of variables, where deviation at the same percent level causes the greatest change in model results and identification of those variables at which the phenomenon is sensitive. When we analyze investment projects the sensitivity analysis consists of study of changes, which can appear in project realization and the exploitation of investment in the formation of the level of the main project variables on value of indicators like Net Present Value–NPV (1) or Internal Rate of Return-IRR [6].

$$(1) \quad NPV = I + PV = I + \sum_{t=1}^n \frac{NCF_t}{(1+r)^t}$$

where:

- $I$  – initial, one-time investment expenditure (usually it is negative),
- $PV$  – Present Value of the investment,
- $NCF_t$  – Net cash flow in year  $t$ ,
- $r$  – cost of the capital in year  $t$  (the serial number from 1 to  $n$ ),

$n$  – number of years of the investment project,  
IRR it is the rate of return, in which NPV is non-zero.

When we use the sensitivity analysis in the risk analysis we need to remember that different level of tested input variables cannot be random and arbitrary and that influence of one or few variables on effectiveness of investment is determined by the use of *a priori* criteria of effectiveness.

The advantage of the sensitivity analysis is identification of variables, which are the most important for the success of the investment project. It is also a method that is showing which variables indicate that we should reject the project. Rules and mechanisms of this method do not include a possibility of changes probability and indicators of probability of creating particular NPV. That leads to a conclusion that this method is used to recognize the risk in a basic point and the trail of its reduction. That makes sensitivity analysis only a source of information about the risk for the rest, more complicated methods of the risk assessment in account of investment efficiency [8].

A scenario analysis, just like the sensitivity analysis, is often used in different areas of life. In general, this analysis it is a process, where different scenarios that are logically connected to the future conditions are created and analyzed. Next, alternative strategies suitable for the previously established scenarios are created. A scenario is a vision of the future in the form of a sequence of events. The purpose of this analysis is discovering the future and showing probable future situations, threats, or possibilities for the subject.

Planning of scenarios is a quality approach to the process of decision making used in situations when basic variables are not easy to measure. In practice there are 3 to 5 scenarios and it is simplification of reality. Building scenarios includes:

- identification of development factors in the environment,
- selection of significant factors and its groups,
- analysis of important factors to draw up scenarios,
- determining the directions in which the environment can develop in accordance with a further scenario.

In case of investment projects, the scenario analysis used to develop a financial assessment of the project is usually creating forecasts for variables of the project recognized as the most important according to designed scenarios of the future. It gives an opportunity to evaluate financial profits from the project according to the value of variables resulting from a different scenario. A universal form is to create three scenarios: optimistic, basic (the most possible) and pessimistic. The obtained results (submitted by NPV) are the basis for analyses, which should simplify decision making process.

The advantage of the scenario analysis is that it enables identifying long-term types of risk and uncertainty connected with the project. Moreover, it gives project managers a better choice and supports collaboration inside the team. What make it better than the sensitivity analysis is that it includes changes of more project parameters. In prac-

tice the effects of this method can be limited because of using the same assumptions about changes in one-way for parameters of the project. That leads to underselling effect in pessimistic scenarios and overstatement in an optimistic case [6].

A statistical analysis (probabilistic methods) is connected with the bill of determining expected values and the statistical measure of the risk. The assumption is that there is a probability distribution of variables shaping the efficiency of the investment income at the expected level. Main tools in this method are: normal distribution probability variables of occurrence of certain values and their variance, standard deviation and coefficients of variation, covariance, etc. Basic rules for using probabilistic methods in the risk measurement are:

1. when cash balances in time of realization of a project are random variables – then the criteria of economical effectiveness of this project is expected NPV (not discounted NPV),
2. streams of cash flow balances connected with the project can be dependent or independent:
  - a. if balances are independent – the variation net discounted value is determined only by the variance of balances in each period at a given discount rate, and so is their sum;
  - b. if balances are depended – the calculation of the variance of the NPV is necessary to accommodate the covariance balances in time[8].

These methods are used to analyze the risk of the implementation and operation of the investment. A popular tool used for the statistical analysis of probabilistic risk investment is a decision tree [11].

A decision tree analysis is an analytical tool that enables structuring decision problems by drawing all feasible alternative managerial actions, conditional on the current market and other factors that occur during the development of the problem. Based on all possible, included chronologically actions and the estimated consequences of the decisions it determines the best solution to the problem. A graphical image of the alternative action is reminiscent of the shape of the tree diagram. With regard to the specific investment projects it should apply in case of sequential projects. This method is suitable for large investments, in which decisions are made repeatedly and each decision is a result of the previous one.

Simulation methods are used whenever it is difficult to examine the actual objects or processes. It is a set of practices that allow to get the solution to various i.e. economic issues through repeated sampling. A method of simulation used in evaluation of investment projects is the repetition of the procedure for calculating a measure of effectiveness of the project (i.e. NPV) according to model, randomly generated values for uncertain variables affecting the value. This method is called Monte Carlo Method and it is a technique of a probable future investment event that is simulated with the use of a computer to obtain an estimate of interest income and the risk. The use of simulation methods for the risk assessment can examine the impact of multiple input

variables on the economic efficiency of the project. In this analysis uncertain variables are considered together, taking into account a relationship between them. It specifies connection between all the variables that can occur with more or less probability and determine all possible outcomes [8].

The essence of Monte Carlo method is a random draw for the characteristic quantities of the process, it applies distribution to simple or complex processes. The method consists of the following main parts: the formulation of stochastic models of real processes under investigation and modeling of random variables with a given probability distribution, to solve the problem in the theory of statistical estimation.

The principal advantage of simulation methods is the ability to simulate multiple tests of the same object or process, due to the presence of the same parameters. A major drawback is the need to simulate a very good representation of reality often by means of mathematical models. This leads to a situation where the time of the research process is clearly disproportionate to the time of the preparation of the test bench [11].

## 2.2. DIRECT METHODS BASED ON THE RISK

A method of discount rate reflecting the risk is an ingested correction in the calculation of the discount rate in such a way as to reflect the risks of the project (Risk-Adjusted Discount Rate-RADR)(2)(3).

$$(2) \quad \text{RADR} = \text{Risk free rate} + \text{Risk premium}$$

$$(3) \quad \text{Risk premium} = (\text{Market rate of return} - \text{Risk free rate}) \times \text{beta of the project}$$

It is assumed that the projects in which cash flows are at greater risk and should be with higher discount rate than projects with lower risk. This rule is mainly used by investors in economic practice, which requires higher risk premium to be included in the discount rate for more risky projects.. Calculating the efficiency of the financial investment project using the NPV method, taking into account the risk of progressing, is similar to the conditions without any risk, and the only change is replacing the discount rate of risk-free interest taking into account the time value of money and the risks of the project[6].

A certainty equivalent method ( $NPV_{ep}$ ) for the risk adjustment is an alternative to RADR. The risk is included not in the discount rate, but in the net cash flow of the project. This method adjusts the level of the estimated project's cash flow stream, so the stream is adjusted to be regarded as a target stream.. Adjustments are made by multiplying the estimated cash flow (of the risk) by a common factor  $alpha$  and the equivalent result is treated as a cash flow risk-free (4).

$$(4) \quad NPV_{ep} = \sum_{t=0}^n \frac{\alpha_t E(CF_t)}{(1+r)^t}$$

$E(CF_t)$  – expected cash flow in period  $t$

$\alpha_t$  – certainty equivalent factor for converting the expected risky cash flow  $CF_t$  its equivalent considered as certain.

Limit payback – it is assumed that risk is a function of time. This means that, if a tested investment project is considered to be more adventurous, it should have a shorter recovery period, even if the NPV is positive or the IRR is greater than the required rate of return[6].

A new method of validation risk models shown by Colletaz, Hurlin and Pérignon is the Risk Map. The advantage of this map is that it is simple to use as a standard validation technique. It is a formal hypothesis testing framework and it can be used to validate market, credit, operational, or systemic risk estimates [2].

### 3. A KNOWLEDGE TRANSFER PROCESS

The transfer of knowledge from universities to business occurs in various ways: by teaching undergraduate and graduate students, research and development as well as commercialization of the results of research carried out at universities.

Knowledge transfer is the process of sharing knowledge and its dissemination. It is important in high-tech organizations as well as organizations that only want to enter the path of rapid growth. In the second case it is a key for better management of existing knowledge. It often happens that in spite of its potential (through a country, company) knowledge is imported from the outside. Sometimes it is enough to exploit its potential by increasing affluence of society to focus on the creation of new knowledge within the framework of science and technology. Nevertheless, care must be taken of the economic stage that is available.

Sharing knowledge brings many benefits. These are, among others: faster implementation of projects, better quality of service, innovation (testing new ideas), cost reduction and the introduction of new participants to the network for the exchange of knowledge. The weight of knowledge transfer depends to a large extent on the size of the organization.

A. Gupta pointed out five factors influencing the transfer of knowledge, and thus influencing its management :

1. the perception of the reputation of the source of knowledge - willingness to use the knowledge of the person who has the reputation of “an expert”;
2. inclination of the holder of knowledge to share it - egoism and individualism are usually reasons for concealing knowledge;
3. availability and quality of the transmission channel (communication of knowledge);

4. motivating the recipient of knowledge to its adoption - curiosity is a trait common among people, a lot of people just do not feel the need for learning and self-improvement;

5. the absorption capacity of the recipient - sometimes the problem is that employees do not have the basic skills, cannot read and understand, have narrow horizons, poor vocabulary, etc. Then, even the most interesting training will not be effective [3].

Knowledge transfer is a process where research results are implemented and reach the end user in the form of a new product. For various reasons, this process can be tedious and lengthy. The implementation of a new scientific idea and its implementation in practice of the market in the form of a new technology or product is usually associated with high costs and other factors that hamper it.

The transfer of knowledge and technology from scientific institutions to the business usually takes place through e.g.:

- joint research projects and targets implemented in cooperation with enterprises;
- research contracts and orders, carried out on behalf of businesses;
- power technology market new patent applications, know-how;
- scholarly and popular publications, patents;
- Programs of staff mobility (mobility, moving employees from science to business and vice versa), student internships;
- sharing licenses for different forms of intellectual property and know-how [7].

When we think about knowledge transfer technology transfer comes to the fore. Nowadays it is recognized that technology is intrinsic to development. Technology can be created, but also it can be borrowed. Diffusion of technology between organizations or countries plays a very important role in satisfaction of needs. The best environment for this kind of exchange are multinational companies, but it can also take place in various places [9].

Business units manage their knowledge and technology to develop their economical environment. But it is not easy to value knowledge or technology, but they can be traded and their price is very flexible. Nowadays, there is knowledge sharing culture. Knowledge transfer on the knowledge market is improved by the power of the market, and the main agents on this market, can activate transfer mechanism [4].

### 3.1 THE RISK IN TECHNOLOGY TRANSFER

So far we have considered a concept of risk, risk assessment and knowledge transfer. Now, it is time to say where sources of risk are in knowledge transfer process. In reality every process is risky. Managing risk in the project is determined by a lot of factors, but at first stage we need to establish sources of it.

Risk can appear in many places in knowledge transfer. To understand what kind of risk we are interested in, let us look at the picture below.

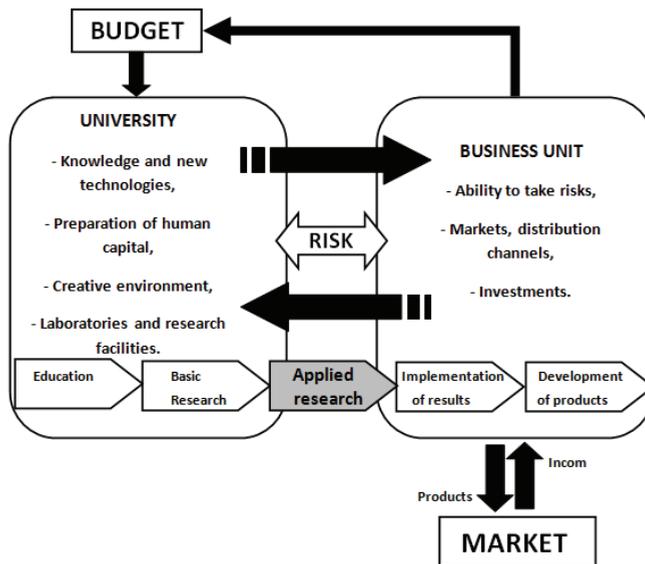


Fig. 1. Technology transfer between university and business unit

Source: own work based on Santarek K. (ed.), *Transfer technologii z uczelni do biznesu; Tworzenie mechanizmów transferu technologii*, PARP Seria Innowacje, Warszawa IX 2008

Both university and business units play specific roles in socio-economic processes. Universities are birthplaces of resources like knowledge and new technologies or human capital. They work in creative environment using highly developed laboratories. The principal activity of a university is education and research - basic and applied. One of the sources of its income is budget.

The aim of a business unit is making profits. This kind of units are able to invest and take risk. They operate on the market and have their share in distribution channels. Their main assumption is doing applied research and, after that, implementation of results and development of a product. In many situations universities and business units have to do applied research and that is a place where they should and they meet. When universities and business units work together they take risk. The field of cooperation is exchange of sources, especially informational. Companies are sources of financial projects, and universities are suppliers of know-how and technological solutions. In that place - where universities meet business - risk appears. There are three criteria of risk - costs, time and quality. Each side is afraid of different things - for example companies need to see effects of their work very quickly. Universities first of all want to be reliable, and secondly - to make the results publicly known - here, the anxiety is about delivery time. The second determinant is quality - for business it is important to have an unfailing product that will attract customers on the market. Universities want to develop their ideas, even if they are not sure whether they will have customers for an innovative product. Those two types of institutions want to

keep costs low, but it is hard to say if the specific project will meet the demands of the market and if its cost, quality or price will be appropriate. The process of the risk assessment in this situation gives a lot of questions about methodological approach. When we need to analyze a specific problem we need to create a specific tool taking all variables into account.

#### 4. CONCLUSIONS AND FUTURE WORK

Knowledge transfer is a new field of studies. This process is complicated and not easy to measure. There are not two identical projects of knowledge transfer, and study based on older experiences is almost impossible. There are a lot of methods for the risk assessment in investment, but they are not adapted to investment in knowledge transfer, where more than two institutions participate. We cannot forget about environment and government. Market demand create orders and companies with the help of universities can satisfy them. The main question is ‘how to assess the risk?’, and here the methods of the risk assessment may be applied only after specific modifications.

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## **INFORMATION AND COMPUTER TOOLS IN SUPPLY CHAIN MANAGEMENT**

In changing market environment getting the right product to the right place at the right time is a source of customer satisfaction and in consequence a condition of market share and revenue growth. This work presents the significance of information in supply chain management. According to the results of Computer Sciences Corporation, the implementation of processes that conditioning the transparency of goods and information flow in supply chains is one of three key competences of undisputed market leaders in creating supply chains. Many different information and computer tools could be implemented in the enterprise to help the information flow management. This work discusses the results of two surveys conducted in Polish enterprises. The level of information and computer tools implementation in departments of logistics is quite high only in big enterprises and the smaller ones lag behind. In this work the mobile solutions for supply chains management are also presented. They can redefine interactions of enterprise with suppliers, customers, and business partners making possible the creation of adaptive supply chains with fulfilment velocity, inventory visibility, and supplier coordination versatility. The most common tool is smartphone but according to the experts, RFID solutions will soon gain significance.

### **1. INTRODUCTION**

The supply chain consists, according to Chopra and Meindl [2], of all the elements that are directly or indirectly involved in fulfilling customers' requests. Manufacturer and suppliers are of course the main part of the chain, but it also includes transporters, warehouses and retailers. Supply chain's performance is influenced by four elements and a change in one of them can significantly change supply chain's efficiency and responsiveness. The elements mentioned above are:

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- inventory – all raw materials, work in process, and finished goods within a supply chain,
- transportation – all ways of moving inventory from point to point within a supply chain. It includes different means and routes,
- facilities – places where inventory is stored, assembled or fabricated,
- information – data and their analysis concerning inventory, transportation, customers, etc. that are necessary for the correct functioning of supply chain.

The last constituent – information – has great meaning for the supply chain correct management. In present economic realities, information should be regarded as a strategic resource of the enterprise. Reliable, relevant, accurate and trustworthy information is an invaluable source of knowledge that is essential to carrying logistic tasks out [2].

## 2. SIGNIFICANCE OF INFORMATION IN SUPPLY CHAIN

According to the results of the eighth annual Global Survey of Supply Chain Progress conducted by Computer Sciences Corporation, the competence of supply chain influences the competitive advantage of the enterprise. The authors enumerate some issues that enterprises should pay attention, among other things they indicate [3]:

- the necessity of continuous collaboration development (in particular with main suppliers and customers) that leads to increase of the integration between elements of supply chain,
- modern processes and systems concerning information and computer technologies that significantly influence the efficiency of goods and information flow.

Analysing the results of survey, the importance of faster and more effective supply chains' respond to the changes in customers' needs and preferences is emphasized. There are three key competences of enterprises that are the undisputed market leaders in creating supply chains: transparency of goods and information flow, analytic capabilities (implementation of advanced decision supporting and planning systems) and flexibility that helps to adjust the enterprise to the changes of the market demand [3]. In the case of goods and information flow transparency within the whole supply chain it is important not only to share detailed information with main suppliers and customers but also to send it in right time and in right form. Figure 1 presents the implementation range of ten processes that mostly influenced the transparency of goods and information flow [3].

The results of survey show that suppliers are more eager to share information in supply chain than customers. The possibility of customers' attitude change is feasible provided that computer tools like Sales and Operations Planning (S&OP) or Acquisition Planning Forecast (APF) are introduced [3].

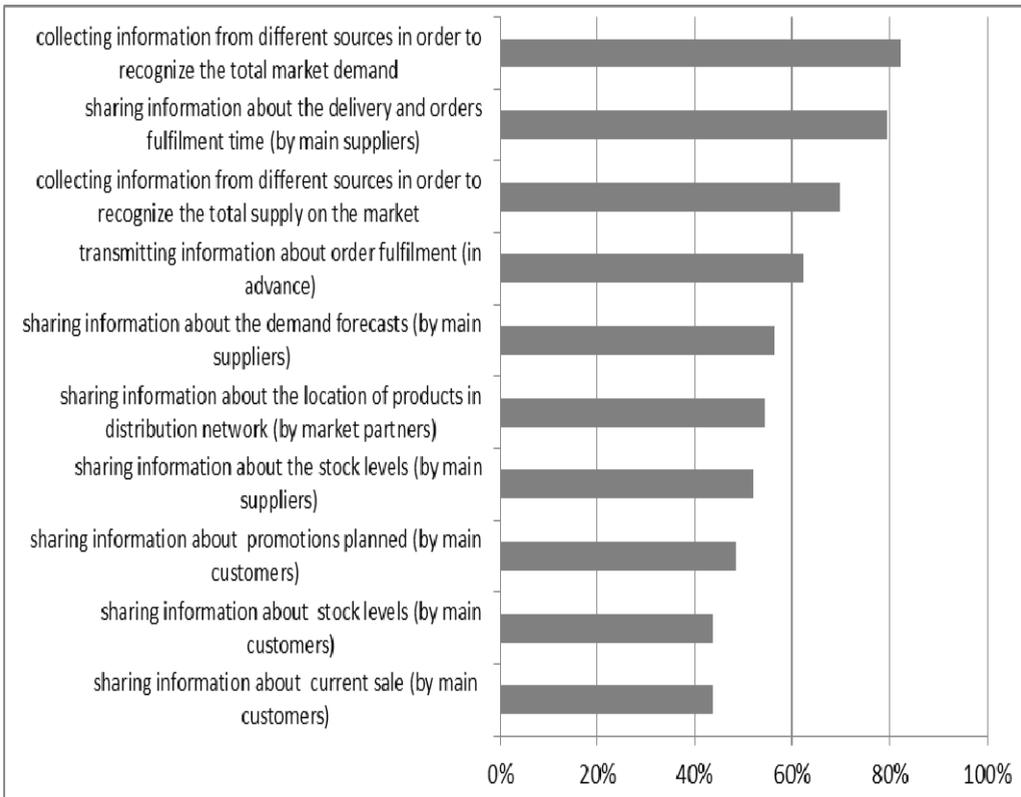


Fig. 1. Implementation of main processes that conditioning the transparency of goods and information flow in supply chains. Own study based on [3]

### 3. INFORMATION AND COMPUTER TOOLS IN LOGISTICS

Striving for higher efficiency in supply chain management, many enterprises use information and computer tools. Apart from well-known systems like MRP/MRP II or ERP systems, modern enterprises use also solutions listed below [1, 9]:

- LIS (Logistics Information Systems) – join elements from MRP and DRP (Distribution Requirements Planning) systems. They gather, collect and process data that are used in decision making process.

- SCM (Supply Chain Management) – they enable inspection of products flow. It is possible to analyze the movement of products between the suppliers.

- EDI (Electronic Data Interchange) – transferring data in standard format between computer systems. It is commonly used for sending orders to warehouses, tracking shipments and creating invoices. Data are interpreted by computer systems without human participation.

– RFID (Radio Frequency Identification) – a technology that uses radio waves to transfer data from an electronic tag or label attached to an object, through a reader for the purpose of identifying and tracking the object. RFID is coming into increasing use in industry as an alternative to the bar code. The advantage of RFID is that it does not require direct contact or line-of-sight scanning.

– Electronic catalogues – list of goods or services on sale with their description and prices published as an electronic document (e-catalog) on the website or on CD, DVD, etc.

#### 4. SITUATION IN POLISH ENTERPRISES

In this chapter the results of two surveys that addressed an issue of information and computer tools that support logistics departments in Polish enterprises are presented. First survey was conducted in 2011 and concerned generally speaking the supply chain management [5]. Most of the companies (45%) belonged to the production sector, 23% were commercial ones, 22% was from the service sector and building company made about 8%.

One part of the questionnaire concerned the instruments that support supply chains management because nowadays almost all logistic strategies require appropriate automation of logistic processes. In first question respondents were asked to point out maximum three tools from following list [5]:

- email,
- electronic catalogues,
- EDI (Electronic Data Interchange),
- GPS,
- RFID (Radio Frequency Identification),
- EPOS (Electronic Point of Sales).

In line with expectations, near all (98%) departments of logistics used electronic mailing (see figure 2). The electronic catalogues were also popular – they were applied in near half of analyzed enterprises (49%). Electronic Data Interchange was used by one fourth of enterprises. Considerably less companies used the others tools (GPS and RFID), probably because they requires more expensive equipment. This result could be also connected with a little number of transport companies taken into consideration in this research [5].

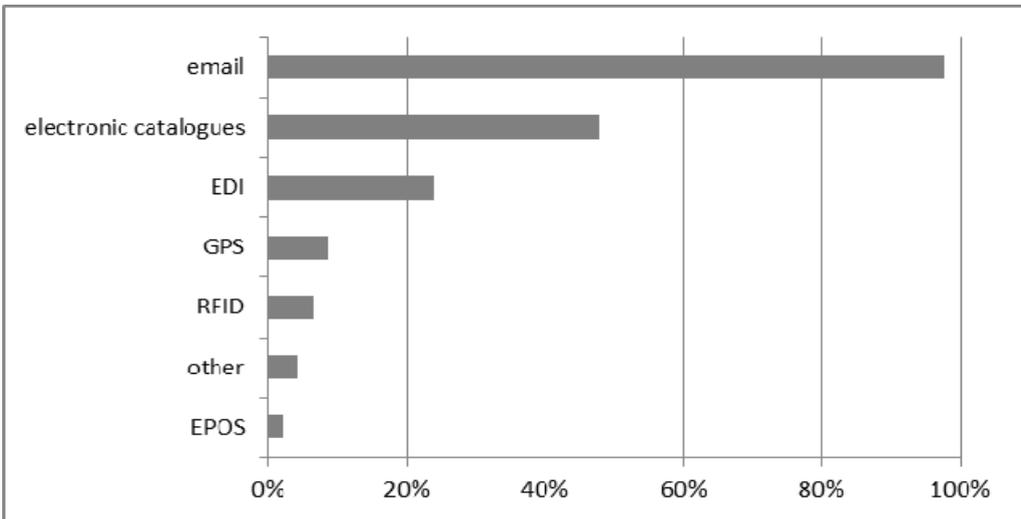


Fig. 2. Tools applied in departments of logistics in analysed companies [5]

Next question concerned the computer systems that were used in departments of logistics. The answers come as surprise because nearly 30% of companies admitted not to use any system. 61% of the investigated enterprises had MRP or MRP II systems, and ERP systems were considerably less common (21%) (see figure 3).

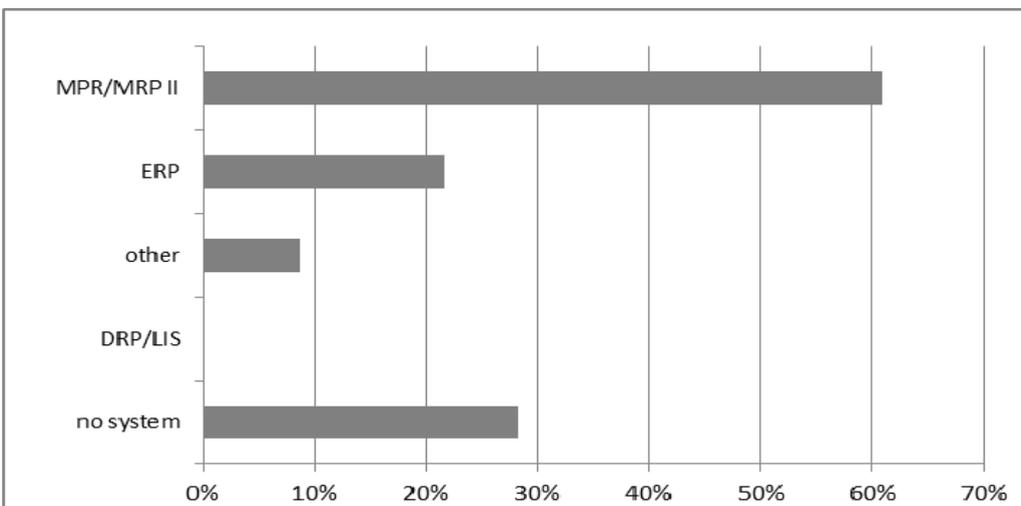


Fig. 3. Types of computer systems applied in departments of logistics in analysed companies [5]

The results described above may be regarded as not very optimistic but it should be taken into consideration that the survey mainly concerned big enterprises. The

situation in small and medium enterprises looks considerably worse. The next survey was conducted in 2010 in Polish small and medium enterprises from farm and food sector [10]. They concerned computer tools that support logistics and information flow. The enterprises were asked to enumerate areas of logistics that are supported by computer systems. As many as 28% of the respondents didn't answer this question – it was possible that they didn't have enough information or knowledge. The areas of orders management (38%), warehouse management (35%) and stock (32%) were mentioned the most frequently. The less computerised area was management of returnable packaging.

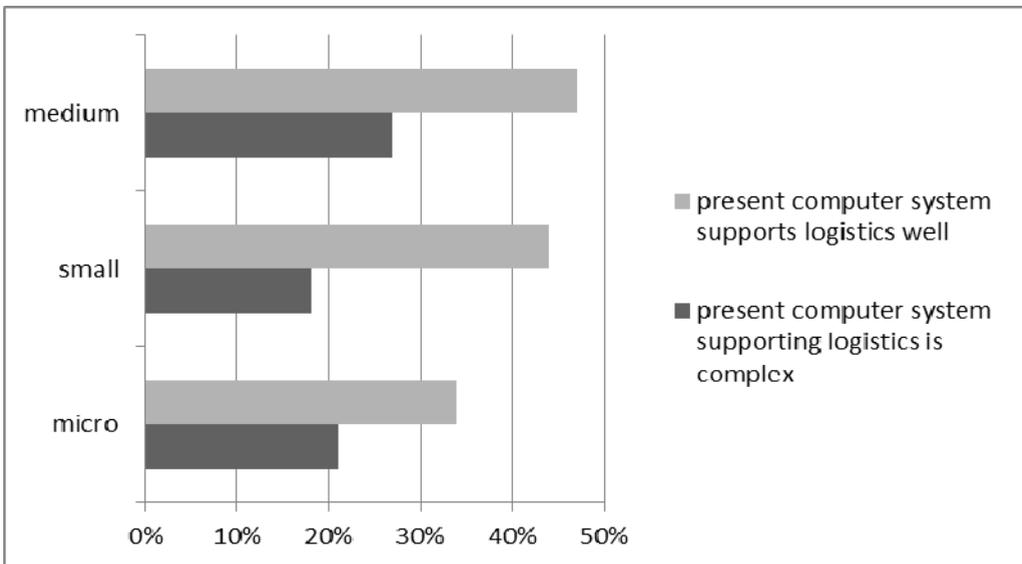


Fig. 4. Opinions about computer systems that support logistics in small and medium enterprises from farm and food sector.

Own study based on [10].

The results of the survey show that according to the opinion of 43% of the respondents present computer system supported logistics well. The most satisfied were medium and small enterprises (47% and 44% respectively) and 34% of micro enterprises shared this opinion (see figure 4). Logistics is mainly supported by many different systems – in total, only 20% of enterprises had complex system. As it is shown in Figure 4, 21% of micro enterprises, 18% of small and 27% of medium ones have complex computer system. More detailed questions however proved that real number of enterprises with complex system that supported logistics was lower because only 4% of respondents that confirmed ownership of such a system pointed at least four areas that were supported by such a system [10].

The next question concerned type of computer systems that were used to support logistics. Only 16% of respondents had MRP/MRP II system and 6% ERP one. Electronic Data Interchange systems were applied by 9% of enterprises. One of the questions concerned the information flow between the enterprise and its suppliers and its consumers. The most popular solutions were: phone (88%), fax (57%) and email (52%). Only 9% of respondents used computer system for exchanging information (this number was in accordance with the percentage of enterprises that used EDI solutions) [10].

The results of the second survey show that the level of information and computer tools implementation in small and medium enterprises in Poland is far from ideal. Because of the lack of data it is impossible to compare the results of SMEs from farm and food sector with those from other sectors. Taking into account the growing requirements concerning food quality improvement, products origin control and deliveries management, enterprises from this sector should strive for implementation of complex solutions that can give them opportunity of better tasks fulfilment. However they don't do it and the lack of knowledge about computer tools and their advantages may be the possible explanation (only 22% of respondents regarded that their knowledge about logistic tools is sufficient) [10].

## 5. MOBILE SOLUTIONS FOR SUPPLY CHAIN MANAGEMENT

Rapid development of mobile technology that is based on wireless communication between devices has been observed since several years. More and more often it finds application in supply chains management and a special term – Mobile Supply Chain Management (MSCM) has been coined [8].

In modern supply chains processing of data should be in accordance with 3V rule (Visibility, Velocity, Versatility). Inventory visibility means that it can be visible from each point of supply chain so it is possible to monitor its level within the chain. Velocity means possibility of demand fulfilment in short time. Finally, versatility is connected with coordination that is necessary in different conditions of collaboration with suppliers and customers. The 3V rule forms the three pillars of adaptive supply chains – the chains that can adjust to the changes in market environment, in ways of process execution and to the internal changes in supply chains that are caused by large scale of computer tools implementation (especially mobile ones) [8].

There are some factors that influenced big interest in mobile technologies [8]:

- necessity of internal business process integration (inside the enterprise),
- necessity of external business process integration (among many enterprises), what is difficult even for modern ERP systems,
- globalisation that is the reason of taking actions even in the places where traditional ways of communication are inaccessible,

- need of real time information operating and necessity of gathering and sending this information exactly from the place where process is performed,
- supporting new business processes,
- limitation of old systems use,
- costs reduction.

Mobile technologies are the suitable solution for adaptive supply chains. They enable tracking the flow of goods in each part of supply chain. It is an online action because each worker that is involved in this flow can confirm his activity using barcode reader or RFID reader. It particularly concerns production workers, warehousemen, drivers and couriers. In consequence, it is possible to prevent a situation of lack of goods and quickly respond to the problems. It is also possible to plan a distribution in a way that enables to fulfil the agreement concerning deliveries.

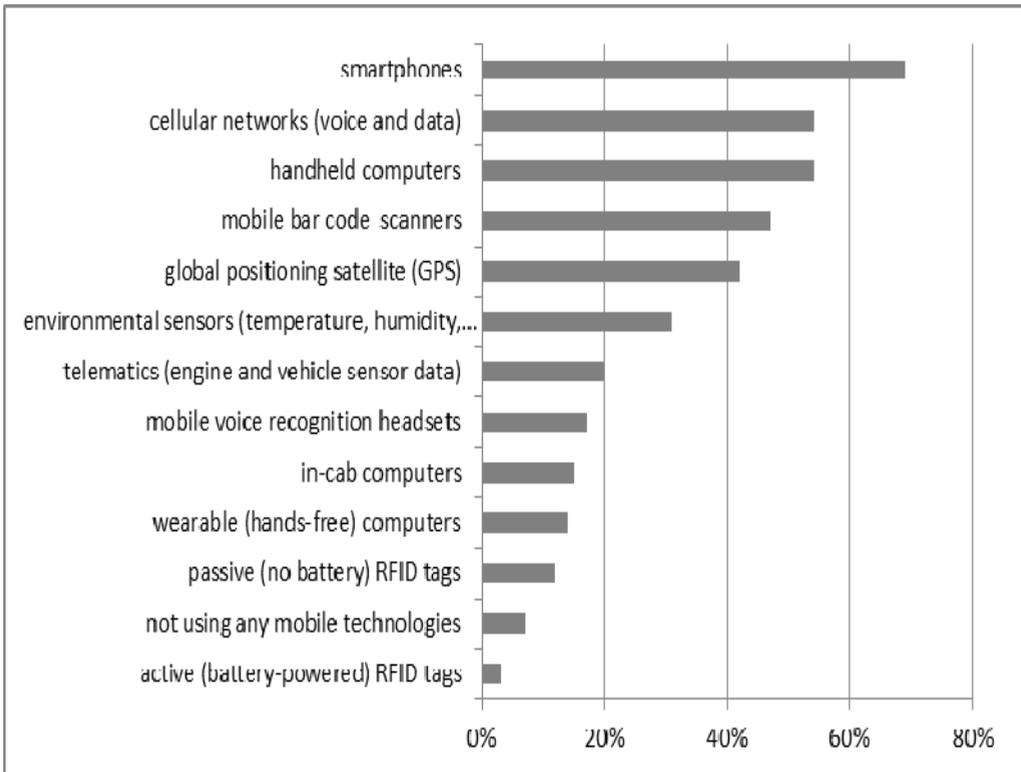


Fig. 5. Usage of mobile technologies in supply chain management [4]

Figure 5 presents the results of survey on mobile technologies usage in supply chain management conducted in 2010 by ARC Consulting Group. Only 7% of respondents didn't use mobile technology in supply chain management and the most popular solutions were smartphones. The mobile phones were used mainly for scanning barcodes, for taking products' pictures, for sending delivery receipts and for signature verification [8].

RFID technology is still not very common, but enterprises are planning to introduce it instead or as a complementary solution to barcodes. A significance of RFID solutions will probably increase because of integration of this technology with many dedicated computer systems [8].

According to the results of survey conducted in 2011 by MIS Poland [6] Polish enterprises appreciate the advantages of mobile technologies in logistics. They understand that the usage of mobile technologies is the formula for success in business optimization. However the main obstacle of popularization of these technologies is unfavourable economic situation of enterprises.

All the mobile solutions presented in figure 5 are accessible on Polish market. The most common solution in Polish enterprises are mobile bar code scanners (also because of their low costs). The solution that gain popularity and may become the standard are the mobile systems for car fleet management. They enable to localise a car and to monitor its route and way of driving [6, 7].

MIS Poland asked the representatives of the IT companies that offer applications and equipment for logistics about their customers' expectations. The answers were almost unanimous: enterprises care about the RFID solutions for products identification and about quick and easy integration of new mobile tools with their ERP systems [6, 7].

## 6. CONCLUSION

Getting the right product to the right place at the right time is today a source of customer satisfaction and in consequence the source of market share and revenue growth. Globalisation of enterprises cooperation means that processes like production, delivery, distribution need a greater amount of information to be completed correctly. Moreover it is necessary to process this information in shorter time. Supply chains have not only changed their dimension but also are forced to act in different circumstances – there is a growing demand of their flexibility, durability and short time of order fulfilment. That is why streamlining supply chains is a high priority for enterprises and information is regarded as the most important assets of enterprise because it enables taking quick and cost-effective actions. The results of Computer Sciences Corporation survey show that the implementation of main processes that

conditioning the transparency of goods and information flow in supply chains is advanced.

There are various information and computer tools that help to manage supply chains. The results of surveys conducted in Polish enterprises show that the situation is not bad in the case of big enterprises that often implementing integrated systems (MRP/MRP II or ERP). However small and medium enterprises should do a lot in this field because their level of information and computer tools implementation is low. It may be the result of relatively little knowledge of such tools capabilities.

Mobile solutions for supply chains management can redefine interactions of enterprise with suppliers, customers, and business partners. They make possible creation of adaptive supply chains with fulfilment velocity, inventory visibility, and supplier coordination versatility. A wide range of new supply chain mobility tools helps enterprises not only to track assets and shipments but also to execute transactions, processes, and to collaborate with partners. The most popular mobile tool is smartphone that finds many different application but probably RFID solution will gain significance in not too distant future.

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