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Ladies and Gentlemen,

Foundation of Management (FoM) journal was established at the Faculty of Management at Warsaw University of Technology in order to provide an international platform of thought and scientific concepts exchange in the field of managerial sciences.

This new publishing forum aims at the construction of synergic relations between the two parallel trends in managerial sciences: social and economical – originating from economic universities and academies and the engineering trend – originating in from factories and technical universities.

Three of the great representatives of the engineering trend in managerial sciences - American Frederic W. Taylor (1856-1915) – developer of high speed steel technology and the founder of the technical with physiological trend in scientific management, Frenchman Henri Fayol (1841-1925), the author of basics of management and the division and concentration of work as well as the Pole Karol Adamiecki (1866-1933) graduate of the Saint Petersburg Polytechnic University and the professor of Warsaw University of Technology, creator of the time-scale system elements scheduling theory and diagrammatic method as well as the basics of the division of work and specialization – have, on the break of the XIX and XX century, all created the universal foundations of the management sciences. Therefore the title of the Foundation of Management is the origin of the scientific and educational message of the journal that is aimed at young scientists and practitioners – graduates of technical and economic universities working in different parts of Europe and World.

The target of the establishers of the Foundation of Management journal is that it will gradually increase its influence over the subjects directly linked with the issues of manufacturing and servicing enterprises. Preferred topics concern mainly: organizational issues, informational and technological innovations, production development, financial, economical and quality issues, safety, knowledge and working environment – both in the internal understanding of the enterprise as well as its business environment.

Dear Readers, Authors and Friends of the Foundation of Management – our wish is the interdisciplinary perception and interpretation of economic phenomena that accompany the managers and enterprises in their daily work, in order to make them more efficient, safe and economic for suppliers and receivers of the products and services in the global world of technological innovation, domination of knowledge, changes of the value of money and constant market game between demand and supply, future and past.

We would like for the Foundation of Management to promote innovative scientific thought in the classical approach towards economic and engineering vision of the managerial sciences.

The Guardian of the journal's mission is its Programme Committee, which participants of which will adapt to current trends and as an answer to the changing economic and social challenges in the integrating Europe and World.

Tadeusz Krupa

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OPTIMIZATION OF WORKPLACE DESIGN FOR PEOPLE WITH ALTERNATIVE ABILITIES

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Abstract: An employer who wants to employ a person with alternative disturbances faces a difficult problem of selecting a workstation and tasks suitable to a given person's disease since even the same case of disease does not guarantee identical organizational solutions of a workstation. However the more complex the movement disfunction, the more difficult the task is. At the same time it is important that work results of a workstation allow achieving complex productivity. The article presents an attempt at elaborating a method aided by a computer system which allows introducing changes or modifications of workstation space, place equipment and facilities or installing additional elements enabling effective and productive work performance by a person with precisely defined abilities. Presented results of piloting researches have proven that the elaborated method of aiding decisions while adapting workstations to needs and abilities of people with movement disfunction will bring social and economic benefits.

Key words: abilities of disabled people, workstation design, computer support, workstation requirements.

1 Introduction

According to the regulations currently in force, each enterprise must be prepared to employ people with alternative abilities with different types of disabilities. Fulfilling this criterion requires the introduction of so-called "integration solutions" in all areas of the company's working environment (technical, economic and social areas).

They consist of:

- adapting buildings and rooms to the needs of people with alternative abilities by abolishing architectural barriers, which make it very difficult for people with alternative abilities to move around,
- elaborating procedures, which, in a systematic way will enable to adapt each workstation to the candidate with a particular impairment,
- creating participation and equal chances mechanisms leading to work satisfaction which will eventually lead to self realization and personal development,
- linking work motivation with the motivation to earn money so that in result work could lead to fulfillment of needs and encouragement of more effective work.

Working conditions created in this way should guarantee substantial benefits for the company as they provide opportunities for people with alternative abilities, facilitate achieving high working efficiency and help gain working satisfaction. Inasmuch as there are a lot of companies in Poland, which can pride themselves for having good architectural solutions, adaptation of workstations to disabled people's needs still creates a lot of problems.

As a result of researches a special method which aids decision taking process when designing workstations for people with alternative abilities and in particular with alternative disfunction, has been elaborated (this research was supported by a grant from the National Science Committee No 7 053 16 supervised by Ewa Górska).

Proper researches were preceded by piloting researches to examine the scale of the problem, its complexity and to estimate potential costs of elaborating and implementing the method. For the piloting researches a test sample was chosen consisting of 100 workstations which function in small and medium companies of work protection, and 100 cases of movement diseases in patients who are registered in companies' medical and rehabilitation clinics.

2 Problem statement

Legal regulations, both in the country and worldwide, oblige employers to create new workplaces for people with alternative abilities. However, they do not specify how to proceed with this serious problem in order to make people with alternative abilities use the opportu-

nity and take the employers' job offer. Hence in many scientific centers there are new initiatives and actions being taken at the moment in hope to increase chances for employment of the disabled. This is done by learning about needs and potentialities of people with alternative abilities [1, 2, 9, 10 - 13], developing methods which allow work and workstation analysis [4, 16, 17] and introducing methods which concern adaptation of workstation to the limited abilities of people with alternative abilities [15].

Despite so many attempts there is no efficient tool allowing effective and precise adaptation of workstation to needs and abilities of disabled people. It is the result of both great variety of disfunctions and workstations. Recruiting an employee for a definite position can take place in the course of adapting a workstation to an employee or selecting a suitable workstation to abilities of a disabled person. Depending on the characteristic tasks for a workstation and spatial parameters, these factors can be defined as conditions of first and second rank.

Conditions of lower rank are those which can be corrected without change of a functional destination of a given workstation, and they include e.g. limitations of movement space, improper geometrical parameters of working place, communication routes, etc. These are re-definable parameters that can be corrected within an existing workstation. They are applicable when an employee with disfunctions is highly required at a given workstation due to his particular skills, either manual or intellectual and disturbances of lower rank do not allow in normal conditions to employ a disabled person for the realization of these tasks.

However, parameters of higher rank are those that cannot be corrected without change of functional destination of a given workstation e.g. technology. In case of non-adaptable workstations it is assumed that a workstation among tasks for which it is created cannot be modified at all. In these cases a given workstation should be matched to persons who despite their disfunctions will not have difficulties in performing their assigned tasks.

Amongst many areas, which require close analysis, this research focuses on the issue of the spatial design of workstation. First of all, it is a question of designing workstations in accordance with the needs of people with alternative abilities, and in particular with limb impairment.

Physical adaptation of workstations can be resolved into introducing changes or modifications which consist in establishing adequate measure proportions of workstations, adequate arrangement of equipment, installing additional elements or removing those which hinder performance of some given professional activities. If need be, an employer should provide a disabled employee with rehabilitation equipment which is adapted to the type of disability and which enables successful performance of professional activities.

It has been assumed that in order to choose a good workplace for a person with alternative abilities it is necessary to:

- perform complex analysis and evaluation of a person with alternative abilities paying special attention to his natural skills and abilities, and not disabilities,
- perform analysis of work and workstations requirements,
- compare the results of both analyses and define relations between skills and abilities of a person with alternative abilities on the one hand and workstation requirements on the other and on the basis of both generate an adequate workplace for a given person,
- design a workstation in such a way so that it gives a disabled employee independence and autonomy, what is more a workstation should be universal enough for a healthy person (workstation should not be recognized as designed especially for a disabled person),
- elaborate a computer program aiding decisions in conditions when there are two sets of elements' features cooperating in definite situations. These cooperating modeled teams are: an employee endowed with perception-alternative dysfunctions and a spatial structure of workstation which is adaptable to his abilities and needs.

3 Industrial context

Elaborating method of designing spatial structure of workstations for persons with alternative dysfunctions required creating a database about workstations and possible cases of limb diseases. For the sake of the method two questionnaires have been prepared: the first one has been devoted to registration of requirements posed by work and geometry parameters of a workstation according to identified modules, the second one is devoted to a detailed description of dis-

abilities resulting from the type of disease, including among others data about the type of disfunction, the range of perception-alternative limitations, preferences concerning potential work.

From the point of view of the aim of conducted researches the companies of work protection and medical-rehabilitation clinics were recognized as the most representative companies and therefore the questionnaires were sent to them. The questionnaire which describes a disabled person was sent to 25 clinics in 16 voivodships. After 3 months 100 questionnaires were sent back from 13 clinics describing from 5 to 10 types of limb diseases. The researches included a group of patients whose limb dysfunctions did not disqualify a person to start a normal job. 96 out of 100 questionnaires were sent back and filled in correctly.

Questionnaires on workstation requirements were addressed to 25 companies of work protection in 13 cities. Besides big metropolis (Warsaw, Łódź, Poznań) the research covered smaller cities (Radom, Siedlce, Kozienice, Kobyłka near Warsaw, Orońsk near Radom). All the questionnaires describing 100 workstations were filled in correctly.

4 Results of piloting researches

Due to complexity and variety of the discussed problem, elaboration of the method of designing workstations for the disabled people was preceded by piloting researches. The scope of piloting researches was to identify conditions which were important for good adaptation of workstation to a disabled person, systematize job market offers for people with limb dysfunction and identify prevailing limb dysfunctions. There are two methods which were used in piloting researches:

- clinical exploration including a detailed analysis of a particular group of disabled people and workstations; the advantage of such researches is depth of analyses and possibility of formulating hypotheses on the basis of obtained results which can be verified in researches on large samples; their disadvantage is low representation of the researches' results which is caused by minimal research sample [6],
- large sample studies consist in analyzing big groups of workstations and disabled people; used information comes from survey reports, statistical database, questionnaire researches; the advantage is a high credibility of results allowing generalizations which concern bigger population; the disadvantage is narrowing the number of analyzed problems [6].

Information used to analysis and evaluation of present state of affairs is the result of current regulations, scientific publications, statistical data, summaries of work conditions inspections, experience of companies and private questionnaire researches in the companies of work protection and rehabilitation clinics located in the company.

Results of piloting researches allowed to settle:

- significance of the problem,
- permanence of the problem in time from the legal perspective,
- scale and structure of the problem,
- complexity of the problem.

In order to settle the above conditions and collect data necessary for the elaboration of the prototype of the method and verification of the method on the representative statistical sample, piloting researches have been carefully designed and carried out.

4.1 Significance of the problem

The degree of adaptation of the company to the needs of disabled people is decided by National Work Inspection (in Polish: PIP). Unfortunately, in reference to the selection of workstations for given dysfunctions, there are no recommendations or contraindications.

The inspection, carried out by PIP in the first six months of 2007 inspected 2437 companies of work protection (13% of total amount), which employed about 373.800 disabled people and discovered the following [14]:

- not all objects met the requirements of work safety regulations (43%),
- workstations were organized without observing the requirements of acts on surface and height of rooms (35%),
- machines and equipment which were operated by disabled people did not always have tools adapted to different types of employees' diseases (41%),
- there were architectural barriers which hindered movement in working places, on the roads and communication routes (20%).

Companies of different profile of activity and, in particular, production, commercial, development and transportation companies were controlled. The conclusion was evident: despite many shortcomings high

unemployment among people with alternative abilities make them accept bad working conditions. A fear of losing opportunity for an active life and sense of stability, which work provides, forces disabled people to look for job by at any cost.

4.2 Permanence of the problem in time from the legal perspective

The increasing problem of disability brings about the situation when countries and different international organizations start special actions and activities for disabled people, also meant to prevent disabilities. In result the question of providing communication opportunities and access of workstations to disabled people with limb alternative dysfunction is a great social and economic problem.

4.2.1 Social aspect

An urgent need to provide people with alternative abilities with accessible workstations has found its solution in the following legal acts:

- on 1st August 1997 The Charter of Rights of People with Alternative Abilities was adopted (M.P No. 50, position 474), in which The Parliament of Poland recognized that people with alternative abilities have right to independent, autonomous and active life and they may not be the object of discrimination,
- Labour Code article. 237 § 1 and Resolution of Ministry of Labour and Social Policy from 26 September 1997 on general regulations of work safety (Dz.U. No. 129, position 844 with later amendments), saying that: An employer who employs disabled people should guarantee adaptation of workstations and easy access to workstation to needs and limited abilities of disabled employers (§ 48),
- Regulation of Ministry from 29 January 2007 on help for employers who employ people with alternative abilities (Dz.U. from 2007 No. 20, position 118),
- law from 7th July 1994 – Building law (Dz.U. No. 89, position 414, with later amendments),
- regulation issued by the Ministry of Infrastructure from 12th April 2002 concerning technical conditions which should be fulfilled in public buildings and their location (Dz.U. from 2002 No. 75, position 690),
- law from 27th August 1997 concerning professional and social rehabilitation and employment of people with alternative abilities (Dz.U. No. 123, position 776, with later amendments).

4.2.2 Economic aspect

In practice an employer who wants to employ a person with alternative abilities, faces a difficult task of finding an adequate job and tasks for the given person with movement problems. The more difficult is the task, the more complex is the movement impairment. What is more an employer does not have at his disposal solution patterns which could aid him to make right decisions in this matter: how to maintain productivity of the job position while employing people with alternative abilities. Estimated figures concerning decreased efficiency of the work of people with alternative abilities according to the type of disability have been presented in table 1.

Decrease in productivity results not only from the particular types of diseases, but also from lowered productivity measured with the ratio of real working time to nominal working time.

Higher cost of employment (lower productivity) is caused mainly by the legal provisions guaranteed to a disabled employee which include:

- working time shortened by 2 hours (5%) per week for people with slighter type of disability,
- working time shortened by 2 hours (17%) per week for people with heavy and moderate type of disability,
- additional break in work for 30 minutes daily in order to do some physical exercise or rest (6%) for all disabled employees,
- additional holidays (10 days) for people with heavy and moderate type of disability,
- being exempt from providing employment but preserving the right to payment for the period of 21 days annually in order to participate in rehabilitation holidays for people with heavy and moderate type of disability,
- providing higher standard of working conditions (adapting sanitary rooms, abolishing architectural barriers, improper lightening).

Table 1. Decrease in efficiency according to the type of disability
(source: [1])

No	Type of disability	Participation in the population of employees (%)	Decrease in productivity (%)	Measured decrease in productivity (%)
1	Diseases of hearing and speech organs	6	10	0,6
2	Mental and nervous diseases	8	50	4,0
3	Mental handicap	8	80	6,4
4	Diseases of sight organ	9	30	2,7
5	Diseases of internal organs	23	20	4,6
6	Diseases of limbs and spine	25	30	7,5
7	Remaining and related diseases	22	40	8,8
	Total number for the whole population of employees (as estimated)			34,6

4.3 Scale and structure of the problem

Data provided by GUS – Main Statistical Office showed that in 2002 there were more than 5457 thousands disabled people that is 10% of all the population of Poles, 84,5% of which do not have any chance for employment. The number of serious disabilities has also increased dramatically, for example annually there are about 1600 new cases of people who have to use a wheelchair on the permanent basis.

Impairments and limb diseases are the major or secondary cause of all identified causes of disability. According to Main Statistical Office in the first quarter of 2002 [14] it was discovered that disabled people with alternative abilities are 42% of all disabled population that is about 2,2 million people, who have only one type of disability. If we take into consideration the occurrence of different types of disabilities then the number of people with limb dysfunctions will increase to 1 million.

Alternative dysfunction can concern:

- alternative and manipulation limitations,
- using special and rehabilitation equipment,
- upper and lower artificial limbs,
- alternative limitations in the particular parts of the body,
- difficulties in moving on an even surface, staircase and ladder,
- limitation limiting kneeling and running,
- difficulties in moving on soft and uneven ground,
- difficulties in leaning,
- rheumatic deformations.

The structure and scope of the problems connected with alternative disabilities has been identified on the basis of the results of my own questionnaire carried out in 13 rehabilitation clinics in companies.

The results of the researches are illustrated in figures 1, 2, 3 and 4 and in table 2.

Out of 96 disabled people included in the questionnaire, the researchers identified 20 cases of spinal impairments. The type and frequency of impairments is illustrated in table 3.

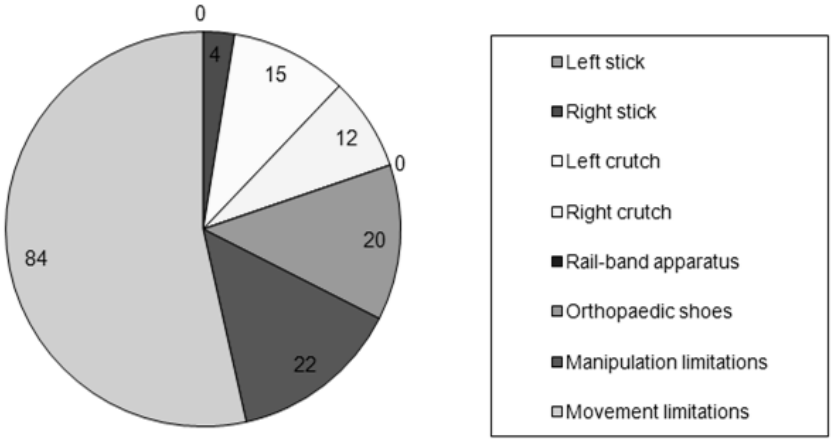

Figure 1. Special and rehabilitation equipment for people included in the research program

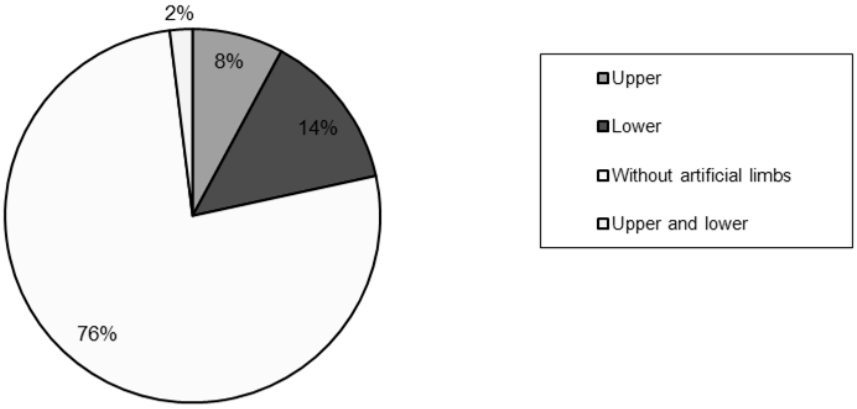

Figure 2. Percentage of people who have artificial upper and lower limbs

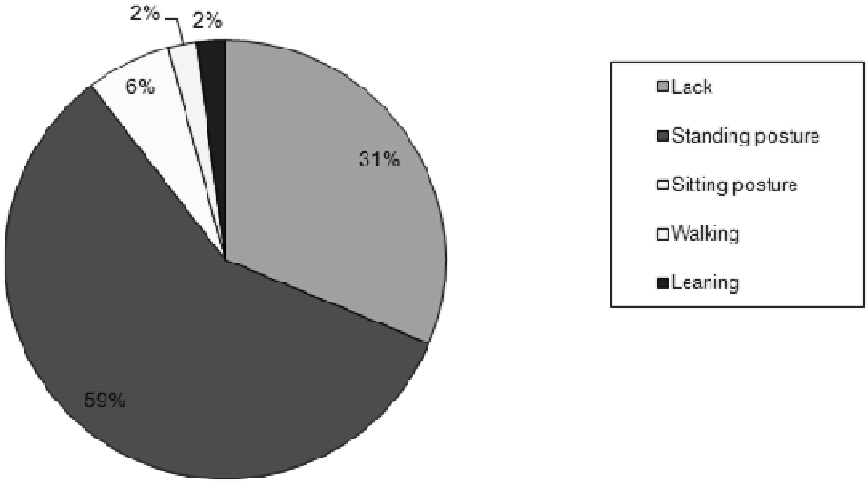

Figure 3. Limitation of movement ability in particular positions

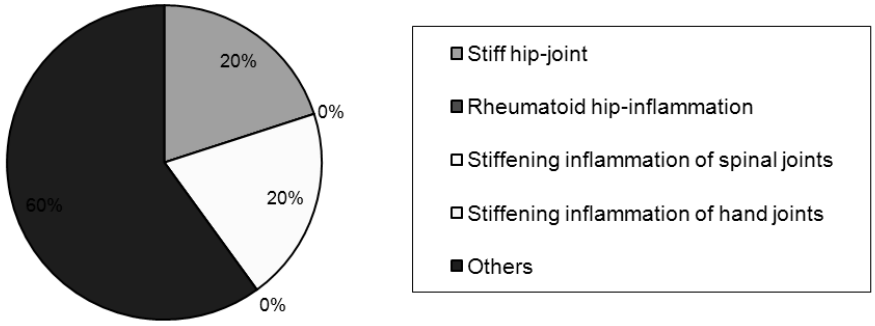

Figure 4. Occurrence of rheumatic deformations

Table 2. Percentage of physical ability among people included in the questionnaire researches

Disease type	Percentage share %				
	Complete ability	Small difficulties	Big difficulties	Practically impossible	Impossible
Limitations in moving on even surface	20	58	20	0	2
Limitations in moving up/down the stairs	8	42	48	2	2
Percentage of people who cannot climb up the ladder	0	23	33	19	25
Limitations which unable kneeling	7	24	43	13	13
Limitations which unable running	2	12	40	15	31
Percentage of people who cannot run	2	8	31	23	36
Limitations in moving on the soft ground	4	27	55	7	7
Limitations in moving on uneven difficult ground	4	29	44	13	10
Difficulties in leaning	12	51	33	2	2

Table 3. Types of spinal impairment

Description	Frequency of occurrence
Limitation in mobility between vertebra on the neck, chest and loins-sacral section	1
Th7-Th8 rupture of pultaceous core	1
Post-accident damage of the loins section of the spine	1
S' chest and loin curvature of the spine	1
Impairment of the loins section of the spine – stiff and aching section	1
Degenerative changes in the neck, chest and loins-sacral section of the spine	1
Degenerative changes in the chest and loins-sacral spine	1
Degenerative changes in the neck and chest spine	2
Degenerative changes in the neck, chest and loin-sacral spine	2
Degenerative changes in the neck and chest section of the spine	1
Degenerative changes in the neck, chest and loins-sacral part of the spine	1
Degenerative changes in all the spinal sections	1

4.4 Complexity of the problem

In order to establish correlation between the requirements of workstations and abilities of people with alternative abilities, it is necessary to take into consideration two groups of criteria:

- type of dysfunction,
- placement of dysfunction.

From the point of view of the type, dysfunctions can be divided into:

- loss of parts of the body and limbs, e.g. innate losses, amputations,
- dysfunctions of joints' kinesis, e.g. limitation of movements, switching off some degrees of autonomy, stiffness of joints (anykylosis, artrodesis),
- dysfunctions to dynamism of limbs, e.g. paresis and paralysis (flabby, spastic),
- complex dysfunctions (different combinations).

Depending on dysfunction placement in relation to reference system defined by fibular and transversal surface we can differentiate:

- symmetric movement dysfunctions in relation to fibular surface, e.g.: paresis or paralysis of both upper and lower limbs,
- asymmetric movement dysfunctions in relation to fibular surface, e.g.: paralysis on one side,
- symmetric movement dysfunctions in relation to transversal surface, e.g.: losses or paresis/limbs paralysis on the same height,
- asymmetric movement dysfunctions in relation to transversal surface, e.g.: similar dysfunctions on different heights.

What is more there are different possibilities in regard to movement and manipulation activities. Manipulation activities consist of elementary movements of upper limbs. Therefore it is necessary to learn the degree of ability for each of these movements which include: movements of fingers, movement of hand (palm and fingers), repetitive movements, turning and indirect movements of forearm, arm movements and arm movements together with shoulder collar. Evaluation includes also such manipulation activities as the ability of taking a grip, reaching, carrying, lifting, putting down, pushing, attracting, spinning, dismantling and squeezing. The indicators of physical ability are also important: adequacy, precision, speed, skillfulness, strength and coordination of movements.

Movement activities are connected with moving the body with the use of the lower limbs. Therefore it is important to learn the degree of ability in such activities as walking on an even surface, walking up and down the stairs, walking up the ladder, kneeling, running, jumping, walking on the soft and uneven ground and leaning.

Table 4. Changes occurring in upper limbs

Type of dysfunction	Area
Fingers missing	- thumb - pointing - middle - annular - small - none
Impairments visible in stiffened joints or movement limitation, within	- thumb - pointing - middle - annular - small
Impairments of the wrist	- below the joint - above the joint - immobility of the joint visible in the stiffness or movement limitation
Impairments of the elbow joint	- below the joint - above the joint - immobility of the joint visible in the stiffness or movement limitation
Impairments of the shoulder joint	- below the joint - above the joint - immobility of the joint visible in the stiffness or movement limitation
Too short limb, if the shortening concerns	- proportionally, the whole limb - section of the limb
Too long limb, if the lengthening concerns	- proportionally the whole limb - section of the limb

Alternative dysfunction can be a result of:

- dysfunction of upper limbs (not resulting from spinal damage),
- dysfunction of lower limbs (not resulting from spinal damage),
- deformation as a result of rheumatic diseases,
- dysfunction of limb caused by spinal damage.

Dysfunction of upper limbs refers to the left or right hand. In both cases there can appear changes presented in table 4.

The performed analysis shows a great variety of dysfunctions of human alternative system. Even identical diagnosis in few persons gives different possibilities of action. Specially when we consider partial disability and paralysis. Within the same formal diagnosis e.g. „limb disability" there can be great differences in ability of a given limb in different people. Therefore every design of workstation for a disabled person should be based on a detailed individual analysis and functional diagnosis.

5 Results

Data collected in the questionnaires served to elaborate a method of designing workstations with limb dysfunctions and its computer implementation. Among many areas which require analysis, the issue of spatial planning of a workstation in accordance with the needs and abilities of disabled people with limb impairment, was taken into focus. The scope of using the method was limited to alternative dysfunctions as the biggest and at the same time the most complex area of functional disturbances in the human alternative system.

5.1 Workstation design procedure

It was assumed that designing workstations will take place at the following stages:

I stage concerns modeling the body shape of the workstation's user and requires building:

- model of database including information on anthropometrical parameters of model forms,
- model of database of diseases and deformations according to medical documentation,
- model of knowledge base enabling translation of „medical base" into the parameters required by the base of models parameters,
- interface: parameters base – Anthropos.

II stage concerns building a model of a workstation in accordance with the identified modules.

III stage concerns examining the relation between the disabled person's alternative possibilities and space in which he/she is to function.

The diagram of the workstation designing method has been presented in figure 5.

In order to elaborate the method two questionnaires were drawn up:

- questionnaire of a disabled person's body shape with an alternative dysfunction,
- questionnaire of requirements posed by a workstation.

A tool which aids the researches in the project is Anthropos, a computer program working in AutoCAD environment. What is more a proper consulting system has been elaborated which aids decision making process concerning selection of workstation for an individual user.

One of the elements of the method is a visualization of the process of adapting an employee to a workstation with the help of Anthropos packet. This packet is a tool which will help visualization provided that the basic objects – human and workstation – have been well defined in three dimensional way. A human has been well described with the help of a questionnaire including data on the employee's dysfunctions. It is true that the geometry of all the elements was not precisely described in the questionnaire, but it was possible to use the base of anthropometrical features of a population, included in Anthropos packet.

The elaborated method of workstation designing enables to:

- select workstation suitable for a given type of dysfunction according to the needs of people looking for a job,
- find among disabled people those who can work at the workstation endowed with definite parameters,
- define adaptation activities for a workstation so that it is possible to employ a disabled employee.

In all these cases we define the priority: human can work only at such a workstation where basic use and ergonomic parameters meet the requirements of a potential employee. This is a basic criterion of selecting workstations for people and people for workstations.

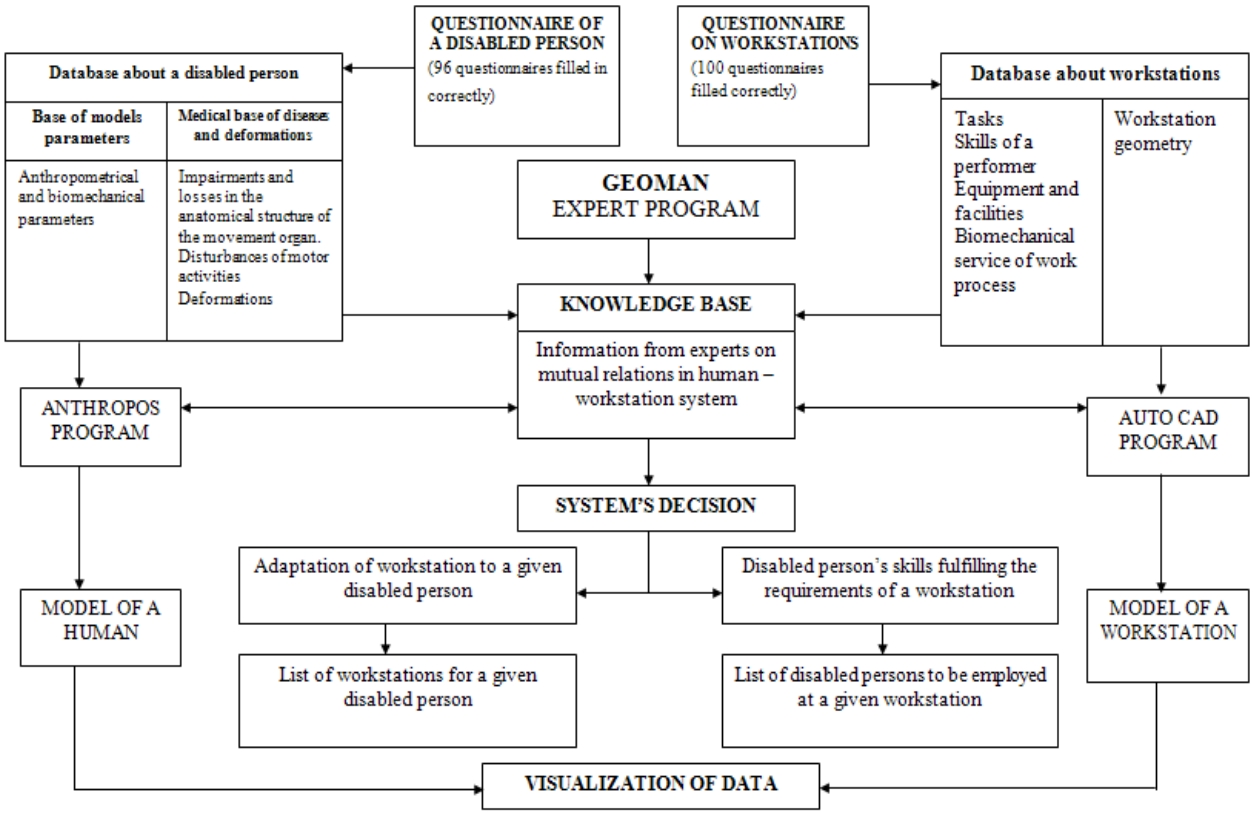

Figure 5. Diagram representing the method of a module designing of workstations for disabled persons *(source: [4])*

The system in the first case will search a database with data on workstations for such workstations whose use parameters are beyond the minimal requirements of a disabled person.

In the second case working of the system is similar and actually operated in the same way but due to the efficiency of database, the system will search a base of individuals looking for persons whose requirements are lower than those at the analyzed workstation. In both cases it is human with his dysfunction that plays the main role.

5.2 Computer implementation of workstation designing method for disabled people

The main aim of creating computer system of workstation designing method for disabled people is the possibility of stimulating the interaction of the elements of the system: human – workstation. Examining the above relations requires building the model of a generalized body shape of a disabled person who has some definite dysfunctions and a workstation model in which the disabled person is to function. Thus it was decided that the designed system should enable to:

- collect information on disabilities among certain population,
- collect information on working environment where people with alternative abilities could be possibly employed,
- search both databases in order to find functional correspondences in the other database; the search can be carried out using equivocal criteria; functioning of such tool enables finding for example not concrete and ready workstations for people with alternative abilities but a group of workstations together with a list of their possible modifications; the role of decision-maker consists in establishing which of the changes proposed by the system are to be actually realized,
- indicate proper matches at a workstation in order to employ adequate people with alternative abilities at a given workstation,

- suggest possible modification of a workstation in a given range so that modifications could meet the requirements of an employed person.

For the sake of the method a model of database including information on anthropometical parameters of modeled forms, given diseases and deformations according to medical documentation was elaborated. What is more a model of knowledge base which enables translation of „medical base" into the parameters required by the base of models parameters was also elaborated. The interface consisted in Anthropos, the base of parameters.

Particular efficiency of the presented attitude consists in creating a set of recommendations about reconfigurations of workstation's geometry in order to adapt to a given case of a disabled person with dysfunctions.

The designed system should serve to:

- select a workstation with a suitable parameters and advantages for a given type of dysfunctions characteristic for people looking for a job,
- find among disabled people those who can work at a workstation endowed with specific parameters.

In both cases we set the priorities: a human can only work at such a workstation where basic use and ergonomic parameters meet the requirements (mainly health requirements) of a potential employee. It is a basic criterion of selecting workstations for people and people for workstations.

The system in the first case will search workstations database for such workstations whose use parameters are beyond the minimal requirements of a disabled person.

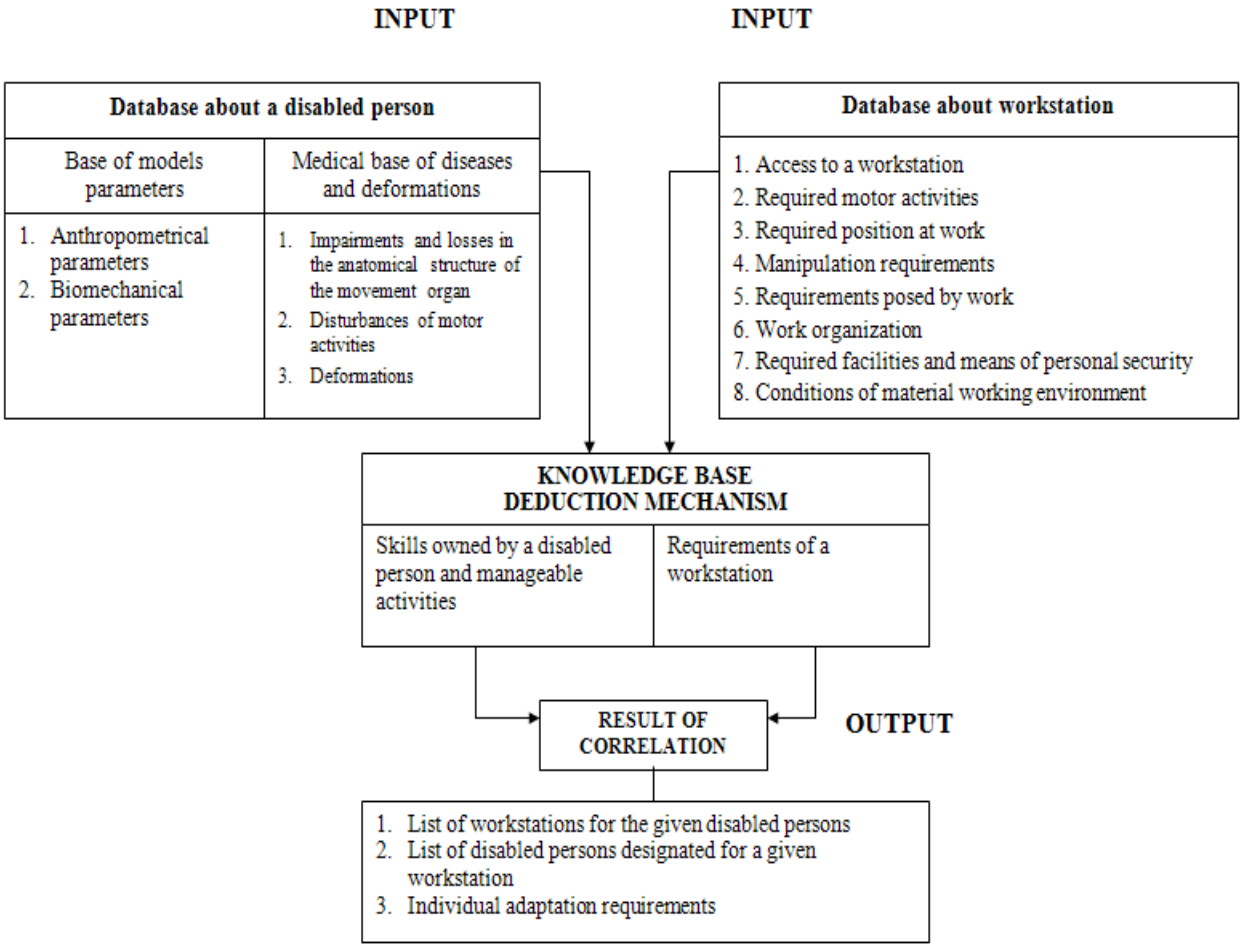

Figure 6. Functional model of computer system workstation designing for disabled persons
(source: [4])

In the second case working of the system is similar and run almost in the same way but due to the efficiency of database, the system will search a base of individuals whose requirements are lower than present at the analyzed workstation. In both cases a human with his dysfunctions plays the main role. The essence of the computer system is presented in figure 6.

The example of selected windows from a computer program aiding the method of designing workstations for disabled people id represented in figure 7 and 8.

The window presented in figure 7 is the first interface dialogue window of the user of the external database application. We have here a possibility of drawing up a description of particular alternative limitations and choosing the areas of occurrence of limb dysfunctions.

Next dialogue window (figure 8) allows introducing additional data not included in direct dysfunctions. Introducing detailed data about disabled people's dysfunctions enables the next third dialogue window etc.

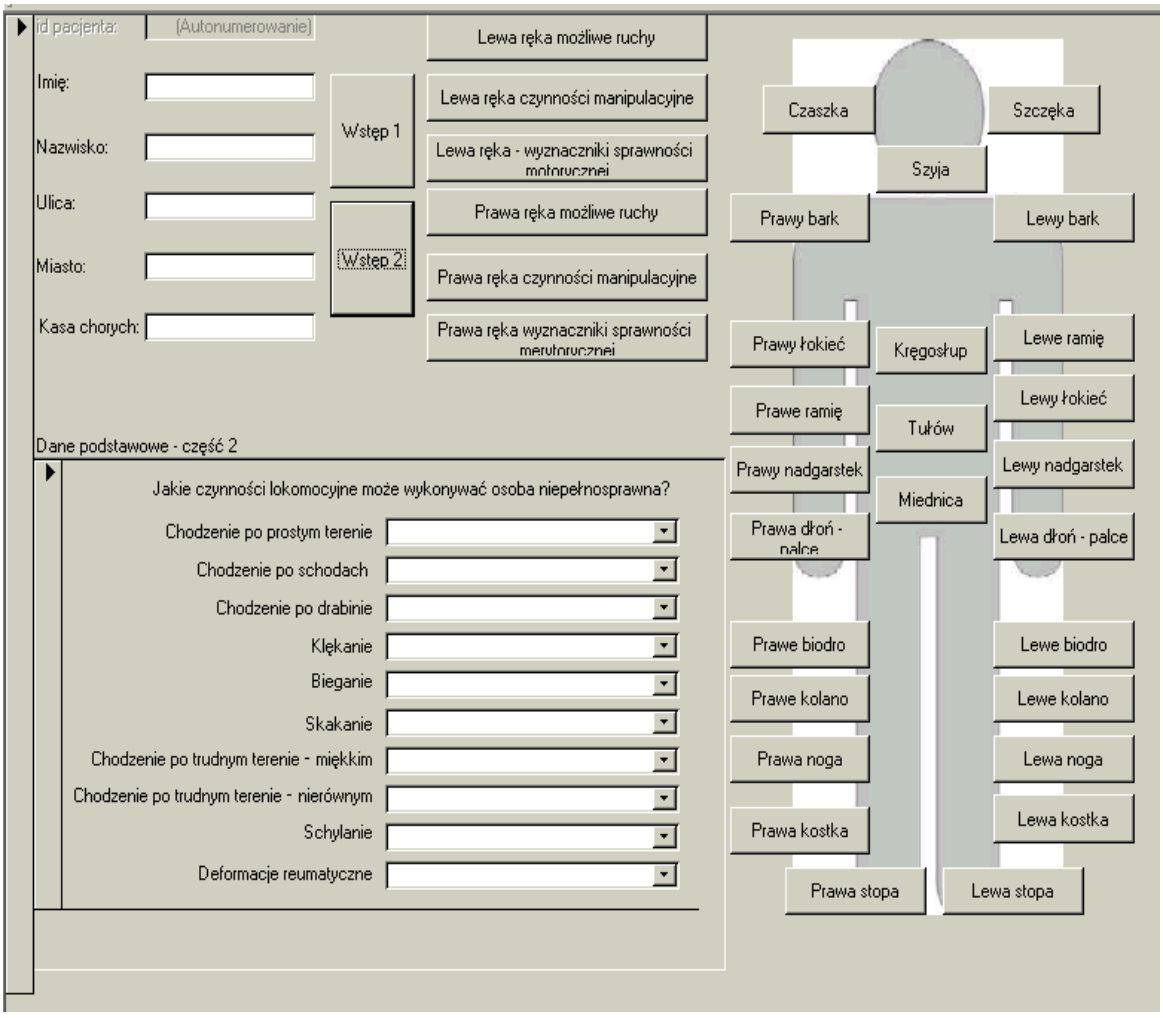

Figure 7. Window of a base to fill in the description of the individual dysfunctions
(source: [4])

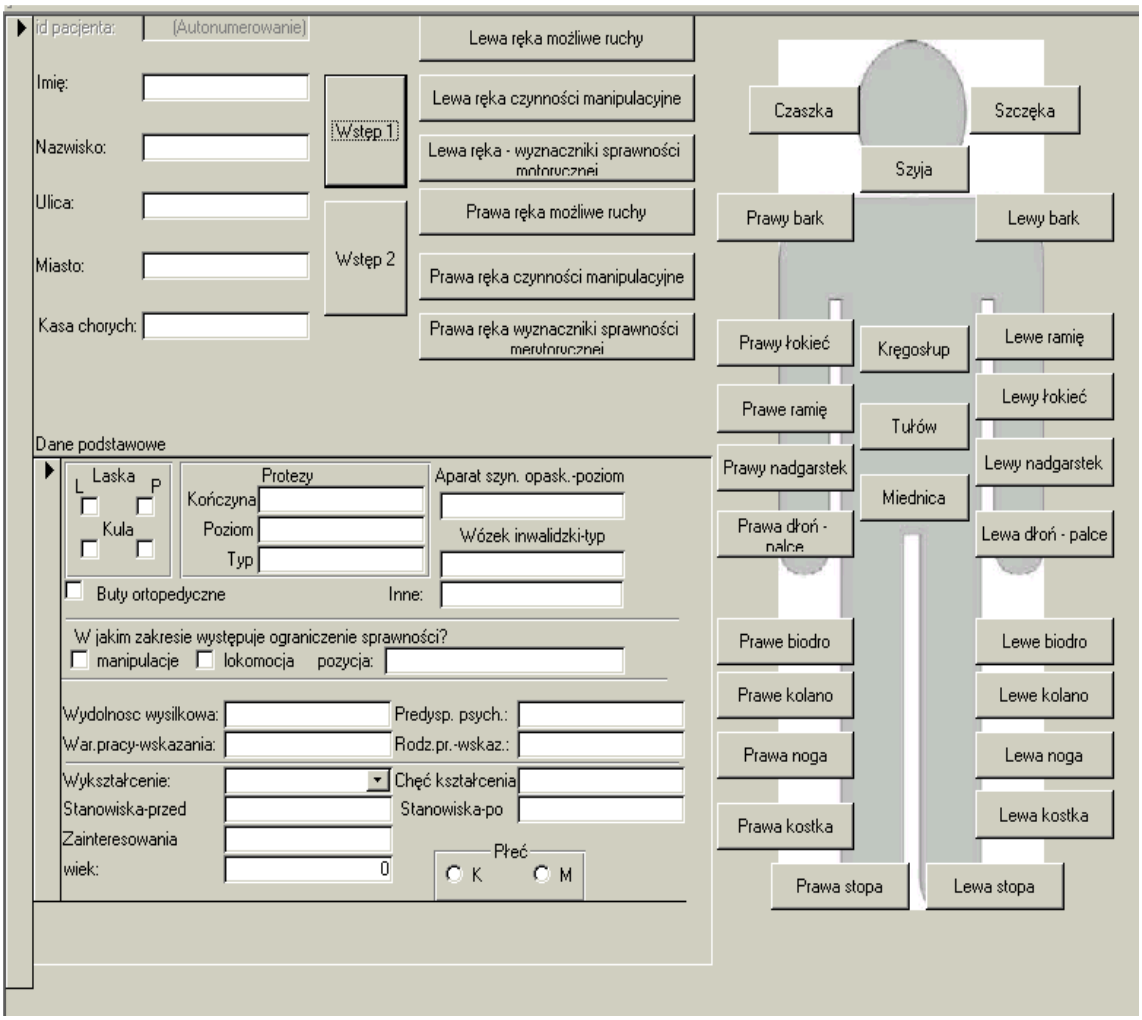

Figure 8. Window to introduce additional data – besides direct dysfunctions
(source: [4])

6 Application

Implementation of the workstation designing method for disabled people was started at S.I. ELERMET Company at the Electromechanical department in Biała Podlaska.

ELERMET, the Co-operative of Disabled People runs its own production activity at the following departments:

- wear (protection and working wear, wear for health service, uniforms and special wear),
- electro-technical (contractional tubes and conductors, installation collets, ampere currant gauges, stabilizers for sodium, mercury and halogen lamps),
- artificial materials (products of artificial materials and furniture, containers from artificial materials made for LUBLIN cars, produced with the use of a special modern technology – the method of gust, retarding reservoirs for the car radiator systems).

The Co-operative has its own commercial network (a warehouse, 8 shops), it runs its own investment and renovation business. It also has rehabilitation clinic. ELREMET Co-operative of Disabled People employs 597 people 306 of whom are disabled people which is 51,3% of the staff. There are 36 disabled people employed at the electromechanical department. The conclusions of the interview, provided by 20 people with different disability group, reveal that 35% of the researched employees notice barriers at their workstations. These disturbances are brought about by a wrong selection of gauges, improper seat, too small working space. Most of the employees complained about the heavy load on hand muscles and mental

overload with the performed work. The overload on the upper limbs, which unfortunately appears very often, has a very bad effect on mental well being and of course on work efficiency.

Good economic condition of the Co-operative helps create new jobs with a special consideration of workstation for disabled people. General working conditions are already adapted to the needs of disabled people. The company has such facilities as lifts, special banisters, vehicles which enable wheelchairs to move around. However workstations need modernizing.

6.1 Registration of data for designing purposes

A register of diseases and workstations was started in the company in the form of catalogues. A list of diseases which occur in 36 employees working at the electro-technical department was drawn up. The register lists disabilities, disability group, classification to one of 7 areas of disability and comments on special recommendations or indications. The evaluation of disability was settled on the basis of health card and medical commission's opinion. The fragment of the register is presented in table 5.

A catalogue of typical workstations was elaborated for the Electro-technical Department. The catalogue lists workstations at which disabled people may be employed. Since people with different dysfunctions can work at these workstations, the catalogue indicates for each workstation the chances of employment for people with specific diseases classified into disability areas. The register of typical workstations including possible diseases, which can occur in the disabled employees, is presented in table 6.

6.2 Designing a workstation to prepare the base of a stabilizer

The procedure of ergonomic designing was conducted in accordance with the elaborated method. On the basis of the collected data about a disabled person and workstation for preparing the base of a stabilizer a simulation of design solutions was performed. According to the obtained results an action was launched aimed at improving working conditions at the workstation. The effects of improvement were presented in the human – technical object – environment system, including specific features of an employed worker. These features include:

A. features of a disabled person,
B. workstation equipment,
C. spatial structure,
D. work methods,
E. work organization,
F. material work environment.

Table 5. Catalogue of diseases of the persons employed at the electro-technical department (fragment)

No.	Type of disease	Sex			Comments	
		Female	Male	Disability group	Disability area	C - contraindication R - special recommendation
1	Spastic paralysis of the left leg		X	III	Limb defect	C - hard physical work requiring a lot of walking
2	Spastic paralysis of the upper right limb		X	II	Movement disability	C - work requiring both hands
3	A deaf-mute person, paresis of hip-joint, shortening of lower limbs		X	II	Defect of speech, hearing, limbs	C - hard work requiring speaking and walking, R - work in a sitting posture
4	Loins and sacral curvature of the spine		X	II	Spine defect	R - work in a sitting posture
5	Spastic paresis of lower limbs, paresis of the upper right limb, mental deficiency of the small degree, astigmatism		X	I	Complex disability	R - easy and simple work to perform

Table 6. Catalogue of typical workstations at the Electro-technical Department

No.	Workstation	Number of workstations	Possibility of employing disabled people according to disability areas						
			Defect of sight	Defect of hearing and speech	Impairments of limbs and spine	Nervous and mental impairments	Mental deficiency	Interior diseases	Complex diseases
1	Insulation winder	9	X	X	X			X	X
2	Workstation for control measurements	2	X		X				
3	Workstation for preparing the base of the stabilizer	3	X			X			
4	Workstation for installing moulders	3		X					X
5	Workstation for designing the stabilizer	10	X	X	X	X	X	X	X
6	Workstation for installing the amperometer	2	X		X				

A. Features of a disabled person

Sex: Male.

Age: 36 years.

Employment practice: 15 years.

Disability group: I.

Description of disability: spastic paresis of limbs, paresis of upper right limb, mental deficiency of the small degree, astigmatism.

Recommendations: No work or work only in the company of work protection in special conditions. Work, which is simple and easy to perform.

Anthropometrical data: while defining data the features differences resulting from disability were included:

- body height in a sitting posture 1700 mm
- sight surface height in a sitting posture 1227 mm
- shoulder height in a sitting posture 1051 mm
- elbow height in a sitting posture from the floor 747 mm
- under-knee height 447 mm
- maximal thigh girth 139 mm
- thigh sedentary length 457 mm
- length of a seat 400 mm
- height of a seat 445 mm
- reach of the left limb 752 mm

A task for realization: preparing moulders for the installation of the stabilizer.

Character of the activities performed: manual work, manipulation – sight work.

Employee's tasks: taking C and T moulders, putting them properly, putting them into strickle and examining a given type of a stabilizer.

B. Workstation equipment

Tools: a hammer, strickle board.

Table: adapted to the people with lower limbs paresis, it has a listed board which prevents small elements and tools from falling, on the left side of the table there is a tool box as the right hand is disable.

Seat: a chair for people with a limited ability of sitting down and getting up, endowed with side arms and mobile leaning seat with an option of autonomous sitting down and getting up which while sitting down turns to the vertical position and while getting up

a special mechanism pushes the seat out together with a person (figure 10).

C. Workstation spatial structure

The measurements of a workstation and equipment were selected in accordance with the anthropometrical data. While defining the measurements the differences of somatic features resulting from disability were taken into consideration. The manipulation height and comfort areas for legs in a sitting posture are presented in figure 9. The measurements of workstation figure 10. A surface which covered by a workstation: 6 square meters and 2 square meters not taken by an employee.

D. Work methods

Description of activities: basic activities performed by the left hand.

Tasks for the left hand:

- taking a moulder,
- putting in the right position,
- putting in the strickle,
- nailing with a hammer,
- winding with a tape.

Tasks for the right hand:
Due to a paresis there are only simple activities performed connected with holding

Work place: optional.

Labor effort: medium.

E. Work organization

A type of work performed: an employee at the workstation performs simple activities connected with packing moulders of type T and C with the help of simple tools: hammer, strickle, moulders.

Work efficiency: efficiency during a labor day is about 20-25 units/7 hours, efficiency per hour is about 3-4 units/1 hour.

Physical load: medium.

Working time: 7 hours.

Number of breaks: 4. Total time for rest is about 40 minutes.

Time of breaks: first break – 15 minutes, second break – 10 minutes, third break – 10 minutes, fourth break – 5 minutes.

First break for corrective exercise should take place in a scheduled time. It should influence general health condition, improve fitness of limbs which have paresis and relax the hand which performs almost all ativities.

The remaining breaks can be regulated optionally depending on the mental and physical well being.

The rule of individualization for work organization: due to the paresis of lower limbs and upper right hand, an employee is provided with material to work and the receipt of ready packets.

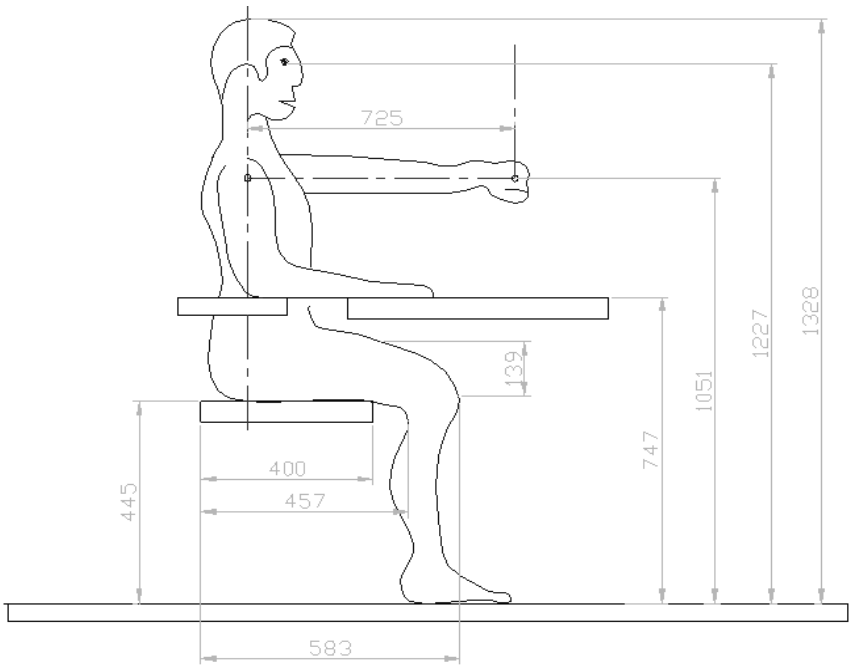

Figure 9. Defining manipulation height and comfort area for legs in a sitting posture

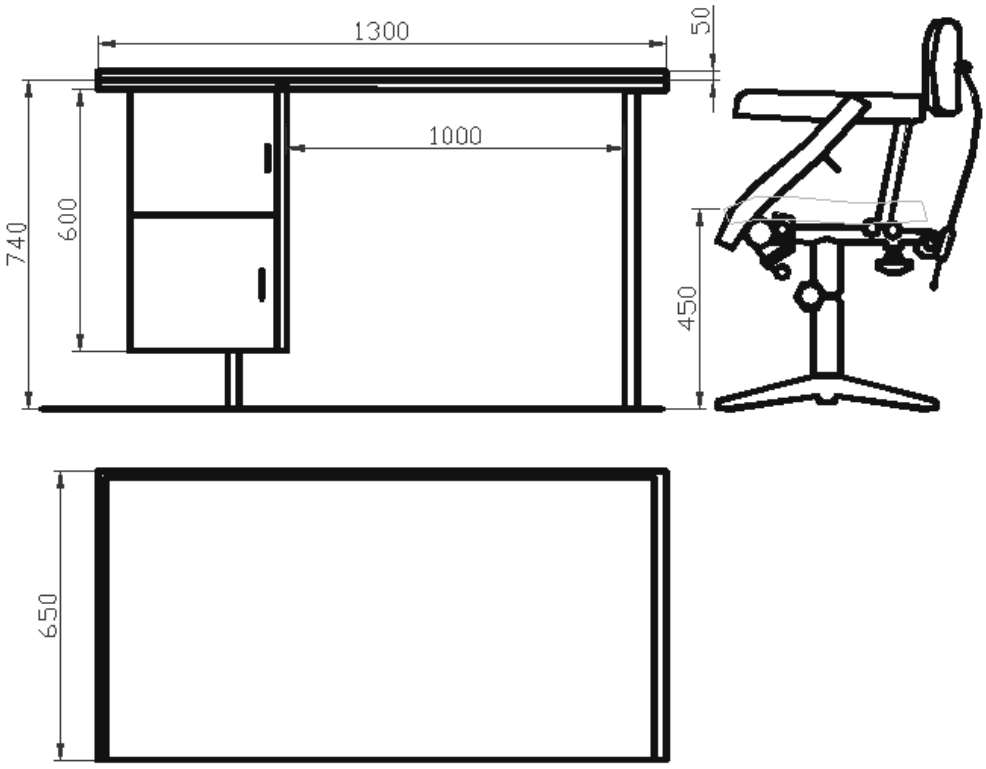

Figure 10. Defining workstation measurements to prepare the base of a stabilizer

F. Material work environment

Temperature: 23 C.

Noise: max. 72 dB.

Light: 300 1x.

7 Conclusions

The elaborated method and a computer program adapted to it will be verified in the companies of work protection and after gaining satisfactory results, they will be implemented into the normal practice of a company.

It is predicted that shaping working conditions at the workstation according to the mental and physical needs of disabled people will help overcome social barriers.

We hope that the suggested method will create equal chances for disabled people and help them function in the society as fully valuable members. What is more the efficiency of the company will increase dramatically as a result of disabled people's work.

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PROJECT REALIZATION SCHEDULING AND ITS MULTI CRITERIA EVALUATION

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***Abstract*:** The paper focuses on project scheduling classification issues according to the type of constraints and optimization directions. Special attention was paid to production scheduling, presenting the basic issues in relation with product flow organizational criterion. Open-cluster issue was formulated and analyzed with the use of modern heuristics. Solution was evaluated with multiple criteria, mainly on the basis of time characteristics. Production process flow relations, in coordinates determined by operation sequence at particular workplaces, as well as the production type factor were presented.

***Key words**:* project management, production process, scheduling, optimization, algorithms, multi criteria evaluation.

1 Introduction

Project management is a discipline that integrates the totality of issues connected with realization of projects. Even though the project management is a relatively fresh area of science, the concept of project was known for a very long time. It is assumed that the first project realized according to the current concept of project management was the construction of trans-continental rail in the USA in 1870 [2]. During the turn of XIX and XX century, F.Taylor, in researching and optimizing the efficiency of workers, came to a conclusion that every type of work can be broke down into smaller elements – the smallest one being a single movement. At the same time H. Gantt elaborated a graphical representation of activities performed in different time intervals that contribute to a common venture - project. In 1903 K. Adamiecki elaborated the diagrammatic method [1, 26] for the representation of a production process. Every process, including production processes, is performed in time and space. Therefore, the production process research methods should be based on both these features. These requirements are met with the diagrammatic method of K. Adamiecki, which is based on the use of the Cartesian coordinate system. In this system the independent variable is the time and the dependent variable is the workplace. With such description of coordinates it is possible to illustrate and present production processes.

During the Second World War mathematical methods (Simplex method) were successfully used for the optimization of complex civil and military projects. These methods were later used in many activities and projects, becoming the basis for a new area of science – operations research. During the turn of 50s and 60s of the XX century, project management entered the wide civil applications. Basic methods of project management, network methods, were elaborated at this time [36]:

- CPM (Critical Path Method) in 1957,
- PERT (Program Evaluation and Review Technique) in 1958,
- MPM (Metra Potential Method) in 1958,
- GAN (Generalized Activity Network) in 1962,
- PDM (Precedence Diagramming Method) in 1964,
- GERT (Graphical Evaluation and Review Technique) in 1966.

Development of project management in the 70s of XX century was stopped due to the computing limitation, which was later overcome in 80s and 90s due to the introduction of cheap and effective computers in the market. New scheduling optimization methods were elaborated at this time mainly because of a quick development of artificial intelligence methods [9, 31].

Project management is becoming more and more popular among enterprises. Production scheduling should assure such production realization which allows on-time customer order realization and increase the efficiency of production resources. Effective scheduling systems synchronize production processes at all lines, control the correlations and optimal sequencing in order to shorten the manufacturing time.

Production planning and management systems work in the areas connected with material and information flow of manufacturing systems. They realize the planning

process, which is the selection of resources for realization of particular production tasks in given time and assurance of target realization, and the management process that is launching, supervision and assurance of production tasks realization [4]. Usability of scheduling tools for the analysis of particular production models depends on the volume and character of production.

More and more often are the methods connected with artificial intelligence used in the scope of production scheduling. Some of these examples are genetic algorithms, simulated annealing algorithms or the tabu search procedures. Schedule creation task is realized with various analytical and heuristic methods [3].

The plan of the article is the following. First chapter presents project characteristics and classification of project scheduling issues. Second chapter describes production project scheduling methods. Third chapter deals with the job shop - open shop production scheduling issues. Fourth chapter presents the multi criteria project scheduling evaluation issues and the fifth chapter evaluates the project scheduling in stochastic environment with the use of stochastic tools.

2 Characterization of project realization and classification of scheduling issues

2.1 Characterization of project realization

Project management has a set collection of definitions used to describe it. According to the British Standards definition presented in [10]: project is a unique collection of related activities (tasks, operations) together with defined starting point and (or) finishing pint, realized by an individual or an organization in order to reach set goals with assigned resources. Therefore every project has three basic types of elements: activities, resources necessary to realize them and set order relations (related activities).

Activity is a task, operation or process that requires specific time and (or) resources for its realization. Activities are described with a number of features e.g. set activity time and others. Resources are everything that is necessary to realize activities and usually are the main constraint in projects.

From the project realization scheduling perspective the most common classification is the one based on accessibility criterion, which divides the resources into [20]:

- renewable resources – accessibility of this type of resources is renewed in the following time periods (e.g. employees, machines),
- non-renewable resources – resource is accessible until it is used for task realization, after that it stops being accessible (e.g. materials, capital),
- partially renewable resources – resource accessibility is limited for particular sub-sets of time in the planning horizon (in these sub-sets the resource is treated as renewable).

Relations project the logical sequence of project task performance. For a single determination of relation it is necessary to provide the predecessor (the activity that via relations conditions beginning or ending of other activity), follower (activity, which realization possibility is conditioned by relations) and relation type.

2.2 Project scheduling constraints

Scheduling is based on determination of allocation of accessible production resources in time and space, in a way to fulfill the demand for manufactured products with the best possible resource usage. Schedule determination requires taking into consideration a number of constraints. There are two types of constraints hard constraints and soft constraints.

Hard constraints must be fulfilled – solutions that meet this type of constraints are the conditional solutions. Soft constraints can be taken into consideration in the selection process of the most profitable solutions from the conditional solutions [7].

Technological constraints decide about assigning of the operations to proper production workstations (resources). Such constraints are deliberated in the first place in order to book resources for particular production tasks. Temporal-sequencing constraints consider the sequence of operations in selected production process. Time-bounds constraints determine starting and finishing time of particular operations or directive terms for task realization e.g. earliest (latest) starting (finishing) time. Task-processing-duration constraints can depend on the type of performed operations, workstation or production task type.

There are a number of other constraints broadly described in the literature e.g. [9].

2.3 Classification of project scheduling issues

There is no unambiguous classification of applied models, due to high diversity of project scheduling issues. Authors, on the basis of various criteria, propose partial classifications for limited scope of issues. This results form complexity and great diversity of constraints and optimization directions in the area of project scheduling. For example the general overview of deterministic scheduling models is presented in [9].
In [23] the classification is based on the types of constraints and optimization directions. Basic classes of issues can be distinguished, according to constraint type and optimization directions in the project scheduling area:

- no constraints – with realization time of financial flow optimization,
- with time constrains – resource division or financial flow optimization (RCPS - Resource Constrained Project Scheduling),
- resource constrains (various types) – time characteristic or finance optimization (e.g. TCPS- Time Constrained Project Scheduling),
- CCPS - Capital Constrained Project Scheduling,
- with multiple constrains – combinations of mentioned models, such as:
  - TRCPS - Time & Resource Constrained Project Scheduling,
  - RCCPS – Resource & Capital Constrained Project Scheduling,
  - TRCCPS - Time, Resource & Capital Constrained Project Scheduling.

Essential element distinguishing project scheduling models is the decision scope, which need to be made in order to solve the problem. Project scheduling models can be divided according to the decision area:

- modes, in which the decisive variable is only the task realization schedule – the evaluation criterion, independent of the optimization directions, depends only on the starting and finishing point of the activity and the problem solution are the task realization deadlines,
- models, in which decisions consider both the schedule and the way of task performing – models with changing resource requirements (and/or the capital) defined as a relation,
- models, in which the decisions consider determination of project schedule and payment terms realization.

2.4 Basic issues (models) of production scheduling

Production scheduling issues is broadly discussed in the literature [9, 35] and was subjected to various classifications. The most common production scheduling issue division, according to organization and product flow criteria, is into three basic types (Fig. 1):

- flow shop issue, in which the flow sequence, through all workstations, is the same for all tasks; in terms of flow issue (f.i.) two additional issues can be distinguished: permutation f.i. which the sequence of operations in particular workstations is always the same and non-permutation f.i. in which tasks can be performed at different workstations in different order,
- job shop issue, in which the production flow sequence through various workstations is different for different tasks, but previously determined,
- open shop issue, in which the production flow sequence through various workstations is arbitrary – there are no technological constraints in the scope of operation sequencing.

3 Production scheduling algorithms

3.1 Basic scheduling algorithms

Basic methods for production scheduling issues are divided into approximate and precise [Fig. 2]. Usually in practical appliances only the approximate methods are used. Precise methods can be divided into division and boundary methods, methods solving special problems in exponential time or the subgradient methods. There are much more approximate methods than the precise methods; they are usually problem-oriented. Approximate methods can be divided into iteration and construction algorithms.

Construction algorithms group includes prioritization rules or heuristics using the bottleneck concept. One of the groups, among the iteration algorithms, consists of artificial intelligence methods such as constraint fulfillment, artificial neural nets, expert systems and ant search. Second group, local search, includes e.g. tabu search, boundary search (e.g. simulated annealing), genetic algorithms and GRASP type meta-heuristic methods [3]. Application of GRASP for the project scheduling issues optimization is presented in e.g. [5, 6].

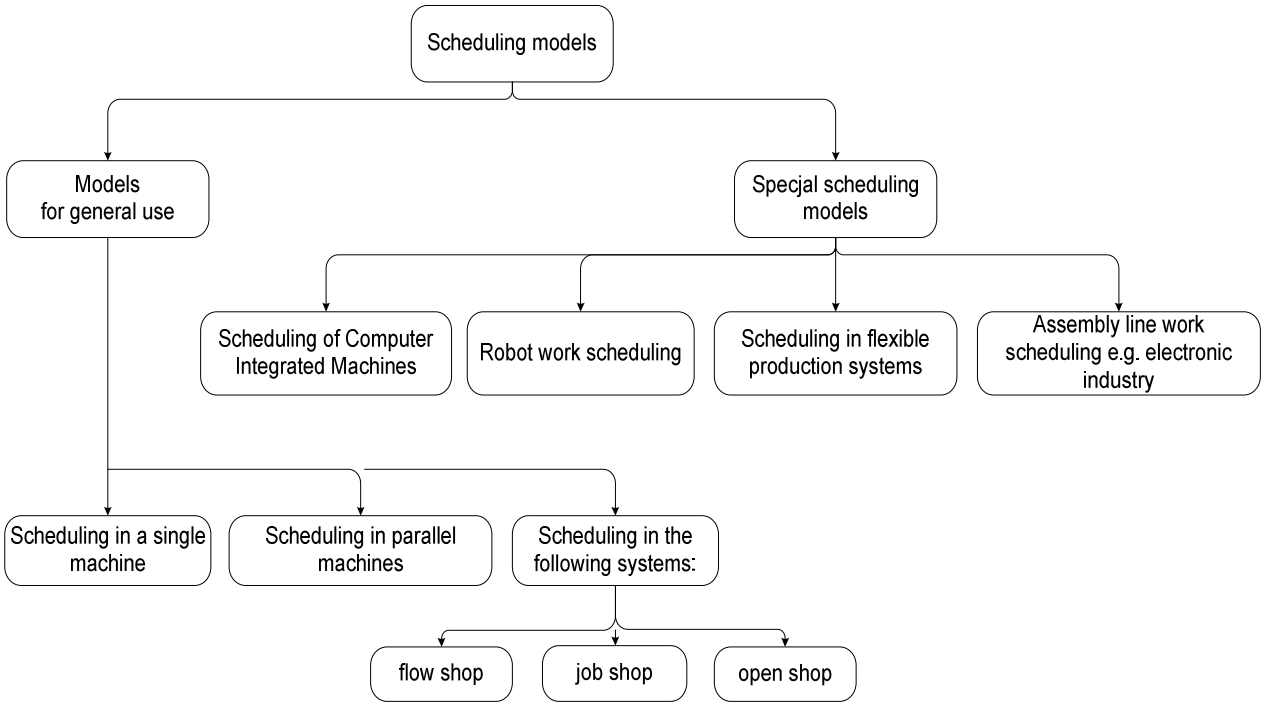

Figure 1. Basic models of production scheduling
(source: [35], p. 11)

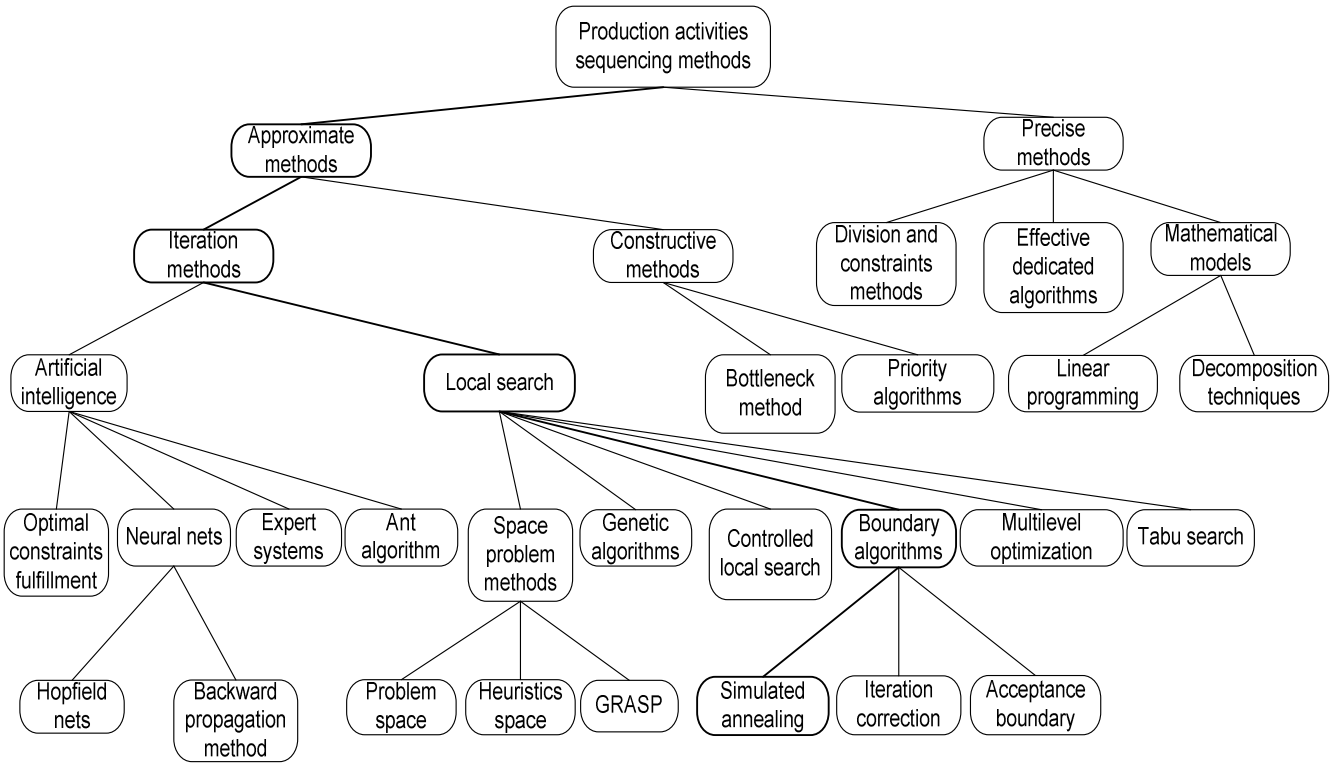

Figure 2. One of the classification tools for the schedule optimization
(source: [3, 9])

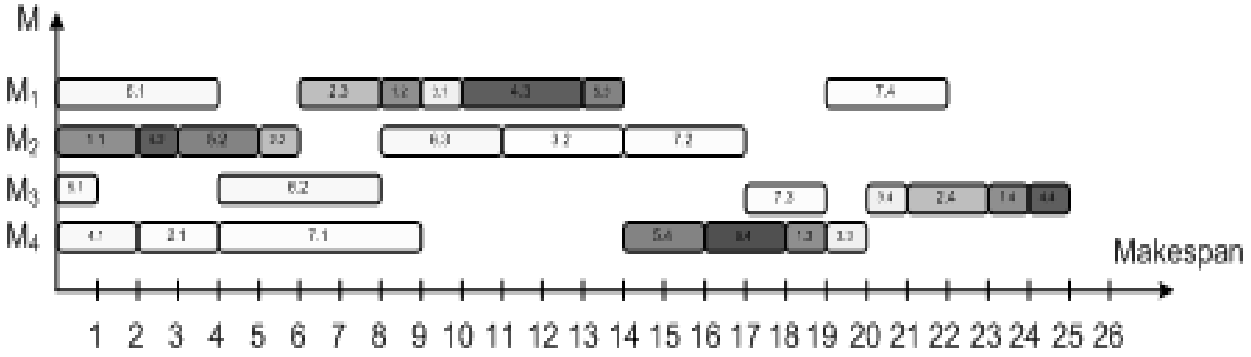

Figure 3. Schedule example with marked critical path
(*source: self elaboration on the basis of* [9])

3.2 Local search algorithms

Different types of neighborhood described in [18] will be presented. First neighborhood N_1 is the change of the sequence of the performance of two activities at the same machine. Operations are sequential, directly after each other, and are present at the beginning or the end of a block, where the block is understood as a chain of successive operations at the critical path that are performed at the same machine. Unfortunately this neighborhood has some shortcomings – any changes in the order of the operations at the machine can lead to the appearance of unfavorable event. Moreover the size of such neighborhood is not very considerable. In case of the mxn issue, when every operation is performed at every machine, its size equals m(n-1). Most of allowed movements does not improve, sometimes even worsens, the makespan value. N_1 neighborhood application rule is presented on the basis of one block of a schedule example (Fig. 3).

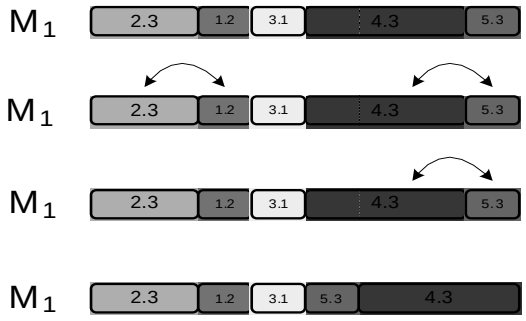

Figure 4. Application of N_1 neighborhood
(*source: self elaboration*)

Figure 4 indicates that the possibility to switch the operations in the beginning/end of the block is performed at first, next one of the possibilities is selected and then the next movement is performed.

Second neighborhood N_2 takes into consideration the change of order of the operations performed at the same machine, which are not realized directly one after another and are placed inside of the block.

Operation from within the block is moved to the beginning or finishing place. If such situation is not possible (because unfavorable event would occur), the operation needs to be moved to a place that is closest to the beginning or finishing place.

Constructed solution in the first or second neighborhood can lead to the creation of new solutions possibilities in the N_1neighborhood in the following steps.

Example presented below illustrates the creation of N_2 neighborhood. Figure 5 shows the change of the operation performance order in case when it is moved from within the block to one of its ends.

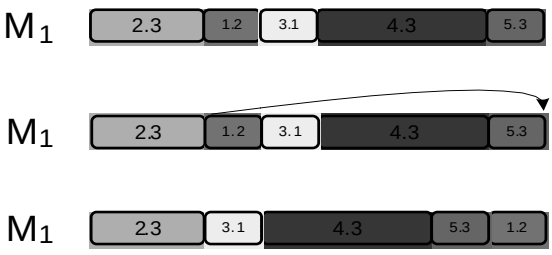

Figure 5. N_2 neighborhood application
(source: self elaboration)

Third neighborhood N_3 is also based on the change of the operations performed at the same machine, which are placed directly one after another at the beginning or end of the block. Creation of N_3 is a little it more complicated from the previous neighborhoods. It has the following formulation: v and w are the successive operations belonging to the block on the critical path.

The operation preceding the v operation is added to these operations - predecessor PMv or the operation following w consequent SMw, resulting in the element collection {PMv, v, w} placed in the beginning of the block or {v, w, SMw} placed at the end of the collection.

All possible permutations of the {PMv, v, w} or {v, w, SMw} elements are determined as belonging to the neighborhood, if the order of the v and w elements is also changed.

Illustration of the creation of solutions belonging to the N_3 neighborhood is presented in the Figure 6 and 7.

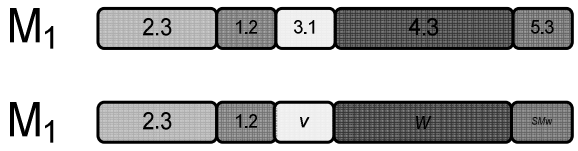

Figure 6. Determination of *v* and *w* operations (*source: self elaboration*)

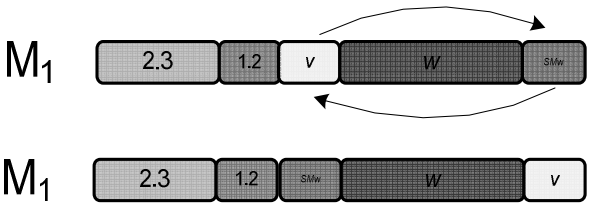

Figure 7. Selection of permutation – solution belonging to the N_3 neighborhood and performance of movement (*source: self elaboration*)

It is important to recognize that first neighborhood is included in the third neighborhood $N_1 \subseteq N_3$ and that $N_2 \cap N_3 = \varnothing$. Another neighborhood exists - N_4 that joins the advantages of second and third neighborhood so it is possible to write down that $N_4 = N_2 \cup N_3$. Therefore the $N_1 \subseteq N_3 \subseteq N_4$.

4 Flexible job shop-open shop production scheduling issues

4.1 Flexible job shop-open shop scheduling issue formulation

The general essence of the problem is the following. There is a certain collection of part types, which needs to be manufactured in the amount stated in the production order. In order to manufacture every type of part it is necessary to perform, in right technological order, a number of operations with limited amount of machines. Every operation has a certain time needed to perform it. Every technological operation can be performed on one machine from the group of technologically changeable machines (flexible job shop problem). Before the start of an operation an initial changeover has to be performed, although if operations of the same type are done the changeover is not necessary (the C/O time is different for particular operations).

It is necessary to select, for every operation, the machine and startup time so that the orders can be produced in required quantity with determined constraints and the schedule fulfills the criterion of optimality. In this paper the optimization criterion is the minimal total time of operations (makespan). Several other criteria are included in multilevel schedule evaluation. Formulation of elaborated case study can be counted as flexible job shop scheduling problem (FJSP) as well as the resource constrained project scheduling problem (RCSP).

It can be described in the following way. Machine set M was determined (power of the M set is marked as m), set of operations O, which elements are particular production operations σ^i, i=1…n, where n – power of the O set.

Every operation $\sigma^i \in$ O has a relating machine subset $M^i \in$ M that can perform these operations. O set is partially sorted – the activity performance order is determined C = $\{\sigma^i \prec \sigma^j\}$, which determines the sequence of operations (« $\sigma^i \prec \sigma^j$ » means that the σ^i needs to be performed before the σ^j operation is started).

In order to start an operation on a machine the changeover has to be performed. Moreover, classes of the

same type of operations are introduced k^j, j=1..K, where K the number of classes of the same type. The main purpose of classes of the same type is the following: if σ^i and σ^j belong to the same operation type class and are performed at one machine, whereas after the performance of σ^i operation the machine does not make any operations to start the σ^j operation performance, initial changeover of the machine for the σ^j operation is not needed.

Time necessary to perform the σ^j operation is marked as $p(\sigma^i)$, $t(\sigma^j)$ − time necessary for the changeover of the machine before the performance of the operation σ^i, $S(\sigma^i)$, $F(\sigma^i)$ − starting and finishing time of the operation σ^i, m^i − machine, selected form M^i for the performance of the operation σ^i.

The essence of the task is to select for every operation $\sigma^i \in O$ machine from the set M^i (i=1…n) and after that determine the sequence of operation performed on the machines from M, in a way to assure the minimization of the total time of operations in the schedule (makespan). If all the $t(\sigma^i)$ values are equal zero for $\sigma^i \in O$, than one can determine the order constraints and M^i subsets in a way to get the classical formulation of the sequential task (job shop scheduling problem).

Production scheduling issue deliberated in this paper can be presented in the following way:

$$\min F \tag{1}$$

with the following constraints:

$$F \geq F(\sigma^i), \forall \sigma^i \in O \tag{2}$$

$$F(\sigma^i) \leq S(\sigma^i), \forall \sigma^i \prec \sigma^j \tag{3}$$

$$S(\sigma^i) \geq t(\sigma^i), \forall \sigma^i \in O \tag{4}$$

$$F(\sigma^i) = S(\sigma^i) + p(\sigma^i), \forall \sigma^i \in O \tag{5}$$

$$F(\sigma^i) \leq S(\sigma^j) - t(\sigma^j) \vee F(\sigma^j) \leq S(\sigma^i) - p(\sigma^i), \quad \forall \sigma^i, \sigma^j \in O,$$

$$m^i = m^j, (\sigma^i \cup \sigma^j) \notin k^l, l = 1...K \tag{6}$$

$$F(\sigma^i) \leq S(\sigma^j) \vee F(\sigma^j) \leq S(\sigma^i), \forall \sigma^i, \sigma^j \in O,$$

$$m^i = m^j, (\sigma^i \cup \sigma^j) \in k^l, l \in \{1...K\} \tag{7}$$

$$F(\sigma^i), S(\sigma^i) \geq 0 \wedge m^i \in M^i, \forall \sigma^i \in O \tag{8}$$

1-2 constraints limit the optimization criterion (the makespan). 3 constraints determine the order constraints according to the sequence of technological operations. The 4 constraints require performing a changeover before the start of the operation. Constraints 5 determine the relations between the beginning and ending of the operation performance.

Inequalities 6, 7 present the resource constraints (machine can simultaneously perform only one operation), they also include the machine changeover time. Constraints 8 require the operation beginning and ending time were the nonnegative values and the operations were performed on the machines from given technologically changeable groups.

Therefore the typical feature of open shop scheduling issues is that particular operations can be realized in any order - different from job shop scheduling issues, where the order is strictly determined. Another version of this issue is the flexible job shop, in which every operation can be performed with technologically changeable machine groups.

4.2 Job shop-open shop scheduling problem solving algorithm

The GRASP procedure [3] was used in the paper for the elaboration of research problem solving algorithm. GRASP procedure consists of two basic stages: construction of the initial solution (stage I) and local searching (stage II). During the initial solution construction stage the allowable solution for the (1)-(8) task is generated and its neighborhood is researched in the stage of local searching.

In the foundation of theoretical research on the scheduling issues there is a relatively considerable spread of, so called, bench marks problems in the literature, which are the basis for the relation in the evaluation of performed research.

The characteristic feature of these issues is the formulation of certain reality simplifying assumptions such as:

- operations of one production order cannot be performed parallel,
- every work has *m* operations – one at each machine,
- changeover time is not included or their time is not dependent on the sequence of the operations performed on the machines,
- there is only one machine of each type (in practice operations are performed with technologically changeable machine groups),

- part of the operations of every work can be performed in any order,
- machines are available during the whole time of production realization,
- there is no variability factor (the known factors are: number of orders, number of machines, operation cycle time, readiness time).

List above justifies the elaboration of algorithms that include the specifics of practical issues , what unfortunately makes it difficult to compare them.

In order to check the GRASP algorithm effectiveness the example for the FT (Fisher-Thompson) scheduling case study will be presented, with the 6x6x6 size of the problem [26]. In the table 1 expression 3(1) states that operation 1 of order 1 is performed at the 3rd machine durin the first time unit. The schedule of machine work is presented in the Figure 8.

Table 1. Data for the FT 6x6x6 case study
(source:[26])

Op.	Job 1	Job 2	Job 3	Job 4	Job 5	Job 6
1	**3 (1)**	2 (8)	3 (5)	2 (5)	3 (9)	2 (3)
2	1 (3)	3 (5)	4 (4)	1 (5)	2 (3)	4 (3)
3	2 (6)	5 (10)	6 (8)	3 (5)	5 (5)	6 (9)
4	4 (7)	6 (10)	1 (9)	4 (3)	6 (4)	1 (10)
5	6 (3)	1 (10)	2 (1)	5 (8)	1 (3)	5 (4)
6	5 (6)	4 (4)	5 (7)	6 (9)	4 (1)	3 (1)

The use of the GRASP heuristics led to receiving the total operations time in given case study equal to 55 time units, what is the optimal solution.

5 Production project schedules multi-criteria evaluation

5.1 Schedule evaluation criterion

Construction of scheduling model, its structure and data are related to the aim of optimizing activities quantitatively determined and set through the formulation of the evaluation criteria. Key difficulties in the scope of project schedule optimization are the constraints that condition the possibility to construct a multi-criteria schedule.

Constraints result from three factors: (1) time, (2) resources and (3) capital. These three factors also determine the optimization directions and used evaluation criteria.

The most common direction is the single-criterion optimization for the selected factor, whereas the two remaining or one remaining factor are treated as constraints or ignored. This allows distinguishing 8 model classes, with such defined three factors. In case of project realization scheduling, the most common are the following approaches:

- assuming the time constraint for project realization and optimization of the need for unlimited production resources or cash flow,
- assuming limited resources and project realization time or cash flow optimization,
- assuming time and (or) resource constraints and optimization of cash flow.

Multi-criteria project scheduling optimization issue is often discussed in the literature. Moving form single-criterion to multiple-criterion analysis is usually realized through the change of constraints (e.g. resources) into the optimization directions (e.g. equal consumption of resources).

In [38] authors deal with multiple-criterion analysis of time characteristics. In [25] the scheduling of simultaneous multiple projects realization is analyzed, with the assumption of the project realization fluency – minimization of project realization time span, minimization of in-process inventory defined as task realization delay caused by resource deficiency, equal consumption of renewable resources and minimization of resource waste. Two first criteria are setting the time characteristics optimization direction and the two remaining criteria deal with resource characteristics.

In the work [24] the authors ignore all constraints and assume two optimization directions: realization time and cost minimization. The conflict resolves due to the possibility to shorten the time of the project with the increase of additional costs. In [18] with the project realization schedule optimization the following directions were taken: minimization of time span, sustainable resources consumption and project realization cost minimization.

Optimization directions are strictly connected with used evaluation criteria: timely, resource and economical. The most common research present in the literature is the one using time criteria.

In case of production scheduling issues (one and multi-workstation) the collection of time criteria is largely

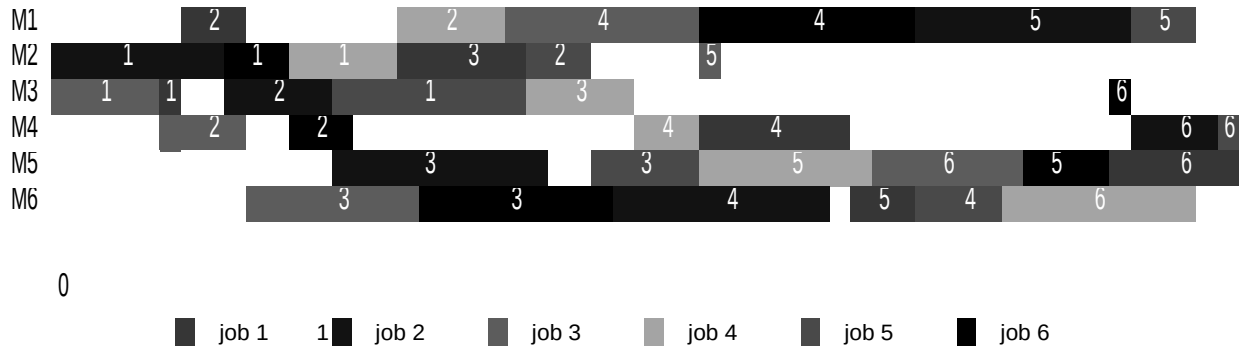

Figure 8. FT 6x6x6 issue schedule constructed with GRASP
(source: self elaboration)

developed and considers such criteria as: finishing time of all tasks, average order flow time, realization delay, realization overtake, missing deadlines and other.

5.2 Schedule evaluation with the use of basic characteristics

Few GRASP, Tabu Search and Simulated Annealing [41-44] heuristic algorithms were used in the research scheduling design. Typical feature of these algorithms is the stochastic generation of large number of alternatives. If the model is not very complex, even thousands of alternatives can be generated in relatively short time. During the optimization the algorithm can generate *n* – dimensional aim vector. Each vector can be represented with n-dimensional aim space point (e.g. one can recognize the place where the 3 dimensional space points are grouped). All vectors exist without normalization or other transformation. This point cluster's structure can also be analyzed to provide three two-dimensional figures.

Additionally, normalization is required for simulation data analysis. In the decision theory different kinds of normalization are used. Usually data is transformed in the 0 and 1 range (where 1 is the best value and 0 is the worst value). Therefore the transformed r_{sk} value is:

$r_{sk} = (z_{sk} - z_{kmin}) / (z_{kmax} - z_{kmin})$, in case of target maximization,

$r_{sk} = (z_{kmax} - z_{sk}) / (z_{kmax} - z_{kmin})$, in case of target minimization,

where r_{sk} - transformed s variant value in relation to the k target, z_{sk} – original (simulated) value with relation to k target, min – minimal value, max – maximal set value of S ($0 \le s \le S$) variants.

During the relation research a limited set of variants was used (in selected case 50, 100 and more simulation courses). However, correlation factors and correlation equations with the regression function are calculated for the identification of relations.

Particular values for the makespan, average flow time and average machine level (factor) are obtained form the following equations:

Makespan equals

$$C_{max} = \max\{C_j\}, \tag{9}$$

average flow time

$$\bar{F} = \frac{1}{n}\sum_{j=1}^{n} F_j \ . \tag{10}$$

where

$$\bar{C_j} = \frac{1}{n}\sum_{j=1}^{n} C_j \ , \tag{11}$$

where C_j finishing time and flow time $F_j = C_j - r_j$, where r_j stands for task availability term – the time in which the task is ready for processing ($r_j = 0$).

Usage of i machine equals

$$\bar{I_i} = \frac{\sum p_{ij}}{C_{max}}, \tag{12}$$

and average machine usage time equals

$$\bar{I} = \frac{1}{n}\sum_{i=1}^{n} \bar{I_i} \ . \tag{13}$$

Relations between the makespan, average flow time and average machine level (factor) are presented in the Figures 10-13.

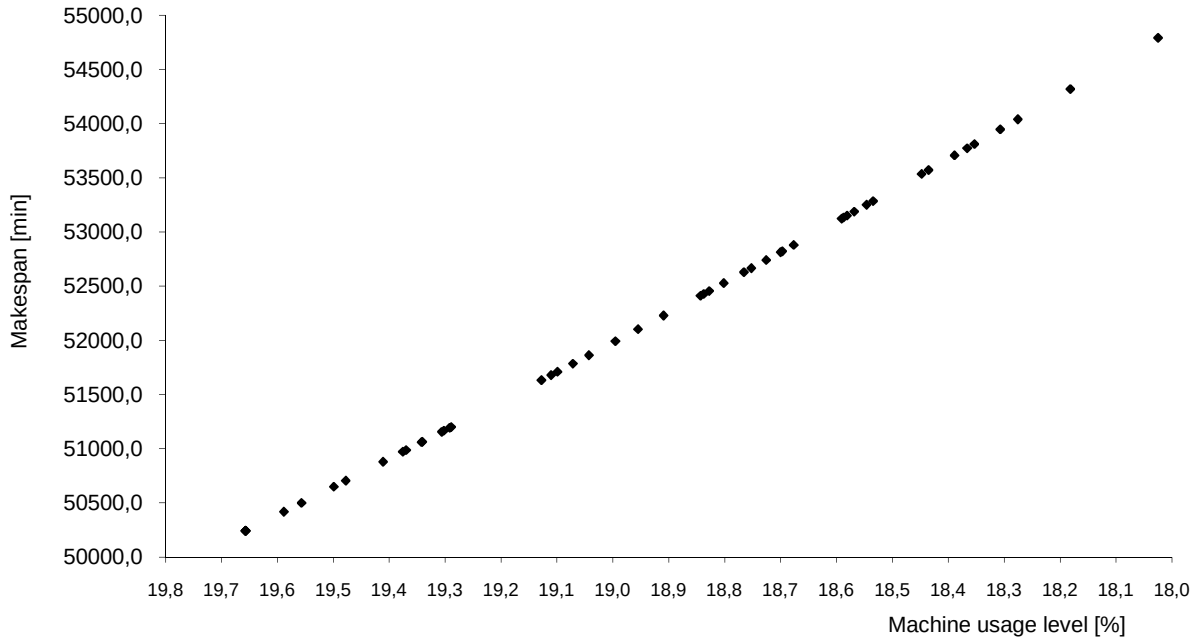

Figure 10. Relation of makespan to machine usage level (series flow)
(source: self elaboration)

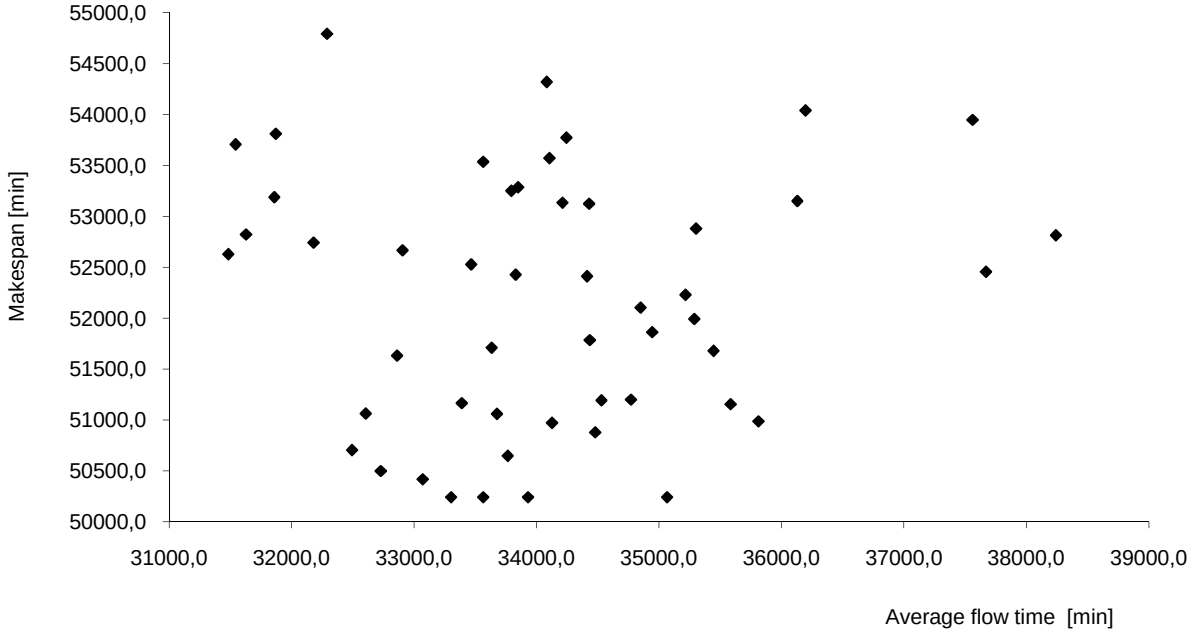

Figure 11. Relation of makespan to the average flow time
(source: self elaboration)

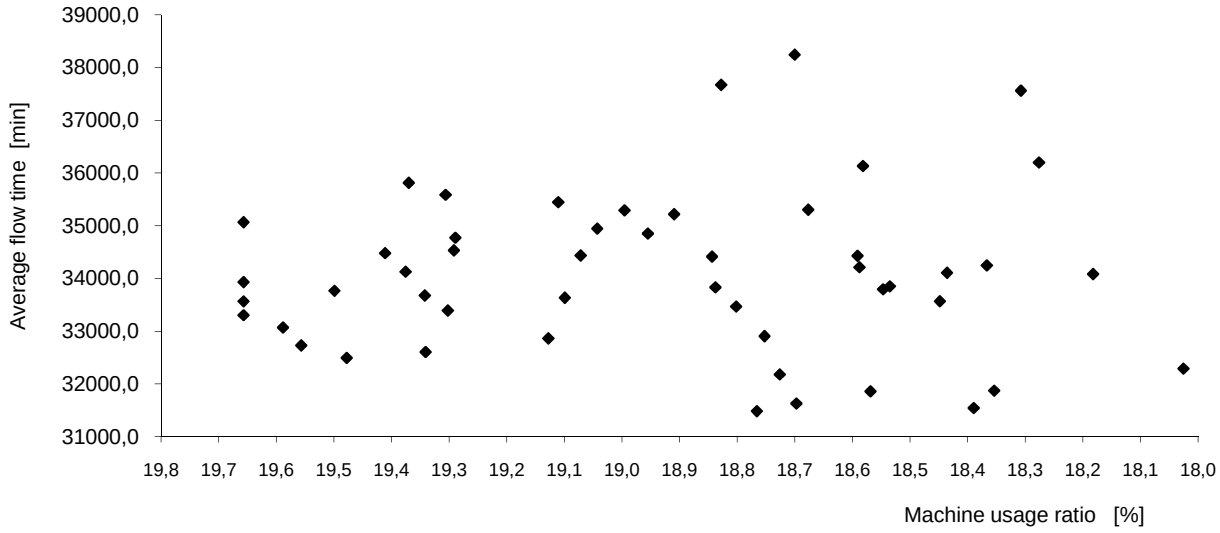

Figure 12. Relation of average flow rime to the machine usage ratio
(source: self elaboration)

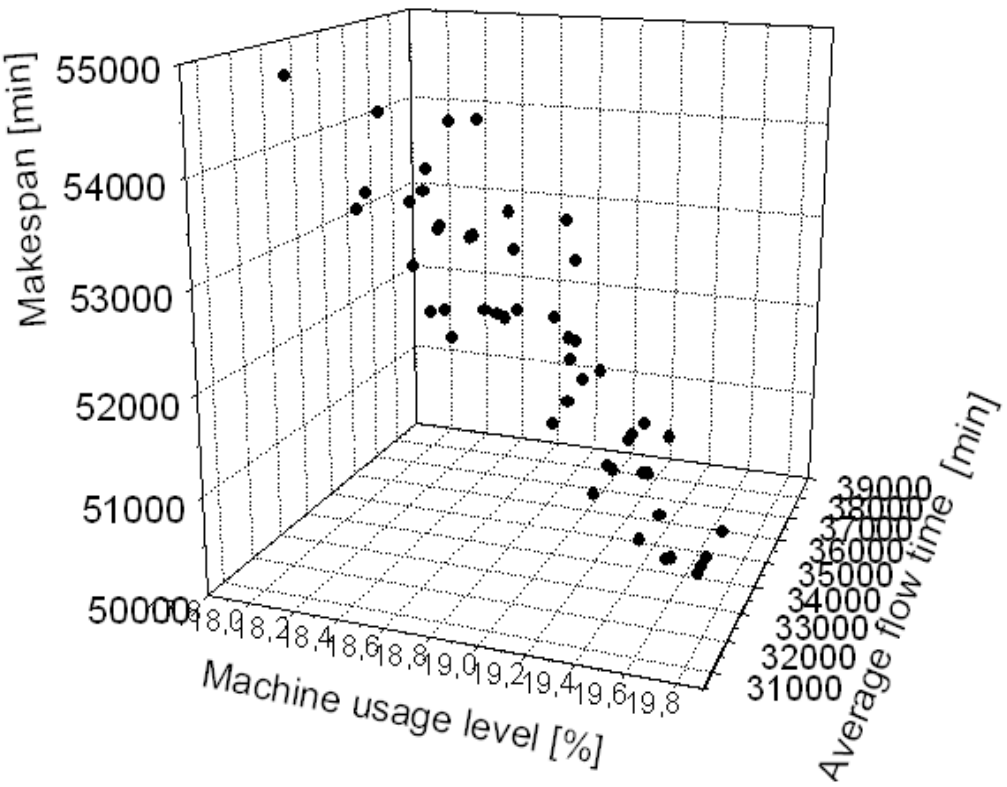

Figure 13. Relations between makespan value, machine usage factor and average flow time
(source: self elaboration)

5.3 Structure and influence of production cycle on the effectiveness of the production

Product production cycle is the most significant from the perspective of production processes management. Cycle time is the period between the start and finish of the product production process, in which the incoming material is processed in successive production phases and turned into the finished product. In the production cycle the following operations can be distinguished: technological operations, control, transport, maintenance and storing. Relatively high portion of time is consumed by various brakes in the production cycle structure, although due to the project management requirements one of the crucial issues is the proper placement of tasks in time, during the performance of technological operations. One of the crucial factors of the production process effectiveness is the relation of the working time to the break time, because its value influences the optimal usage of workstations and the economy of enterprise activities. Long production cycle negatively influences its adjustment to the changing market conditions. Therefore it is necessary to shorten production cycles.

One of the modern methodologies of production management is the OPT (Optimized Production Technology). OPT philosophy is currently used to support existing production management systems (MRP I, MRP II), or strengthen the Just–in–Time approach. Main target of OPT is the maximization of production result with determined production resources. These activities focus on elimination of production bottlenecks and relate to the general activities of the enterprise.

However, as indicated by the research, sometimes the suitable commercial production scheduling tools based on the theory of constraints used in the OTP systems do not bring expected results. This indicates that used optimization methods are not always the most effective (e.g. use of classical priority rules). Current research, in the scope of production scheduling, reveal that the best results can be reached with meta-heuristic methods, usually defined as the computing intelligence methods.

5.4 Influence of the task order on their realization time

Issues connected with the analysis of the classical scheduling problem for production clusters (groups of technologically changeable machines), despite relatively long research period, are still one of the basic optimization research subjects in the operations research. This is due to two facts: classical cluster problems module a series of real production processes and algorithms constructed for these problems can be relatively easy transferred to other less complicated processes.

Multistage nature of the dynamic optimization with discrete time in case of production can be presented as follows. Let us assume that an enterprise is processing the substation from the A state (resource) to the finishing state Z (finished product) in multistage production process. At every stage (production process operation) the responsible decision-maker has to select one of the possible variants of produced products order, every of them connected with a certain cost (operation finishing time). The following question should be asked: what order needs to be selected at every phase to minimize the total cost?

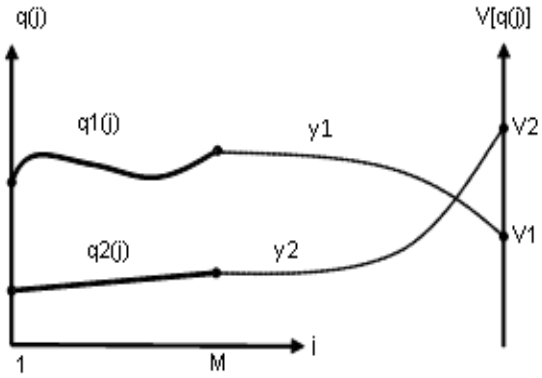

Figure 14. $V\,[q(j)]$ values in relation to the change of production task order trajectory in a production process *(source: self elaboration)*

Figure 14 illustrates the selected problem, where the x axis shows the particular phases (production operations) and the y axis shows states (the order). Starting point (first operation) is the point 1 and the finishing state (last operation) is the M point. In order the possible changes from the A = 1 state to the Z = M state, many different trajectories are created and researched. Every trajectory has a value, in this case the cost (time of manufacturing). Therefore, the main problem is to select the trajectory, where the optimal path needs to be selected in a way to assure the minimal total time of operations.

Let us assume that the functions above are the time trajectories marked as y1(t), y2(t), etc. (Figure 14). In the Figure 14 - V1 and V2 stand for suitable path values. For the researched scheduling case the value of a particular path can be marked as V[q(j)], where q (j) is the basic unit and marks the time "paths". That is why V is not the function of j, but is rather treated as the "q(j)" function. Instead of the V[q(j)] notation one can use the V[q] or V{q} marking. In case of V[q(j)], q(j) stands for the trajectory change marking, where „q(j)" = {q(1),...,q(M)}. Such record emphasizes that the change of the q path – variation of q path – but not the change j that lead to the change of V value.

Whereas the q symbol is used to pinpoint a particular state e.g. q(1) is a starting state and q(M) is the finishing state. When we speak of the q(j) path we do not give any special value to j but when we pinpoint a particular path or its segment, we use the notation q[1,M] or q[1,k], where k (1 < k < M). Optimal path is marked as y*(j) or y*.

More systematic problem solving method is required for complex issues. Numerous examples indicate that short-sighted optimization, increasing selected criterion on a single phase (production operation) forward (optimal ordering at every operation determined on the basis of the local aim function), do not bring the optimal path.

5.5 Schedule searching and (criteria) evaluation space

Searching space presented above can on one hand be used to generate solutions that use different ordering schema and on the other hand to present V[q(j)] relations reached with particular optimization techniques. Obviously, due to the combined nature of solved problem it is more proper to speak of path group (suboptimal) rather than about a single trajectory (solution).

For example the suboptimal solutions subspace, for the particular type of scheduling issue, reached with partially controlled random algorithm, can be presented with lower and upper values of q.

Performed research is aimed at the criterion function value (minimal time of task realization) with the use of currently most popular meta-heuristics (simulated annealing, tabu search, genetic algorithms) confirms its considerable effectiveness.

One of the characteristics used in production process analysis is the production type indicator k=n/m (n- part number, m- machine number). It can be described with the "production type" function $\mu_{TP}(k)$ (Figure 15).

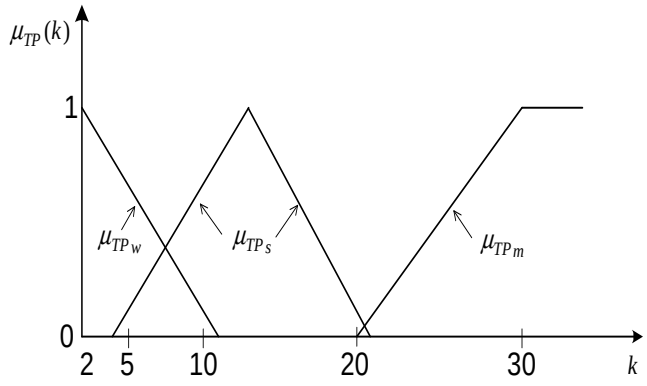

Figure 15. „Production type" function $\mu_{TP}(k)$
(source: self elaboration)

Let us assume that K={2, 3, ... , 30} – collection of states representing production type; TP={TPw, TPs, TPm} - collection of dispersed states representing production type: TPw – high volume production, TPs – mass production, TPm – short-run production; where dispersed collections corresponding to TPw, TPs, TPm have the values (Figure 15).

Particular TP values can be described as follows:

$$TPw = 1/k_2 + 0{,}5/k_6 + 0{,}1/k_{10}$$

$$TPs = 0{,}1/k_5 + 1/k_{13} + 0{,}1/k_{20}$$

$$TPm = 0{,}1/k_{21} + 0{,}5/k_{26} + 1/k_{30}$$

Searching space for the scheduling issue is shown in the coordinate system (j, k, q), where j operation of the process, k=n/m – production type indicator, q – order of product manufacturing at the j operation [q^T = {1,...,n}; q^{-T} = {n,...,1}] (Figure 16). This relation can also be shown in the coordinate system (j, w, q), where w – indicator describing the relations between realization time and realization time + startup time.

Reached results with the use of AHP method, described in the following part of the paper, can be presented in a way shown in the Figure 16.

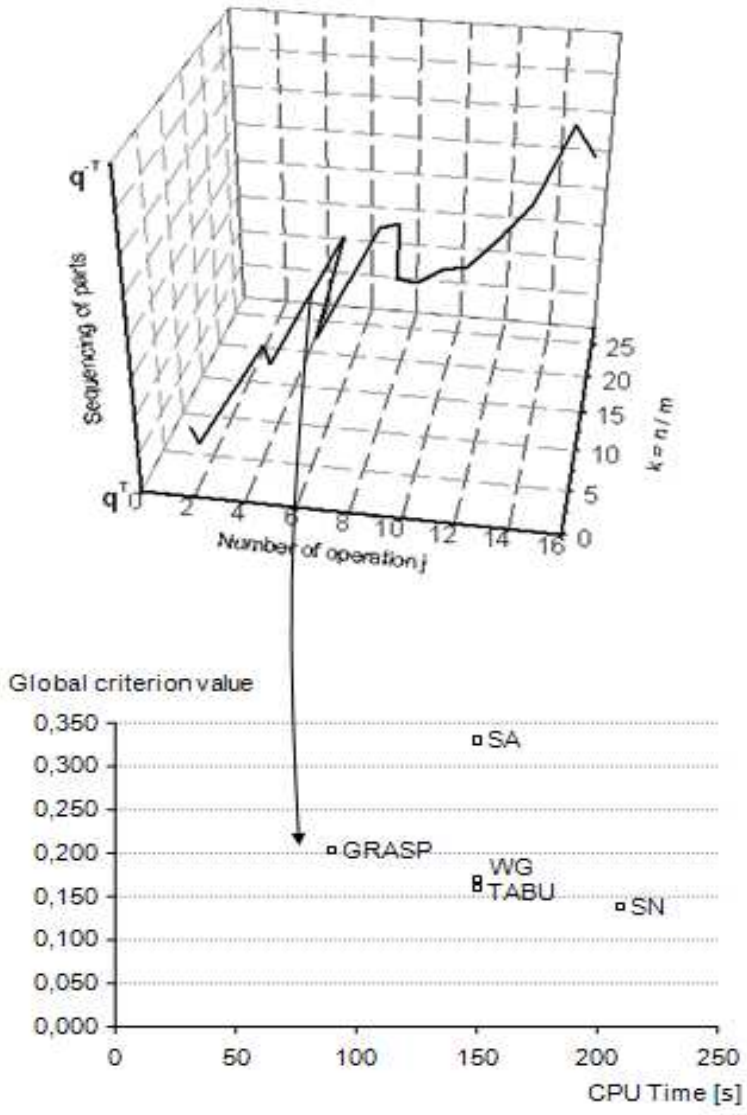

Figure 16. Schedule searching and evaluation space
(source: self elaboration)

5.6 Multi criteria evaluation with the use of the AHP method

Multi criteria decision method AHP allows formalizing the decision-making process.

Decision-making process structure with the use of AHP procedure is shown in the Figure 17. Decision-making process requires double hierarchy with five criteria and five alternatives (methods). First hierarchy represents few of the experiments (weights of the experiments are equal due to their equivalence - a=b=...=z).

Second hierarchy is a projection of selected criteria, which are: C - makespan, F – average flow time, L – maximal possible delayed delivery time, D – average latency and E – average speed-up of performed activities. These criteria have different weights (from a_1 to a_5) because some of them are more important than others e.g. the most important one is the makespan and it was assumed that it is 3-times more important for the decision-maker than the average flow time.

The alternatives are the five methods: GRASP, SN, TABU, SA, WG, with the use of which the experiments were performed. For a single schedule, received with every method, the values of, previously mentioned, schedule evaluation criteria were determined. Weights from a_{11} to a_{55} have alternatives. Weights of particular hierarchies must add up to 1, e.g. $a_1+a_2+a_3+a_4+a_5=1$; $a_{11}+a_{12}+a_{13}+a_{14}+a_{15}=1$.

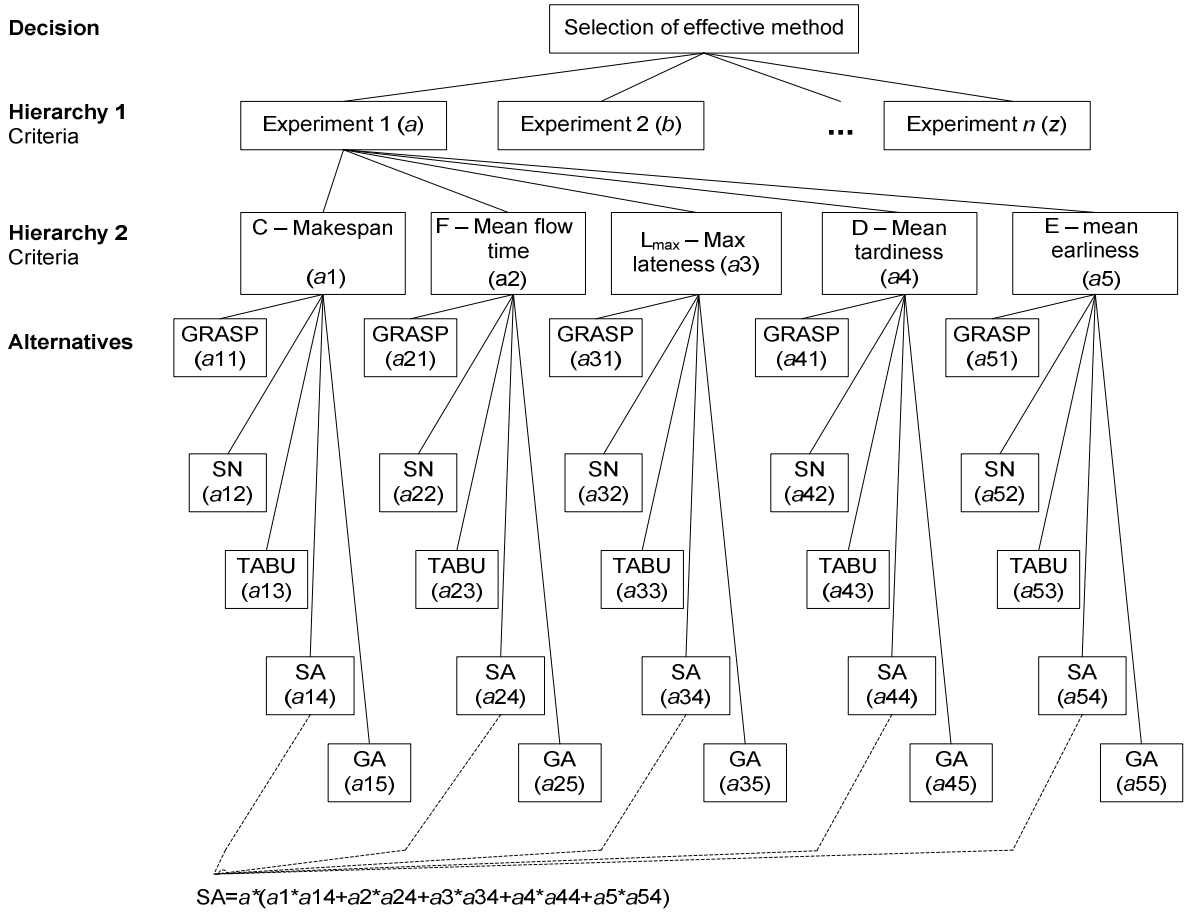

Figure 17. Decision-making process structure with the use of AHP procedure
(source: self elaboration)

The essence of the AHP is the determination of relative weights to order the alternative decisions. Assuming that we deal with n criterion in particular hierarchy, procedure assumes that the comparison matrix A with the n x n dimensions is created, which determines the decisions concerning the relative meaning of each criterion. Comparison is performed in pairs in a way that the i (i =1,2,...,n) criterion in the row is classified in relation to every other criterion. We assume that a_{ij} defines the (i,j) element in the A, matrix, whereas AHP uses scale e.g. from 1 to 9, in which a_{ij}=1 means that i and j are equally important, a_{ij} =5 indicates that i is more important than j, and a_{ij} =9 means that i is definitely more important than j. As a result if a_i =k than a_{ji} =1/k.also all elements of A matrix that are on the diagonal must equal 1, because they order the criterion with relation to themselves.

Steps, that need to be undertaken with the use of AHP method are as follows:

1. First step is the construction of the comparison matrix, which allows to compare the criteria in pairs.

This matrix indicates that e.g. C - makespan, is more important than L – maximal accepted delay and that is why a_{13} =4 and automatically a_{31} =1/4=0,25.

$$A = \begin{array}{c} \\ C \\ F \\ L \\ D \\ E \end{array} \begin{array}{c} \begin{array}{ccccc} C & F & L & D & E \end{array} \\ \begin{pmatrix} 1 & 3{,}000 & 4{,}000 & 2{,}000 & 4{,}000 \\ 0{,}333 & 1 & 1{,}333 & 0{,}667 & 1{,}333 \\ 0{,}250 & 0{,}750 & 1 & 0{,}500 & 1{,}000 \\ 0{,}500 & 1{,}500 & 2{,}000 & 1 & 2{,}000 \\ 0{,}250 & 0{,}750 & 1{,}000 & 0{,}500 & 1 \end{pmatrix} \end{array}$$

2. The next stage is creation, for every comparison matrix A, matrix of normalized values N. This requires the division of every A matrix element with the sum of elements from this column.

$$N = \begin{array}{c} \\ C \\ F \\ L \\ D \\ E \end{array} \begin{array}{c} \begin{array}{ccccc} C & F & L & L & E \end{array} \\ \begin{pmatrix} 0{,}429 & 0{,}429 & 0{,}429 & 0{,}429 & 0{,}429 \\ 0{,}143 & 0{,}143 & 0{,}143 & 0{,}143 & 0{,}143 \\ 0{,}107 & 0{,}107 & 0{,}107 & 0{,}107 & 0{,}107 \\ 0{,}214 & 0{,}214 & 0{,}214 & 0{,}214 & 0{,}214 \\ 0{,}107 & 0{,}107 & 0{,}107 & 0{,}107 & 0{,}107 \end{pmatrix} \end{array}$$

3. Third step is the calculation of weights for the criteria as an average for every matrix row in the normalized values matrix, e.g. fr the C criterion it equals:

$$w_C = \frac{0{,}429 + 0{,}429 + 0{,}429 + 0{,}429 + 0{,}429}{5} = 0{,}429$$

The result of the calculations is:

$(w_C, w_F, w_L, w_D, w_E) =$
$(0{,}429;\ \ 0{,}143;\ \ 0{,}107;\ \ 0{,}214;\ \ 0{,}107)$

4. Further activities include creation of comparison matrix for the alternatives.

One of the comparison matrixes is presented blow:

$$A_F = \begin{array}{c} \\ GRASP \\ ANN \\ TS \\ SA \\ WG \end{array} \begin{array}{c} \begin{array}{ccccc} GRASP & ANN & TS & SA & WG \end{array} \\ \begin{pmatrix} 1 & 1{,}165 & 1{,}087 & 1{,}174 & 1{,}004 \\ 0{,}858 & 1 & 0{,}933 & 1{,}008 & 0{,}862 \\ 0{,}920 & 1{,}072 & 1 & 1{,}081 & 0{,}924 \\ 0{,}852 & 0{,}992 & 0{,}925 & 1 & 0{,}855 \\ 0{,}996 & 1{,}161 & 1{,}082 & 1{,}170 & 1 \end{pmatrix} \end{array}$$

5. Normalized values matrixes N for the alternatives need to be created at every stage of the comparison matrix A.

$$N_F = \begin{array}{c} \\ GRASP \\ ANN \\ TS \\ SA \\ WG \end{array} \begin{array}{c} \begin{array}{ccccc} GRASP & ANN & TS & SA & WG \end{array} \\ \begin{pmatrix} 0{,}216 & 0{,}216 & 0{,}216 & 0{,}216 & 0{,}216 \\ 0{,}186 & 0{,}186 & 0{,}186 & 0{,}186 & 0{,}186 \\ 0{,}199 & 0{,}199 & 0{,}199 & 0{,}199 & 0{,}199 \\ 0{,}184 & 0{,}184 & 0{,}184 & 0{,}184 & 0{,}184 \\ 0{,}215 & 0{,}215 & 0{,}215 & 0{,}215 & 0{,}215 \end{pmatrix} \end{array}$$

6. Sixth step (similar to third step) calculates relative weights w for the alternatives as an average for every row in the normalized values matrix. The result of the calculation is:

$(w_{F(GRASP)}, w_{F(ANN)}, w_{F(TS)}, w_{F(SA)}, w_{F(WG)}) =$
$(0{,}216;\ 0{,}186;\ 0{,}199;\ 0{,}184;\ 0{,}215)$

For example one of the weights in the N_F matrix for the fourth alternative is:

$$w_F = \frac{0{,}184 + 0{,}184 + 0{,}184 + 0{,}184 + 0{,}184}{5} = 0{,}184$$

7. Classification of every method is performed in the end, based on the calculations that include calculated weights.

Calculation results for all methods are collected in the table 2. Results were also illustrated in the chart - Figure 18.

Table 2. Method classification
(source: self elaboration)

GRASP	0,203
SN	0,137
TABU	0,161
SA	0,330
WG	0,169

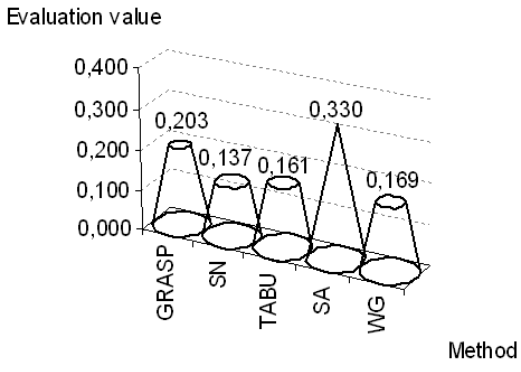

Figure 18. Graphical illustration of method classification
(source: self elaboration)

6 Project scheduling in the stochastic environment with the use of modern tools

6.1 Project scheduling in the stochastic environment

Most activities in the scope of limited resources constrained project scheduling (RCPS) focuses on the project minimization time in the deterministic environment. Project activities are usually bound with uncertainty, which can result from variety of sources: tasks can be performed faster or slower than originally estimated, resources can be unavailable, material delivery can be delayed etc.

Resources constrained project scheduling in the stochastic environment (stochastic RCPS - SRCPS) is a stochastic equivalent of RCPS issue, where time of activity are not known in advance but rather represented as the random variable.

SRCPS activities are performed seldom. Few examples from this scope can be fount in [34], where an experiment with division and branch-and-bound algorithms. In [37] greedy and local search heuristics were elaborated. Time/resources relations with stochastic realization time are presented in [16, 17].

In [6] analysis is performed for many possible aim functions of the project scheduling in stochastic environment. Experiment proved that different aim functions are similar and, for most practical appliances, the focus on the minimization of estimated general task performance time (makespan) is sufficient.

GRASP was elaborated - heuristics, which application brings high quality solutions, exceeding the existing algorithms for the minimization of existing makespan value. Moreover, the makespan value distribution, for particular scheduling policy, was analyzed.

SRCPS issue project realization can be deliberated as a dynamic decision-making process. The solution is the *P* policy, which determines the activities in determined decision making periods (decision times).

Decision times are usually t=0 (project start) and activity finishing time. Therefore the schedule is constructed gradually in time. In the decision making during the *t* time it is only possible to use the information that will be available before and during this time; this requirement is usually deliberated as an unexpected constraint.

In [6] the elaborated GRASP-heuristics is compared with other SRCPS algorithms present in the literature. Genetic algorithm (GA) [5] is deliberated, where the same data collection was used with *U*1 and *U*2 distribution and Exp (normal or exponential distributions). Comparison was also made for tabu search and simulated annealing [37].

6.2 Project scheduling with the use of stochastic optimization

Hybrid algorithms are more often used in project scheduling. One of the stochastic optimization methods is the simulated annealing (SA). In [32] the SA algorithm together with the variable neighborhood search for the optimization of scheduling with limited resources, time and other constraints, mainly for RCPS issues, is presented.

Apart form genetic algorithms, simulated annealing procedures or tabu search, other modern stochastic tools are used for project scheduling. One of such solutions is the Particle Swarm Optimization.

Particle Swarm Optimization (PSO) is one of the modern heuristic stochastic optimization algorithms based on populations. Models used in the swarm optimization keep some of the heuristic features characteristic for living organisms e.g. ability to herd (cumulate) or possibility to find certain points in space. Virtual units with these features are defined as the particles.

Intelligent particle swarms are identified with the properties of every unit which: determined coordinates, knows its position, knows the evaluation function value for its position, has determined speed and turn, remembers the best position ever reached, remembers the evaluation function value for its best position, knows its neighbors, knows the evaluation function value of its neighbors.

Determination of "solution projection" mechanism is one of the crucial factors in the specific domain problem solving PSO application. For the project scheduling issue solution in [13], the concept of energy function was introduced.

State variable V_{ijk} is defined as the performance or work *i* that is performed at the *j* machine in given *k* time. Moreover, V_{ijk} =1 state indicates that the work *i* is realized at the machine *j* in time *k*, otherwise V_{ijk} = 0. Because the *j* machine can perform only one work *i* in given time *k*, so the energy can be defined as follows [13]:

$$\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=1}^{T}\sum_{i_1=1,i_1\neq i}^{N} V_{ijk}V_{i_1jk} \tag{14}$$

where V_{ijk} is defined as above; i (i=1,...,N) presents the general number of tasks for scheduling; j (1,...,M) presents the general number of machines to use; k determines the specific time from 1 to T, the latest possible finishing of work. Minimal value of this expression equals zero, when both V_{ijk} and V_{i1jk} are equal zero. It is assumed that if a work is assigned to a particular machine, then it has to be performed in total at this machine. According to this constraint the energy function is determined as follows [13]:

$$\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=1}^{T}\sum_{j_1=1,j_1\neq j}^{M}\sum_{k_1=1}^{T} V_{ijk}V_{i_1jk_1} \tag{15}$$

Number of other more complex energy function forms, connected with the determination of the constraint scheduling, were introduced in the work [PSO] as well as the algorithm to solve this issue was presented. In this work the aim of the energy function is the evaluation of energetic value of the candidate for the solving of every particle and selection of the best solution for the next iteration according to the energy value. Therefore coding the particle for the projection in a discrete matrix (with element values from the 0-1 range) is a significant factor in the use of energy function for the PSO.

Single-dimensional vector for the marking of a three-dimensional candidate solutions discrete matrix was used in the paper. Particle P_i is represented in the swarm by s dimensions and can be determined as $P_i = [p_1,p_2,..., p_s]$. Where s stands for the size of the three dimensional matrix of the solution candidates, that is: work = 4, resource = 2, time = 2.

S-dimensional vector of each particle is calculated with the product of: work x resource x time. In this example s = 16.

In the three-dimensional candidate solutions matrix the X axis stands for the "work" variable and presents the work form 1 to N, where N is the general number of works designated for ordering.

Y axis stands for "machine" variable and given j point at this axis indicates a dedicated machine from the collection from 1 to M.

Z axis stands for "time" and k is the specific time, which should be lower or equal T (finishing work). Therefore the V_{ijk} =1 state variable means that the work i is realized at the j machine in the k time; otherwise V_{ijk} = 0. Presented PSO optimization, which uses the energy function, is a satisfactory work scheduling method with the use of multiple resources (multiple machines).

7 Summary

Experiments performed in the paper as well as the literature analysis confirm the high effectiveness of the heuristic algorithms, including GRASP both in deterministic and stochastic environment.

For the selected scheduling issue the relations between makespan (minimal total time of operations) and average production cycle time as well as machine usage in relation to average production cycle time, were presented.

Criterion relations in three-dimensional space were presented, apart form the relations in two-dimensional criteria spaces. Production process flow was presented in a three-dimensional space determined by the order of activities at particular operations and production type indicator.

Selected modern dimensions of scheduling optimization in the stochastic environment and stochastic optimization tools were presented.

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INFORMATION SECURITY ASPECT OF OPERATIONAL RISK MANAGEMENT

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Abstract: Improving organization means on the one hand searching for adequate product (service) matched to the market, on the other hand shaping the ability to react on risks caused by that activity. The second should consist of identifying and estimating types of risk, and consequently creating solutions securing from possible forms of it's realization (disturbances), following rules of rational choice of security measures as seen in their relation to costs and effectiveness. Activities of creating the security measures should be organized as constantly developing and perfecting and as such they need formal place in organizational structure and rules of management

Key words: operational risk, risk management, information security, information security management, IT security.

1 Operational risk

1.1 Operational risk management

Concept of operational risk, first as a definition and, next, as a full classification, appeared for the first time in documentation of Basel Committee[1] in the middle of 1990's. Although in its English form operational risk management is unfortunately similar to operational management of risk, the term became gradually more and more popular outside the banking industry and, recently, even outside the finance sector.

According to Basel Committee "operational risk is the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events." [1]. "The definition includes legal risk (i.e. the risk of loss resulting from failure to comply with laws, ethical standards and contractual obligations) but excludes strategic and reputational risk." [2].

An important matter seems to be the observation concerning universal character of the Basel Committee's concept from the point of view of other branches of economy. It can be safely stated that operational risk is the risk of sufficiently efficient functioning of an organization, characterized by the same regularities in case of financial institutions, production plants, trade companies or public administration.

[1] Basel Committee on Banking Supervision "Operational Risk Management", IX.1998.

Risk, as a characteristic of activity, is subject to influence of conscious management, which means both possibility and professional obligation to manage it in such a way to identify, analyze and estimate it. On basis of this knowledge, its level and signs should be influenced. Classic model of such approach to management is presented in Fig. 1.

Such a complex risk management should lead to a situation, in which the organization (management) is aware of risk and its magnitude. Awareness means, that risk has been identified, researched from the point of view of its causes, way of realization and scope of possible effects.

The most important stages of risk management are: risk identification, analysis and measurement (assessment). Until this happens, it is hard to speak concretely of risk, because risk-limiting or security actions cannot yet be taken. In general, it can be stated that, without knowing the risk, one deals with a threat viewed, above all, as: unawareness, recklessness, negligence.

When appropriate diligence of activity is maintained, there is no speaking of unclear threat. On the contrary, the risk is referred to as probability of given result or probability distribution of an imaginable set of results. This is described by the most general risk equation: $R = P \times I$, where R refers to risk, P to probability of an event, I to the influence of the event on the organizational activity (size of losses).

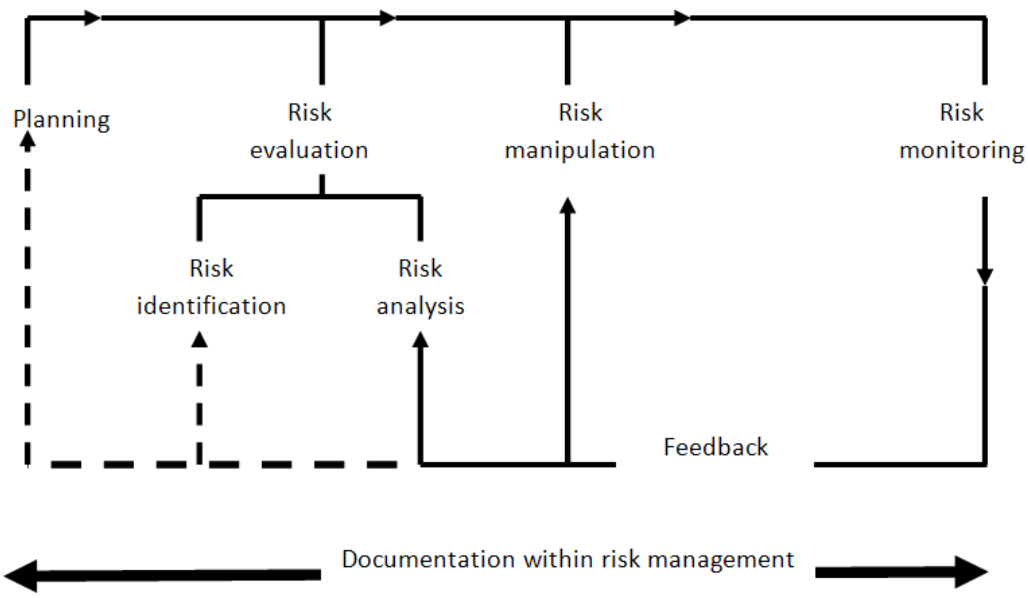


Figure1. Structure of risk management process
(source: [6])

In the operational risk management it is not a risk of single, critical event that matters, but the general map of risk composed of all possible critical events. This enables us to determine total risk, risk of especially probable events or risk of especially severe events. The above mentioned equation points to two fundamental risk factors, which, in the course of analysis, allow us to classify particular possible critical events according to their importance for the appropriate functioning of the organization. Subsequently, intensive actions can be carried out towards those critical events, which were found most important during the analysis. This is shown in Fig. 2.

Reaction to critical events, viewed as signs of risk, may refer to causes of these events (prevention as ex-ante activity) or to their results (therapy as ex-post activity). The first type of activity is referred to as ensuring operational security, the second one as ensuring business continuity. Reactions of both types base on analysis of risk, its causes and effects, but also on the analysis of core organizational activity – the one that is characterized by the given sign of risk. In reality, risk reveals itself through phenomena of a given character, but the final influence on organization is only possible, when such phenomenon encounters organizational vulnerability concerning one or a few organizational processes, either in the sense of organizational imperfectness of such a process, or weakness with regard to choice of resources used by the process. Therefore, risk analysis consists in determination and evaluation of:

- processes which decide about realization of organizational tasks,
- set of disrupting phenomena and probability of their occurrence,
- resources vulnerability, in the sense of magnitude of disruptive phenomenon potential influence on organizational activity.

A desirable situation is to possess sufficiently reliable statistical data, which describe probability distribution of disruptive events. In reality, however, this happens with regard to not so many types of events, though i.e. Basel Committee has recommended, and Polish governance organs including Polish Financial Supervision Authority (before 1.01. 2008 Commission for Banking Supervision) instructed to gather such statistical data within framework of systematic risk analysis. In case such statistical data is unavailable, what remains is to perform evaluation based on risk factors assessment. It is, nevertheless, necessary to assume that an entity with high organizational culture, independently from governance bodies' requirements, will gather and analyze adequate statistical data, referring to the organization and its activity, out of its own belief.

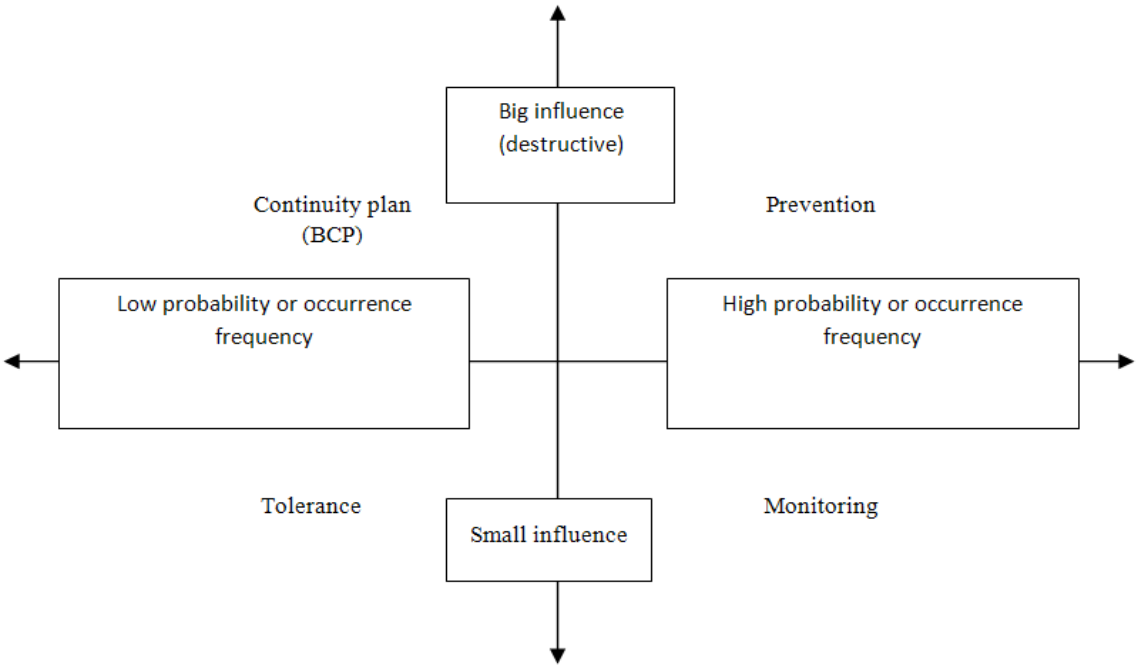


Figure 2. Model approach to threats
(source: [16])

Currently, there exists no final classification or convincing-enough interpretation of types of operational risk. At present, it is only possible to suggest directions for such classification, which could consist in presenting types of risk in three different orders:

- from the point of view of causes of critical events,
- from the point of view of mechanism of their realization,
- from the point of view of critical events results.

An approach towards classification of operational risk from the point of view of its causes could be the well known and often quoted in literature proposition [10]: fraud risk, lack of reconstruction plans after a catastrophe, regulatory risk, risk of losing reputation, administrative risk. However, this classification is relatively superficial because it lacks clear explanation for the chosen criteria of division.

This requirement is, on the other hand, fulfilled by classification shown in Table 1. It is based on the observation, that risk realization is a result of given type of threat's interference with an organizational vulnerability, which reflects organizational actions inefficiency. Therefore, organization and its threat vulnerability was treated with the use of process approach, which includes interpreting management model as goal realization through a cycle of managerial activities based on use of basic types of resources.

The classification described below does not meet such rigorous assumptions concerning ordering criteria. However, it is the most commonly quoted one because it is recommended in Basel II documentation and EU regulations as well as Polish Banking law. It consists in dividing risk into categories: internal fraud, external fraud, staff policy and occupational safety, clients, products and business policy, damage to physical assets, disruption of activity and system failures, carrying out transactions, process management [8].

This classification, as an approach of experienced professionals to order the list of well-known and repetitive critical events, is also used outside the banking sector. However, when it comes to designing security and business continuity solutions, this classification causes some problems. These problems refer to lack of sufficient precision in distinguishing between particular categories and ambiguous ascribing of responsibility. Therefore, when designing risk management solutions, most commonly a simple division is used, which encompasses:

- management of physical and technical security,
- management of personal security,
- management of information and IT systems security,
- business continuity management.

Table 1. Classification of types of operational risk
(source: [16])

		↑ ***Vulnerabilities*** ↑					
		Organizational efficiency					
↓ ***Threats*** ↓	**Environment**	Risk of natural disasters					
		Risk of terrorism					
		Risk of external disruption of functional working environment (i.e. lack of access to headquarters)					
	Core processes	Risk of physical working environment disruption (i.e. too high temperature)					
		Risk of internal disruption of functional working environment (i.e. strike, accident)					
		Risk of disruption of technical working environment (i.e. A/C malfunction) including Risk of disruption of IT working environment (i.e. computer malfunction)					
	Supporting processes	***Areas of risk realization (expression of resources security and organization)***	***Ideal organization postulates (expression of management goals)***				
				Effective	*Efficient (organizationally optimal)*	*Rational (cost-optimal)*	*Safe*	*Repetitive*
			Human resources	Risk due to lack of competence	Lack of staff reserves risk	Risk of staff fluctuation	Risk of relative interpretation Risk of ill will	Risk of routine (fossilization)
			Material resources	Risk due to lack of functionality	Risk due to lack of material reserves		Risk of side-effects	Risk of wearing-out
			Financial resources	Risk due to unsuitable expenditures	Risk of excessive expenditure		Risk of running out of resources	
			Information resources	Risk due to lack of full information	Risk of not keeping up with development		Risk of inaccessibility	Risk of distortion
	Management processes		*Organization*	Risk of an incident (malfunction)	Risk due to lack of organizational potential		Risk of security superiority over efficiency	Risk of deficiencies

1.2 Risk analysis

The most common approach is so called BIA (business impact analysis), based on identification of core processes and their particularly critical elements as well as factors, which may negatively exploit this criticality. Such a primary analysis is then described in detail through assessment of the identified risk. An exemplary assessment is provided by TSM-ORA method (total security management – operational risk assessment) [17].

First stage of analysis in this method consists of:

- determination of system boundaries, within which its resources are located,
- description of environment, in which the system operates (both physical as well as legal and organizational one),
- definition of assets.

It consists in determining goals and business system functions, which require ensuring resource availability; next, in determining system processes aimed at realization of system goals, and, finally, determining resources (also intangible), which enable that. Assets should be assigned values, which would determine their importance in the light of system goals. These values should relate to costs of obtaining and maintaining the assets.

Second stage is the identification of threats. Their analysis consists in determining which of them actually concern the analyzed system and what is the probability of their occurrence. This probability may depend on the type and value of business system asstes, which are exposed to particular threats. Evaluation of such resource vulnerability may be carried out in two ways. First of them is to create a list of system weaknesses, which could be used by potential sources of threats, and to assess the easiness of their use. This technique

is difficult in the sense that business weaknesses are most often observed after the vulnerability has been used and caused disruption. A reliable-enough evaluation is possible in this case only on the basis of gathered statistics of incidents, which, in reality, are still very rare. The second method is to start from identified threats and evaluate, how vulnerable to them the particular assets are. When it comes to system interaction with threat, as a result of use of vulnerability, we speak of disruption.

Crowning of the risk analysis process is elaboration of map of potential disruptions, which comes into being after combining analysis with assessment of two factors (see Fig. 2): probability of the disruption and influence of this disruption on the business system.

One consequence of risk analysis is that, subsequently, works on ensuring security and business continuity are being undertaken. Those are achieved through solutions for manipulating and monitoring signs of risk.

1.3 Codes of best practices

Such codes of best practices are [14]:

- COSO-ERM, Committee of Sponsoring Organizations of the Treadway Commission – Enterprise Risk Management,
- FERMA, Federation of European Risk Management Associations,
- POLRISK, Polish Risk Management Association,
- MiFID, Market in Financial Instruments Directive,
- M recommendation of Polish Banking Supervision Inspectorate,
- ISO 27005 standard,
- AS/NZS 4360 standard.

Risk management maturity may be evaluated with the use of model suggested for banking industry with regard to financial risks (BBA model [3]). A sufficient analogy exists here concerning organizational and methodical rules.

2 Organizational security

2.1 Security viewed as value

In the context of operational risk management, security is a certain state of social and subjective reality, limited to a single organization or branch of similar organizations. From the general society point of view, which is characteristic for crisis management, it appears to be, above all, a value. “On one hand it is a certain social, civilization, cultural, economic and ecologic value, etc. – on the other, however – it is a hard-to-overrate existential, moral and spiritual value” [15].

In accordance with Maslow’s research [11], feeling of security is the second need among fundamental human needs. Therefore, it is right to say that “goal of crisis situation management is not just fastest possible return to normality. The essence of this type of management is to force an organization to become aware of moral and social responsibility with regard to internal and external stakeholders.” [13]. Creating such a awareness, both in solely professional (organizational culture) as well as social and moral dimension, is currently a great challenge in the field of management. It is defined as corporate social responsibility (main idea of Forum in Davos, since 1980’s).

2.2 Ensuring security viewed as risk manipulation

Security issues are realized through solutions, which mainly aim at prevention, consisting in observation of threat factors, monitoring of characteristic and typical symptoms of their activation and prevention of their interaction with organizational business system and organization environment. If these actions fail and the organizational activity is disrupted, it means it is the time for planned and organized reconstructive activity, which should determine the acceptable ability to maintain business continuity.

In design of security solutions, the following general rules, which are mainly referred to people as the main source and object of threat, are used [16]:

- rule of authorized access – each employee has undergone a training in principles of security and protection and meets the job and information access criteria (official secrets),
- rule of necessary privileges – each employee has only these job and information access rights, which are necessary for him to carry out his tasks,
- rule of necessary knowledge – each employee has at least the knowledge about the job, to which he has access, that is necessary to carry out his tasks,
- rule of necessary services – organization provides only those services which are demanded by client,
- rule of security measures – each security mechanism must be protected by another (similar) one, and

in special cases additional (third), independent security measure may be used,
- rule of collective awareness – all employees should be aware of the necessity to protect organizational resources and actively participate in this process,
- rule of individual responsibility – particular persons are responsible for particular elements' security,
- rule of necessary presence – the right to be present at given places is granted only to authorized persons,
- rule of constant readiness – organization is prepared for each and every threat; temporary switching-off of security mechanisms is unacceptable,
- rule of weakest link – level of security is determined by the weakest (least secured) element,
- rule of completeness – effective security measure is only possible when a complex approach is taken, which includes all levels and parts of the general working process,
- rule of evolution – each organization must constantly adapt its internal mechanisms to changing external conditions,
- rule of suitability – mechanisms used must be suitable to the situation,
- rule of acceptable balance – security measures used cannot exceed the level of acceptance (cost measures with regard to outlays, effects and potential losses are especially advised here).

2.3 Areas of ensuring organizational security

Ensuring organizational security refers to particular types of resources. Therefore, personal, physical, technical, financial, information and IT security are distinguished. As can easily be seen, particular categories remain in tight relationship to one another and, partially, even overlap. One speaks of: physical security of people, security of personal data, financial instruments' physical security etc.

Ensuring physical and technical security is derived from the following key rationales:
- need for precise definition of organizational location boundaries and spheres of provision of particular functions and services for clients, as well as through and for the organization employees,
- need for imagining and defining potential threats and their possible realization scenarios as disruptions of normal organizational work,
- need for organization of processes concerning organizational functions, organization of ensuring physical security as well as choosing and applying security measures, including technical ones.

Employment of good practices with regard to this issue consists in elaboration of:
- division (classification) of security zones,
- rules for choosing security solutions,
- security rules for particular zones,
- rules of access authorization,
- rules of security control,
- rules for choosing and verifying security employees.

Ensuring personal security, on the other hand, is derived from the following key rationales:
- need for choosing and employing people who are characterized by high level of morale and responsibility (so called "righteousness rule"),
- requirement concerning adequateness of employees' professional sills with their tasks and potential ability to adapt to changing requirements, which may result from organizational and business development of the organization or competitive market development (so called "competence rule").

Employment of good practices with regard to this issue consists in elaboration of:
- employee ethics code,
- rules of employees selection and verification,
- rules of entering and leaving the organization,
- rules of determining individual and team roles as well as designing workplaces,
- rules of delegating tasks,
- rules of remuneration and motivation,
- rules of staff reviews,
- rules of determining individual career paths,
- rules of promoting employees,
- rules of systematic employee training,
- rules of protecting secrets of company, clients, etc.

As far as ensuring information security is concerned, it is derived from the following key rationale:
- ensuring that information is made accessible only to authorized persons (so called confidentiality rule),
- ensuring total precision and completeness of information and methods of processing information (so called "integrity rule"),
- ensuring that authorized persons have access to information and related assets only when there is such a need (accessibility rule).

Three levels of content-related information security management are distinguished:

- information security policy – determination of security requirements at the level of whole organization and with regard to all information groups, systems and solutions, which are used to process these information (including storing and transportation),
- information group – specification of security requirements for information groups, mainly distinguished as an autonomous class of information used for specific problems, processed in a given functional department (i.e. financial information, staff information, client information, etc.), but also, in some cases, covered by separate legal regulation i.e.: classified information, personal data information,
- processing system – fulfillment of security requirements both by traditional and IT systems, which process certain groups of information for particular categories of users.

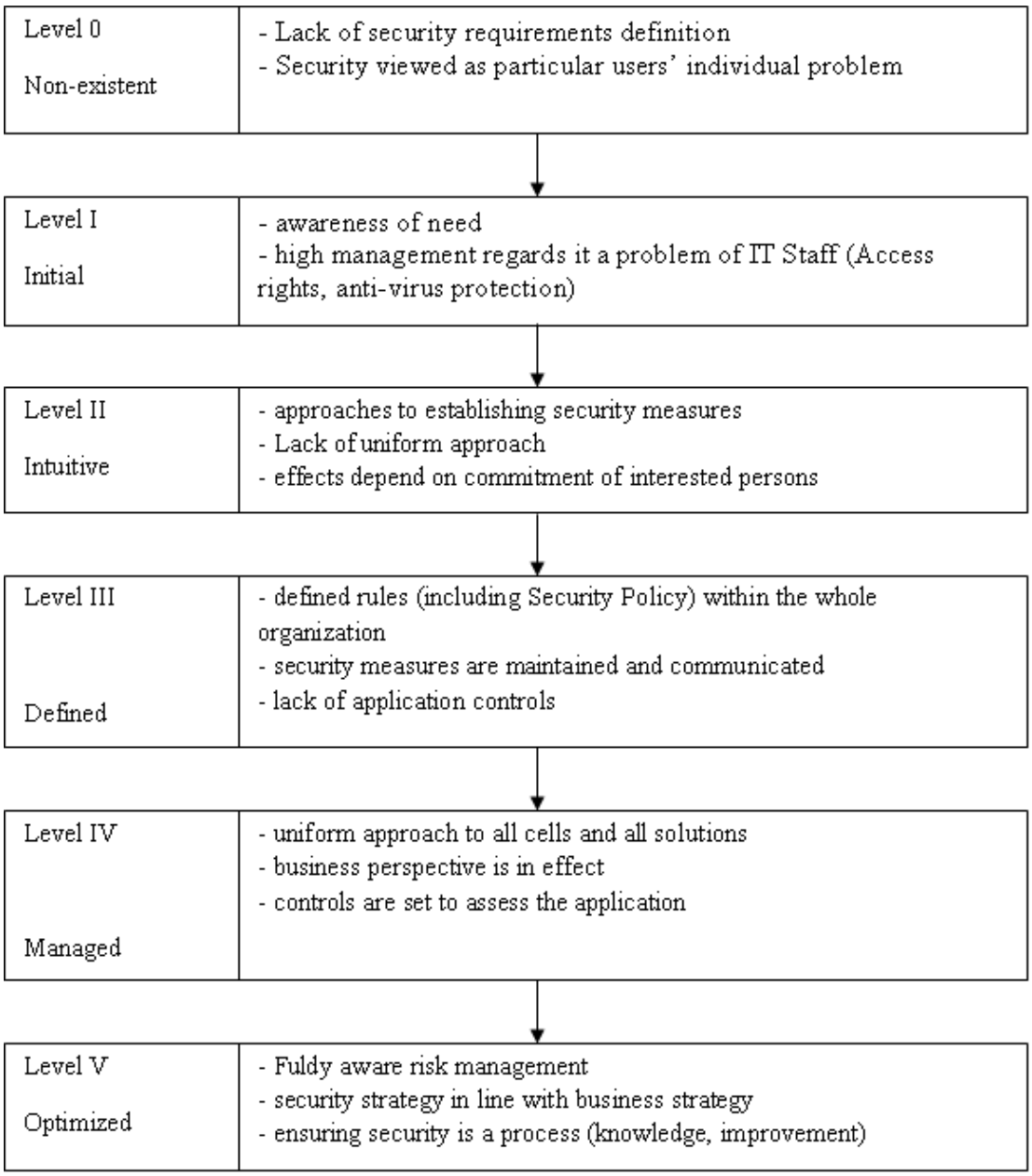


Figure 3. Information security management maturity levels
(source: [7])

2.4 Management of ensuring security

Security management in an organization is conducted differently, depending on the area it concerns. And so, physical security management, but also occupational hygiene and safety, is institutionalized (partly defined by general law i.e. concerning occupational hygiene and safety, or industry law, i.e. banking) and takes form of separate workstations/cells. On the other hand, personal security management in the area of "hard approach to HR" is also institutionalized, whereas in case of "soft approach to HR" it has a character of a certain organizational activity policy towards employees and of researching its effectiveness in relation to employee attitudes towards tasks and the employer. Furthermore, information security management consists in appointing specific roles to employees, who, at the same time, fulfill other tasks within the organization. Especially with regard to IT security it is connected with the necessity of constant development of professional knowledge from the field of IT, which is dynamically changing. Similarly, the security requirements change.

In case of security ensuring activities there is a general rule of separating tasks concerning determination of security standards/requirements/rules and controlling their fulfillment/abidance from tasks concerning their implementation/appliance. This is achieved through delegating them to separate persons/organizational cells.

2.5 Codes of best practices

- Act on Protection of Persons and Property (consolidated text.: Journal of Laws 2005, no. 145, pos. 1221),
- Banking Act,
- Personal Data Protection Act,
- European Committee resolution no. 2001/246/EC of 19 March 2001 (reviewed on 19.11.2001),
- ISO/IEC 27002:2007.

Fulfillment of the information security ensuring rules described so far is a basis for evaluation of security management maturity. A model for such evaluation was proposed by Information Systems Audit and Control Association (ISACA).

3 Information security

3.1 Information security management

Ensuring security of the processed information in an organization has to consist in providing complex solutions to the problems of information and information security management, as well as in implementation and development of security measures (organizational and technical). The primary goal is the protection of the interest of a given organization (business security) and minimizing risk of legal consequences on the ground of lack of security or improper activities towards information, the protection of which is required by law. Therefore, a complex solution must encompass both business and legal aspects of information security.

Such a complex approach recommended by various standards is ISMS (Information Security Management System ISO 27001, in Poland: PN-ISO/IEC 27001:2007). "Information Security Management System is a part of the total management system, based on the approach which results from business risk, referring to establishing, implementing, using, monitoring maintaining and improving information security". ISMS has an interdisciplinary character, combining different disciplines including: information technology, law, organization and management. Introduction of this type of system is important because it creates a stable company image of being worth the trust of a wide group of stakeholders. Standards do not say precisely how to build the management system. Therefore, in practice, it is possible to base on expert solutions. According to TISM (Total Information Security Management – ENSI methodology) methodology, organization of ensuring information security, with regard to information that is processed within the organization, consists in establishing rules of information management at three levels: Information Security Policy, Information Groups and Processing Systems (source: [4, 5]).

At the level of information security policy basic rules for protection of information within organization are established. At the level of information group specific requirements towards protection for given group of information are established. At the level of processing system the fulfillment of requirements of the higher levels by a processing system, containing given group of information, is assessed.

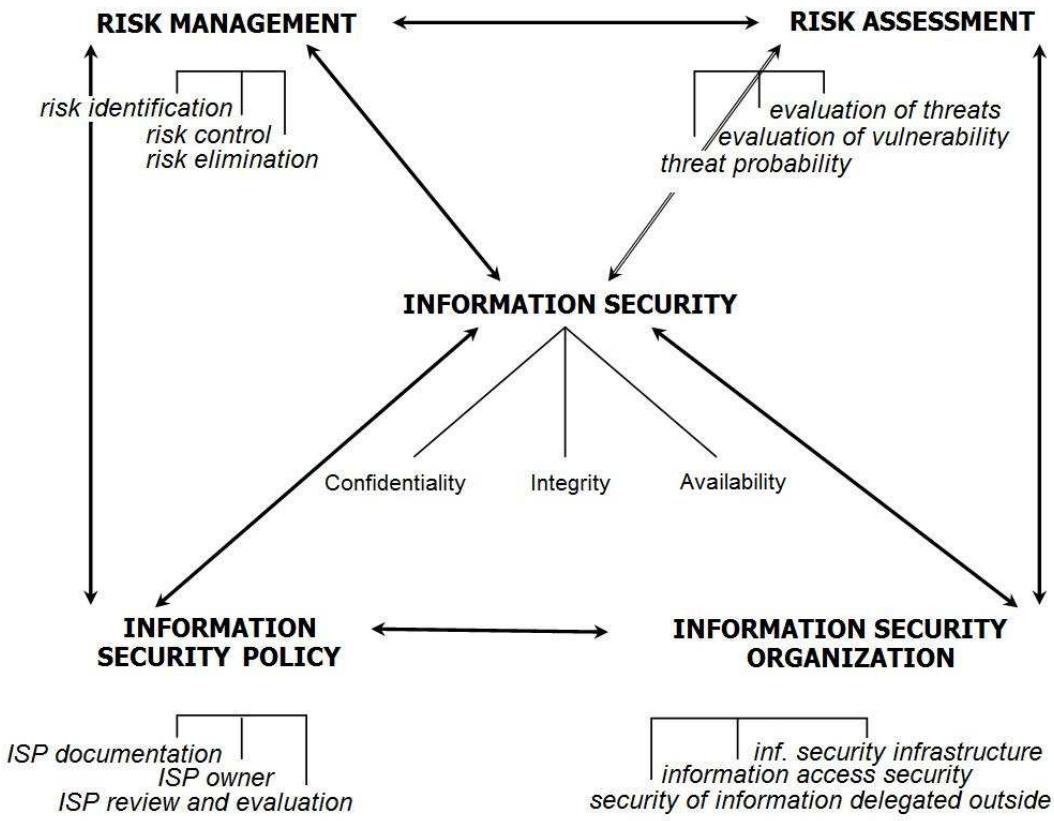


Figure 4. Aspects of information security management
(source: [4])

Information security concept is based on three pillars:

- existence of a suitable organizational structure with regard to information security management,
- information classification – division into limited information (company secrets, to be used within company) and public information (publicly available),

setting appropriate processing (zones) and storing places (IT system, paper archives).

3.2 Structure of information security management

Through elaboration of information security policy and appropriate internal regulations of an organization a specific information and information security management structure is formed. It consists, in accordance with TISM, in determination of proper managerial and controlling roles, which, in line with the "rule of two" (separate management of information processing and establishment of security guidelines and control of compliance with them) are grouped in two functional departments: managerial (administrative) and control (security), and refer to three levels of information security management presented above.

At the level of information security policy the following roles are defined: Information Manager (IM – most often a member of the highest management) and Plenipotentiary for Protection of Information (PPI). At the level of information group, the roles of: Information Resource Manager (IRM – most often the head of organizational department) and Information Security Administrator (ISA), are defined. At the level of information processing the roles are: System Administrator (SA), System Security Administrator (SSA), for big organizations Chief Security Systems Administrator (CSSA). The primary role in information security management is played by PPI. All the employees of both departments, who fulfill the mentioned roles are subordinate to him. Control (security) department is responsible for supervision and control of information security at each of the three levels. The roles cannot be combined between the departments. However, one person can fulfill the role of ISA for a couple of information groups. Also, one person can be the SSA for a couple of processing systems.

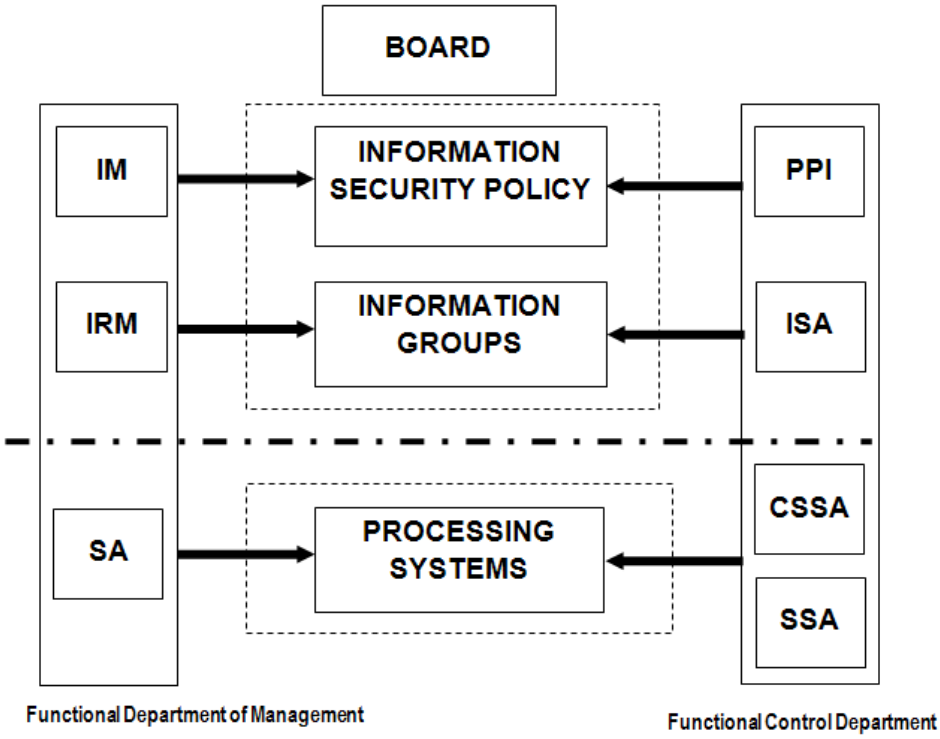


Figure 5. Structure of information management and information security management *(source:[4,5])*

3.3 Information security management processes

Processes of information security management encompass the management of all information resources (including resources aggregated in IT systems) and their use on three hierarchical decision levels: strategic, tactical and operational.

At the strategic level a general information security policy is conducted, with regard to identified, defined and analyzed risk and fundamental expectations towards level of information security and with regard to model tasks and solutions, which result from these expectations. Therefore, the highest management is involved in the decision processes at this level. The highest management determines fundamental information security criteria (derived from normative criteria and to be realized on the basis of identified attributes of information).

At tactical level information security standards and rules for control of their execution within the IT solutions and products, which are used, are established. Also, standards for compliance in practice with proper use of those solutions and products are created (in accordance with the pre-determined levels of security: standard, increased or special).

These decision processes involve mainly the management of departments responsible for general, physical, technical, personal and information security as well as information technology.

At the operational level, information security administration is carried out from the viewpoint of full employment of security standards and solving disruptive situations, which result from breaking these standards (intentional or accidental).

In the information security management organization it is assumed, that basic rules for creation of total security and information security management structures are:

- complete separation of management and controlling functions from executive functions,
- preventing misconduct and maximal limitation of mistakes made by individuals within the area of one-man responsibility,
- ensuring independence and unbiased character of individuals who carry out security audit, having guaranteed that the company secrets will be kept.

All the security processes, security solutions and organization of ensuring security must stay in accordance with the above mentioned rules.

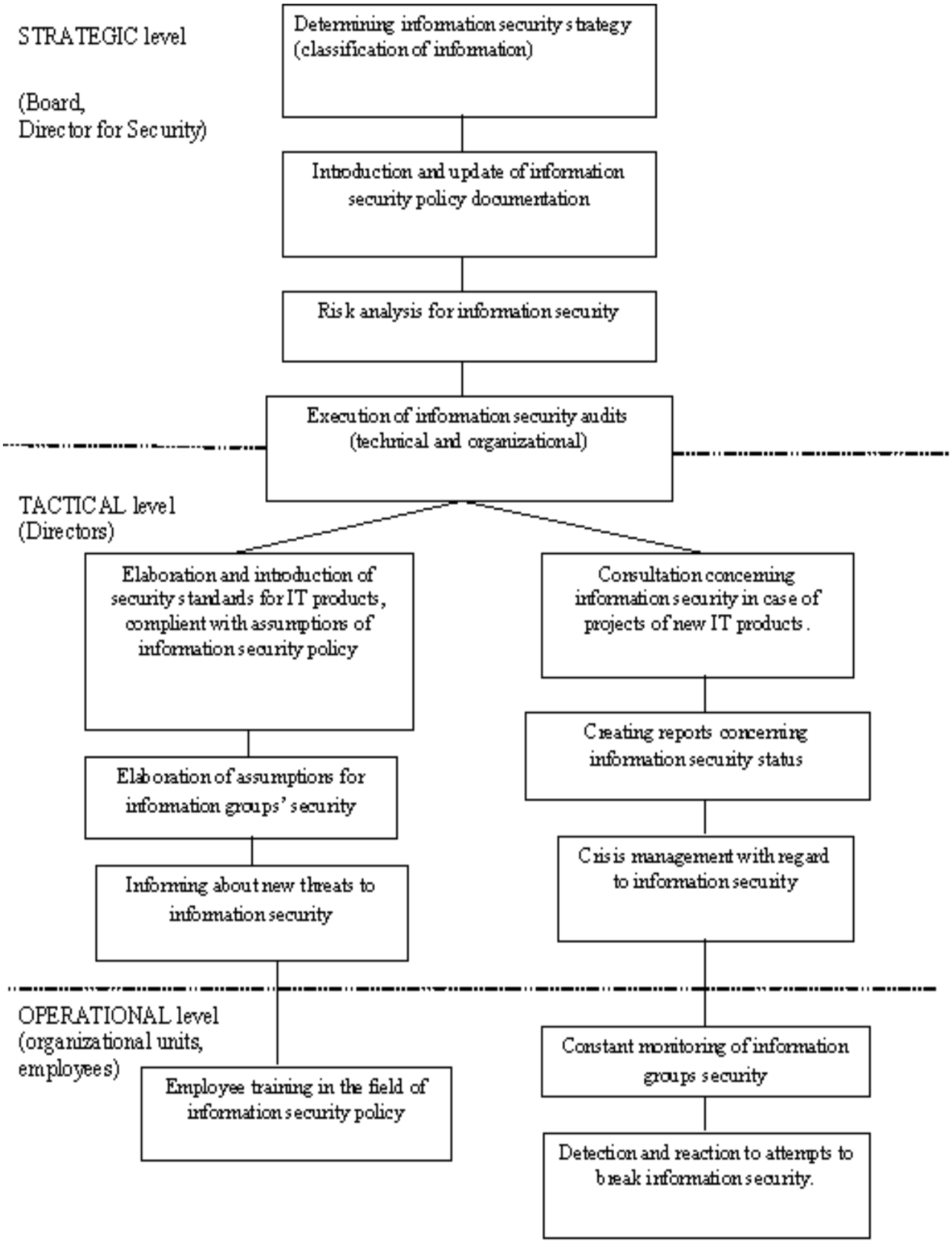
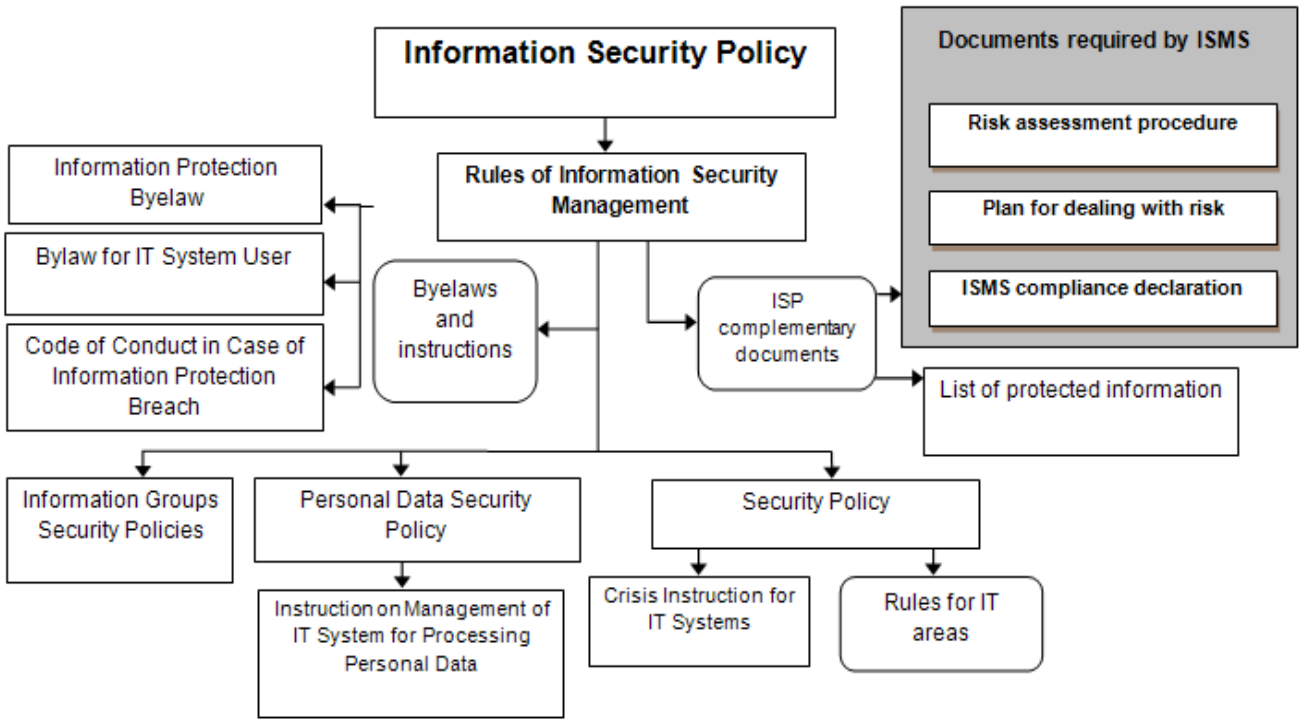


Figure 6. Processes of information security management
(source: [16])



Fiure. 7. Map of Information Security Policy documentation
(source: [5])

3.4 Information security policy documentation

Rules for protection of information should be contained in information security policy – set of documents aimed at certain users (managers from both departments and all other users of information), which consists of:

- Information Security Policy – main document,
- Rules of Information Security Management,
- Regulations, including:
  - Information protection byelaw,
  - IT system user's byelaw,
- Information Groups Security Policy, including
  - Policy for Personal Data Security,
- IT system security policy, including:
  - Rules for IT areas,
  - System procedures and configuration standards,
- Instructions, including:
  - instruction on conduct in case of breach of information protection,
  - instruction on management of IT system for processing personal data.

The Information Security Policy document defines:

- which information groups will be subject to protection (this means that, through formal internal management, groups of protected information are determined, including: company secrets, personal data and legally protected information, while all the other information will be regarded public),
- which systems will process protected information (broad understanding of processing system as both IT but also traditional, paper one),
- who and on ground of what rules will have access to protected information (information users – employees, persons from outside),
- who will be responsible for information security in the whole organization (Plenipotentiary for Information Security),
- who will be responsible for management of protected information groups (Information Resources Managers),
- who will be responsible for management of protected information groups security (Information Security Administrators),
- who will be responsible for security of information groups processing systems (System Security Administrators).

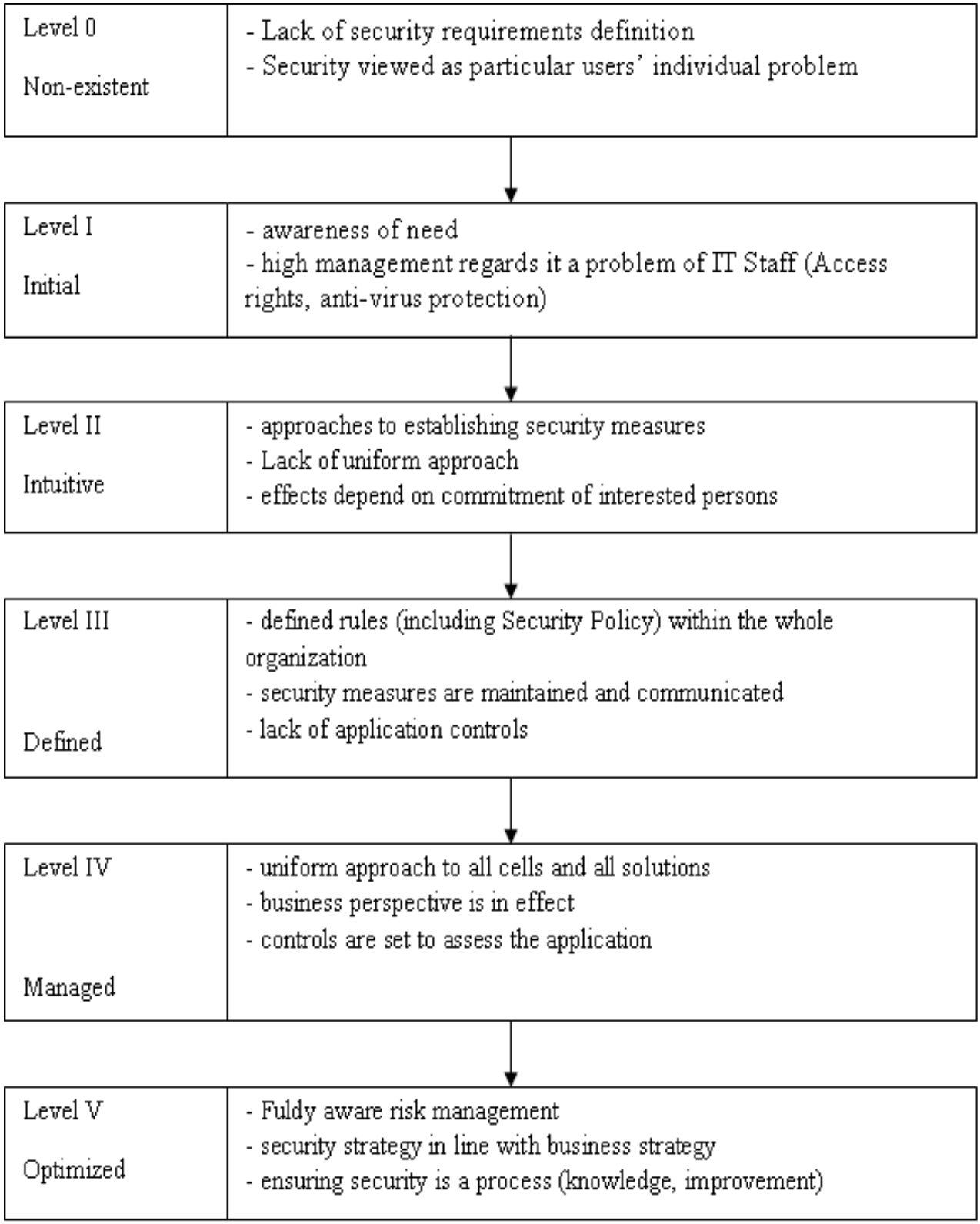


Figure 8. Information security management maturity levels
(source: [7])

Rules of information security management defined by Information Security Policy are applied for:

- all employees in the understanding of Labour Law, consultants, interns and other people, who have access to protected information,
- all existing, currently implemented or to-be-implemented IT and paper systems, in which protected information are or will be processed,
- all paper, magnetic or optical storage means, which contain or will contain protected information,
- all locations – structures and rooms, in which protected information will be processed.

"Rules of Information Security Management" document defines:

- goal and scope of management,
- general security rules,
- classification of information (limited, public),
- access to protected information,
- management of protected information processing,
- security requirements for information processing systems,
- rules on dealing with crisis situations,
- management of information groups users,
- information security management structure,
- rules for delegation of roles,
- rights and obligations for roles in controlling (security) department,
- rights and responsibilities for roles in administrative (management) department,
- reference to byelaws, procedures, instructions and standards defining information management.

Exemplary byelaws are: information protection byelaw, computer system user's byelaw.

Exemplary byelaws are important as they apply for all information users. They might be separate documents or one document, the model of which contains:

- definitions of basic concepts,
- scope of use of byelaw,
- division and ownership of processed information,
- list of protected information,
- general rules for using information and their protection,
- rules for protection of information in IT systems,
- rules for using Internet for protected information processing,
- rules for using information storage devices,
- rules for protected information processing on portable computers,
- rules for protection of rooms in which protected information are processed,
- rules of granting access to protected information, control of information protection, responsibility for breaking the rules,
- declarations of keeping information confidentiality.

Security policies for information groups result from legal requirements and define specific requirements concerning protection and processing of information from a given group (i.e. personal data, confidential information, stock-exchange information, etc.), requirements concerning access to a given group of protected information, as well as guidelines for creation of particular security instructions and procedures with regard to information groups.

IT system security policy describes specific security rules for such areas as: access control, cryptography, IT networks, servers, workstations, network services, business users' applications, portable computers, antivirus protection, monitoring and detection of security breaches and malfunctions, emergency plans and procedures for reconstruction of infrastructure, security audits and tests, new systems development and implementation.

Security rules for IT system areas also define the needs and guidelines for creation of particular procedures and security standards. In the stage of establishing systems they take form of security assumptions.

Standards are documents which describe configuration of particular elements of processing systems, such as: operation systems, databases, applications, telecommunication network, encryption and electronic signature.

Standards are established in order to ensure appropriately uniform level of security of protected information processing systems. Examples of standards are model configurations of server, e-mail or user's workstation.

4 IT systems security

With reference to strictly IT systems, in order to meet security requirements, standards such as ISO 12207, ISO 13355, ISO 15408, ISO 27000 series and codes

of best practices such as ITIL [19, 9] standard have to be used.

The established security solutions, that is: formal rules, management organization and their technical implementation (including IT) must, without exceptions, apply the rules of best practices named above, which were, out of necessity, very synthetically characterized in Fig. 8.

A properly constructed IT system should, regardless of form and character of information, fulfill three fundamental criteria:

- ensure information security,
- ensure security of providing services,
- ensure authenticity and accountability of data and subjects.

First criterion consists of the following elements:

- information confidentiality – which means that the information are only accessible for the authorized persons,
- information integrity – which means guaranteeing precision and completeness of information as well as methods of information processing,
- information availability – which means ensuring that authorized users have access to information and resources connected with them always when this is necessary.

Second criterion consists of the following elements:

- reliability of systems – which means the system may be always counted on, is user friendly and "fool proof",
- integrity of systems – precision of system and methods and ways of information processing used in this system,
- system availability – which means that authorized users are guaranteed access to system and its resources.

Third criterion consists of the following elements:

- Data indisputable – data which is stored in the system and accessed via the system is trustworthy and reliable,
- Indisputable of subjects – which refers to precision of system-using subject identification and confirmation of his authorization to use information gathered in the system,
- Settlement accounts of subjects – which refers to ensuring that authorized users do not have the ability to deny having accessed the system and the use of system resources is documented.

Meeting the so-far mentioned rules of ensuring information security is a basis for evaluation of security management maturity. A model for that was proposed by the IT auditors association ISACA.

Ensuring information security is a part of activity which constitutes a response to the identified operational risk factors.

Consequently, it is based on the rules characteristic for this more general issue, which draw significantly from the achievements of quality approach.

Simultaneously, ensuring information security and, in many aspects, IT security, consists in specific rules. An approach to signalize these rules was made in this work.

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WOMEN SCIENTISTS IN GENDER ORIENTED RESEARCH

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Abstract: The aim of the article is to present and analyze the results of the questionnaire research performed in Poland between November of 2006 and February of 2007 as well as to discuss their meaning for product design and manufacturing management. The project aimed at clarifying the process of how the women scientists are engaged in technological and R&D response to the needs of women end-users. The study examined economic and socio-cultural factors that influence gender-specific end-user interaction with women researchers by comparing and analyzing gender equality in R&D in the case of agricultural implementations for rural applications.

Keywords: gender-specific, end-user, R&D, GDP, product development process, Lisbon strategy.

1 Introduction

The article focuses on the issues of the general condition of scientific research in Poland with a special attention paid to the situation of Polish female scientists. Quantitative research was performed in the Polish Patent Office in Warsaw on the patents that involved women as well as questionnaire research among women in Poland in order to verify whether particular research and development institutes take into consideration the needs and requirements of the product final users. First and foremost, the answer to the following question was sought: „How are women scientists engaged in technological R&D responses to the needs of women end-users? The questionnaire distinguished several phases of product development and the questions concerned each of the phases. Therefore the discussed research might contribute to the improvement of R&D projects' management and/or manufacturing of products at different stages from the testing phase, through the product usability development to the stage of final shape of the product.

The following part of this chapter presents the structure of the article. It consists of 11 chapters. After the introductory chapter the scientific research expenditure in Poland analysis is presented (Chapter 2), with a special attention paid to agricultural sciences, due to the fact that most of the research presented in the article is based on the achievements of scientists from this area of science.

Third chapter presents the Innovative Economy Operational Program 2007 – 2013, elaborated by the government in order to improve the innovativeness of Polish enterprises.

Fourth chapter focuses on the approach and plans of enterprises in the difficult times of global economic crisis.

Fifth chapter describes the situation of women in Poland with the consideration of the employment factor and awarded scientific titles.

Sixth chapter presents the author's research results on the participation of women in the creation of innovative products that were awarded with a patent in Poland.

Following chapters include the description of the questionnaire research: the origin and genesis of the research is presented in chapter seven, short characterization of the research is presented in chapter eight, detailed research results are presented in chapter nine, summary and discussion on the results influence on the improvement of management is collected in chapter ten.

Eleventh chapter consists of the literature sources for the article.

Next chapter is characterizing the difficult situation of Polish scientists, based on the data from the GUS - Central Statistical Office.

2 Science and technology in Poland

The impact of the science and technology development on the state of economy and quality of life of the society is recognized in Poland, similarly to most other developed and developing countries. However, the turbulent history of Poland, geo-political situation

as well as corruption, nepotism, increasing level of unemployment and many other causes contribute to the common lack of financial resources to finance science and technology adequately to the needs and potential possibilities.

Table 1 presents the resource division on research and development activities.

Research described below concerns mainly the agricultural sciences, therefore in order to compare with the totality of financial expenditures on R&D activities (see Table 1) the table 2 the employment and expenditures from this area are presented.

Data collected in the table 2 indicates that more or less 1/10 of the total research and development activities expenditures are given to Agricultural Sciences. Values from Table 1 will be clearer when presented in relation to the gross domestic product (see Table 3).

Data from Table 3 indicate that approximately 0.6% of GDP is given to scientific research in Poland, whereas e.g. Japan this ratio is equal to 3,3%, it is even greater in Finland and Sweden has the biggest value of this ratio – almost 4% among 31 other highly developed countries [4]. This leads to a conclusion that science is heavily underfinanced in Poland.

Great expectations are given to European Union. One of the directions of the Lisbon strategy, approved by the European Council in 2000, which Poland – and other EU countries – should realize, is the knowledge based economy. Successive governments in Poland declare considerable financial support for scientific research in modern areas of knowledge, especially the ones concerning innovation. It is possible due to a considerable financing provided by EU for Poland in the period of 2007-2013 for telecommunication and IT projects.

Table 1. Gross domestic expenditures on research and development activities
(source: self elaboration on the basis of [7])

SPECIFICATION	1995	2000	2005	2006
	grand total in million PLN			
TOTAL	2132,8	4796,1	5574,6	5892,8
Scientific and R-D units	1276,1	2449,6	2617,6	2839,1
Science support units	2,8	13,8	25,8	33,6
Development units	292,9	791,6	1150,1	1171,4
Higher education institutions	561,0	1512,4	1760,3	1826,9
Other units	---	28,7	20,8	21,8

Table 2. Employment and gross domestic expenditures on research and development activities in agricultural sciences
(source: self elaboration on the basis of [7])

SPECIFICATION	1995	2000	2005	2006
Agricultural sciences	Expenditures in million PLN (in current prices)			
	245,7	439,4	474,8	532,1
	Employment (in full-time equivalents)			
	9257	8213	6494	6609

Table 3. Main research and development activities indicators
(source: self elaboration on the basis of [7])

SPECIFICATION	1995	2000	2005	2006
Gross domestic expenditures on research and development activity (current prices):				
ratio to gross domestic product in %	0,63	0,64	0,57	0,56
per capita in PLN	55	125	146	155
Employment in R-D activities per 1000 economically active persons	4,9	4,6	4,4	4,3
of which researchers	2,9	3,2	3,6	3,5

3 Innovative Economy Operational Program

Special Innovative Economy Operational Program for 2007-2013, which support investments in innovative ventures, was elaborated, in order to improve the innovation level of Polish enterprises. Priority includes projects from enterprises including implementation of self or purchased new technologies. Additional support for enterprises investing in R&D activity includes financing of expert advisory and consulting as well as investments necessary to undertake R&D activities that include preparation of enterprises to gain the status of research and development centers.

Special support will be given to manufacturing and servicing enterprises for new investments with high innovation potential. In such case supported projects must include the implementation of modern technological solutions used worldwide not more that 3 years back. Activities will support new investments and advisory and training projects necessary for their realization.

All enterprises can be the beneficiaries of the activities, including large enterprises (at least 250 employed people). Due to the special treatment of the SME enterprises sector it was assumed that 75% of the resources will be allocated into investment activities with high potential in this sector.

Investments projects that use modern technological solutions in manufacturing and services, which lead to the creation of new or considerably improved products or services, will be supported.

Moreover, as part of the investments, new organizational solutions that lead to the increase of productivity and effectiveness (e.g. marketing, logistics, distribution, IT and management systems) will be supported as well as purchasing of required material, legal and immaterial assets necessary for organizational changes [3].

Our specialists are appreciated worldwide, especially the IT specialists, which led to the visit of Bill Gates (founder of Microsoft) and his plans to establish IT center in Poland.

4 Approach of enterprises in the time of global economical crisis

Poland noted considerable economical development in recent years. It was forecasted that such pace of development will continue in the following decade. However the global economical crisis emerged also in Poland, what let to the slowdown of the development and forced necessary savings in all resorts. This can lead to the increase of unemployment rate and decrease of expenditures - among others - for scientific research. Unemployment rate is currently rising. According to the Ministry of Labor it grew to 11,2% in March 2009 with relation to 10,9% in February of 2009.

Research of Polish Chamber of Commerce performed in February of 2009 performed on the sample of 160 large, medium and small enterprises indicated that every fifth enterprise is willing to dismiss employees. At the same time 87% of enterprises share an opinion that currently we are witnessing the beginning of the crisis and are expecting the situation to be worse. Research results are collected in the Chart 1.

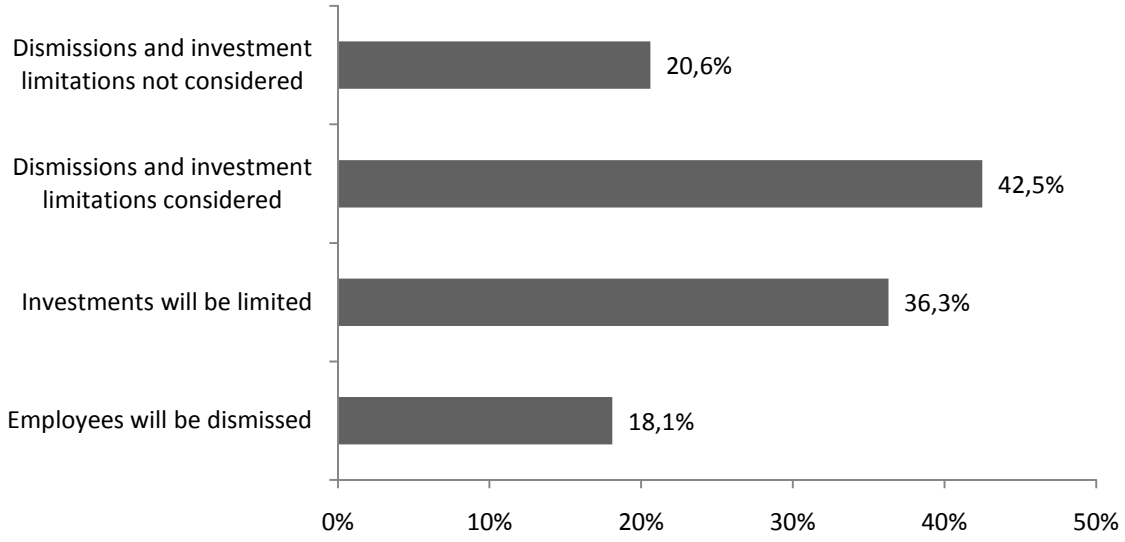

Chart 1. Enterprise questionnaire
(source: self elaboration on the basis of Chamber of Commerce research results)

Nevertheless one can assume an optimistic approach towards this issue. Poland is one of relatively large countries – it takes ninth place in Europe according to its size and eight place according to population (38,6 million). Polish people do not have to extol but also there is no need for complexes because of its culture, history or present activities. It is a member of many important international financial, economical and military organizations such as the World Bank, European Union and in March of 2009 the 10th anniversary of NATO participation was celebrated. Therefore it is reasonable to assume that Poland will overcome the current crisis.

5 Social and economic role of women in Poland

Global social structure is dominated by men and women are playing a secondary role in it. During the seventies in the United States the concept of the "glass ceiling" was created, which meant an invisible barrier that separated women from reaching the highest career positions. "Glass ceiling" is a symbol of the visibility of the possible promotion with the simultaneous impossibility to attain it [9]. Another definition which is describing the mechanisms of women's' discrimination is the concept of the sticky floor, which relates to low-status jobs with no possibility of promotion – people performing such types of work are attached to the lowest level [9]. Such job positions include civil servants, secretaries or dressmakers – jobs usually performed by women.

Generally the issue of employment of women is not very positive. Table 4 collects the employment level in recent years in Poland. The ratio is calculated as the relation of employed people, 15 or over in given employment group, to the total number of people in the population.

According to the statistics over 50% of the population in Poland are women. Over 31,4 million people are able to work, whereas there are 1,6 million women more than men[1]. These proportions are changing unfavorably for women when the employment gender-ratio is taken into consideration (Table 4); therefore unemployment is more painful for women than men.

Data from the last periods is also not favorable for women, indifferent from the region of Poland they originate in. Here is an example of two regions distant form each other[2]. Małopolskie province in the February of 2009 had the domination of women in the group of unemployed – 54,4% (approx. 62 thousand). Slightly better indicator was noted in the opolskie province: 53,5% of unemployed were women and in the kujawsko-pomorskie in 2008 59,8% (approx. 65 thousand) of unemployed were women.

[1] Data from Main Statistical Office for the IV quarter of 2007 according to [4].

[2] Source: drogowskaz@agora.pl.

Table 4. Employment ratio during 2005 -2007
(*source: self elaboration on the basis of Main Statistical Office data [4])*

	2005	2006	2007	
	Average during the year			IV quarter
Men	52,4%	54,1%	56,4%	57,4%
Women	38,6%	39,6%	41,5%	42,3%

Table 5. Number of titles of professor granted
(source: self elaboration on the basis of [7])

SPECIFICATION	1995	2000	2005	2006
TOTAL	367	470	503	397
of which women	61	111	136	108
in the field of agricultural sciences	45	56	68	70

On the other hand, significant increase of the role of women in the economic, political and social life is being observed. Awareness of women about the job market situation and politics is increasing and many women organizations are created – even a political party of women was created – due to the fact that women are educated as good as men and they aim to get equal job positions and salaries as men.

The fact that Polish women are more enterprising than women in other EU countries is optimistic. This is indicated by the number of women who start their own companies. Poland is one of the top countries in EU in this matter[3]. Polish women are not afraid to take risk and they start their own businesses - small service oriented but also large like the Polonia Theater (Krystyna Janda) or the Institute of Cosmetics (dr Irena Eris).

Table 5 collects information about the number of scientific titles awarded to women in general and in the field of agricultural sciences (due to the character of described research). Data indicates that considerably lower number of women was awarded the professor title than men. In relation to the number of scientific titles in the field of agricultural sciences the biggest number of titles was awarded in 2006.

6 Participation of women in the creation of inventions for that apply for patent

Polish women are not only involved in performance of simple jobs like services but also many educated women are managers and participants of research and development activities that increase the innovation level of enterprises. Results of their work are usually a source for patent applications. Patent office does not prepare statistics on the participation of women in patent applications. Main Statistical Office also does not provide such information. That is why the author of this paper performed hard work in the main Patent Office in Warsaw, where the names of all female patent creators and co-creators accepted in Poland during 2001 - 2004 were listed [11]. Female patent project managers were of the highest interest for the author. Unfortunately patent applications do not have the information about the patent project manager.

The order of listed names in a patent application was entirely up to the project team. There are some project teams with a single female in the top of the name list and others with several women in the list in random order. Statistical calculations do not include recent years, even though patent applications with female participants are filed in every year. However the time to evaluate the patent application lasts usually from 5 to 7 years. Even some applications are present that are not yet evaluated, even though the application was pro-

[3] Chudzicka J., Wybrane aspekty globalizacji przedsiębiorstw, w: Wybrane aspekty Zarządzania Wiedzą w Przedsiębiorstwach Unii Europejskiej, Krupa T. (red.), Oficyna Wydawnicza Polskiego Towarzystwa Zarządzania Produkcją, Opole 2006, p. 77.

vided in 90ties (usually cases that have the legal aspects not clear). Presented data collection shows data concerning published patents and reveals all women creators and co-creators. Therefore this information shows the number of Polish women who created or participated in the creation of patents, but does not indicate how many of the women single creators and managers of patent projects are. In order to check who the patent project leader was one would have to contact each and every team, what seems practically impossible.

Table 6 collects all the patents applications accepted by the Polish Patent Office 2001-2004, which included women as participants.

One of the difficulties in gaining this data is that the Patent Office dies not provide information about the gender of the applicants. For example it is hard to evaluate whether Idris is a male or female name. Such problem was encountered three times in the analyzed data. Table 7 collects the number of patents with the unspecified gender of the applicant.

For example tables 8 and 9 present data about applied inventions and granted patents as well as the information about the utility model applications (without specified gender of the applicants) based on the data from the Main Statistical Office.

However, when comparing data from tables 6 and 7 with table 8, one can see that in 2004 the number of women participating in granted patents is the highest, what leads to a conclusion that Poland has more female inventors every year.

Table 6. Number of granted patents with female participants
(source: self elaboration)

	Year			
	2001	2002	2003	2004
number of patents, in which women participated	302	316	256	419

Table 7. Number of patents with the unspecified gender of the creator/co-creator
(source: self elaboration)

	Year		
	2001	2002	2004
number of patents with the unspecified gender of the applicant	1	2	5

Table 8. Domestic inventions and utility models in 2000-2004
(source: self elaboration on the basis of the data provided by the Main Statistics Office [7])

Year	2000	2001	2002	2003	2004
Patent applications	2404	2202	2313	2268	2381
Patents granted	939	851	834	613	778
Utility model applications	1274	1057	865	732	648
Rights of protection granted	680	484	558	666	894

Table 9. Domestic inventions and utility models in 2005-2007
(source: self elaboration on the basis of the data provided by the Main Statistics Office [4])

Year	2005	2006	2007
Patent applications	2028	2157	2392
Patents granted	1054	1122	1575
Utility model applications	600	625	604
Rights of protection granted	829	869	605

Data in table 9, in comparison with the data from previous years (Table 8), indicate that the ratio between patent applications and granted patents has increased - over half of the applications were granted with a patent.

Information in tables 8 and 9 indicates that that the number of rights protection granted in 2004-2007 is higher than the number of applications. The most probable cause is the delay in granting these rights, therefore some of the right protections can relate to cases originating before the year 2004.

One of the main issues that the inventors fight with is the transfer of scientific inventions into business practice. Therefore there are many active initiatives to improve this situation. One of such examples can be a conference organized in 2007 by the Enterprising Poland foundation and Independent Students Union from Warsaw School of Economics "Innovators – the program of transferring the science into business practice". The main topic of the conference was to determine how to allow and effective and profitable transfer of knowledge into practice beneficial for the enterprises and the society.

Following part of the article questionnaire research results, which was performed among women scientists in Poland from November of 2006 and February of 2007, are presented.

7 Background

In January 2006, the project *Women Scientists in Gender-Specific Technological R&D – How do Women Scientists in Technological R&D Respond to the Needs of Women End-Users? (WOSISTER)* was launched with support from the European Commission. The project aimed at clarifying the process of how women scientists engaged in technological R&D respond to the needs of women end-users.

The study examined economic and socio-cultural factors that influence gender-specific end-user interaction with women researchers by comparing and analyzing gender equality in R&D in the cases of two technologies – agricultural implements for rural application and teleservices - and in two transition economies - Poland and China [2].

As part of this project, questionnaire research was performed among women scientists in Poland, November of 2006 and February of 2007, mainly from the fields of Agricultural Sciences and Telecommunications; as well as few scientists from different areas of knowledge. Author's research concerned specialists form the field of Agricultural Sciences. Listed project includes results for both Agricultural Sciences and Telecommunications, although this paper focuses in detailed results and their analysis in different scopes as well as the conclusions of the author based in the interviews with women agricultural scientists and ladies who, despite working in institutions connected with agriculture, indicated their specialization as „other".

Selection of the respondents for the designed questionnaire was not an easy task. Information displayed in the Polish scientific websites, which seemed to be the best solution for this type of research was usually incomplete, outdated and included information only about scientists with the Ph.D. title at least. It was extremely difficult and time consuming to search for information about companies who employ women scientists and get some contact information hoping that the selected respondents will be kind enough to answer the questionnaire. Some of the responses did not include filled in questionnaires. Sometimes the responses were a tough lesson of humility, due to the fact that some of the answers included unpleasant comments. In one case a respondent did not like one expression in the questionnaire, even though it did nit influence the understanding and results of the research.

On the other hand there was a respondent who was enthusiastic about the research and provided all necessary answers.

Some of the respondents required some proof and identification for the questionnaire what indicates that the women were not willing to provide answers to an anonymous interviewer. It was one of the reasons for a strong engagement in the collection of the responses by the author.

Most of the questionnaires were delivered personally by the author to the respondents located in Warsaw. In some of the institutions employees were not allowed to fill in the questionnaire due to the policy of confidentiality. Fortunately such cases were not common. Most respondents were not keen on filling in the questionnaire so receiving the answers required much engagement, encouragement and persuasion. Moreover the author tried to thank every respondent e.g. via e-mail.

Despite the hard and time consuming work, the author managed to collect a relatively high number, in the limited field of the research, of 100 responses with questionnaires.

The following chapter describes shortly the questionnaire research.

8 Characteristics of the questionnaire research

The survey has been run on the sample of 82 women researchers working primarily on the fields of Agricultural Technologies.

Research was performed at universities, research and development institutes and agricultural companies in Poland.

The purpose of this questionnaire was to carry out a quantitative analysis of how, and at what stage of the R&D process, interaction between end-users and researchers take place. In other words, how are customer preferences integrated into the product development process?

The questionnaire mainly consisted of multiple choice simple questions. There were also provided possibilities for comments to each question, in case somebody wished to clarify his position. However, not many of the respondents provided comments in written form but rather in the form of remarks in discussion.

9 Results of a questionnaire survey

9.1 Sample characteristics

Before starting to analyze the results of the merit part of our survey one has to look at the structure of our sample from the point of view of characteristics of respondents.

One of the questions required to estimate the age group. Chart 2 presents the quantitative result and the percentage of each age group[4].

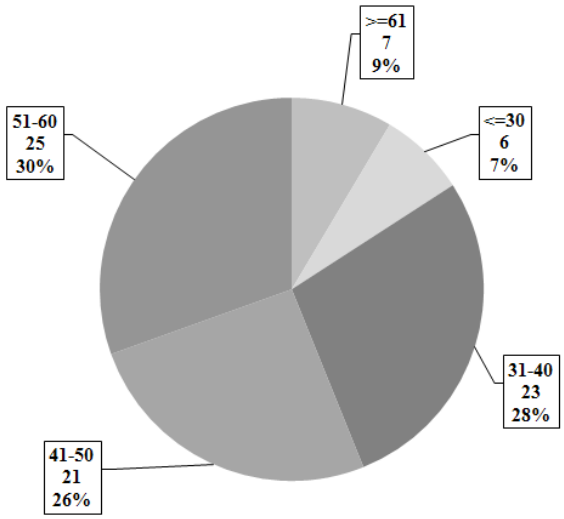

Chart 2. Number of respondents in particular age groups (presented in numbers and percentage)

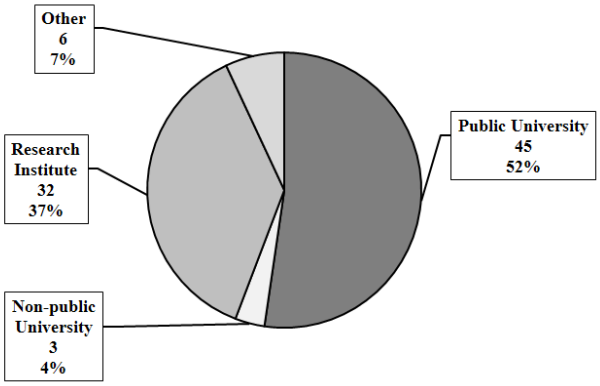

Chart 3. Type of employer (number and percentage of people employed in particular institutions)

Results in the chart 2 indicate that the majority of the respondents were qualified in three age groups. Percentage in all of these groups was similar. Relative-

[4] All charts and tables in the chapter 9 are author's elaborations.

ly small group were young women (under thirty years of age) and women over 60.

Most of our questionnaired women worked either in Public Universities or in Research Institutes (see Chart 3) and it seems to more or less mirror the actual structure of employment of researchers in Poland.

Questionnaire respondents were also asked to indicate their scientific title. Chart 4 presents the number of people with the title of M.Sc., B.Sc. and Ph.D. It the last case also people with additional titles and degrees are taken into consideration e.g. professor title or the post doctoral degree. Results are presented in percentage and quantitative.

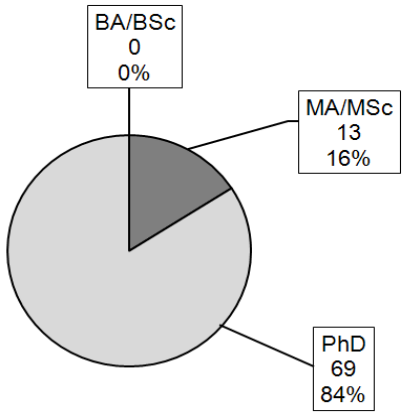

Chart 4. Scientific degree of questionnaired women (in percentage and quantitative)

People who had high influence on the created upcoming projects/products were of special interest. Therefore the author had asked whether there were any people, currently or in the past managing projects, among the respondents. Results are presented in percentage and quantitative in the chart 5.

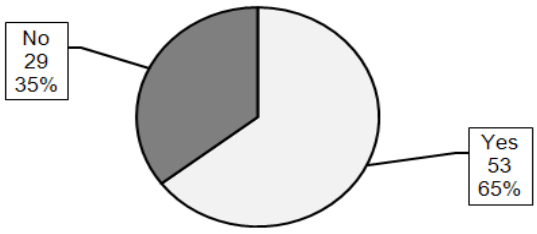

Chart 5. Project leaders (in percentage and quantitative)

It is easy to see that the majority of respondents have a Ph.D. degree and 2/3 of them had experience with project management. If particular values from the charts 2, 3, 4 and 5 are compared, one can conclude that the typical features of the respondents were: age between 31 and 60 years and scientific degree of Ph.D. (wit a relatively large group of professors), place of employment – public university or research and development institute, experience in managing at least one project.

With all the factors considered it is possible to state that our questionnaired women where competent enough to treat their answers as reliable.

9.2 General integration of user's perspectives at institutions

At first we look at the institutions our respondents work for. For the purpose of this study, we have divided the process of developing and bringing a product to the market into three broad phases:

- the research phase (the discovery of new knowledge),
- the product development phase (developing the technical functionality of the product),
- the design phase (modeling, shaping and redesigning the product).

Questionnaire concerned the activities of the respondents in particular phases of product development. The question was as follows: In the work at your institute/department, do you integrate user preferences by consulting with or receiving any kind of feed-back from prospective end-users, either directly or through other types of market research studies:

- in the research phase? (answers in percentage and quantitative are presented in the chart 6),
- in the product development phase? (answers in percentage and quantitative are presented in the chart 7),

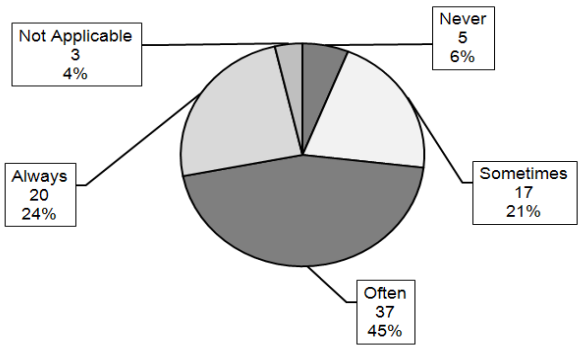

Chart 6. Integrating user preferences in the research phase

- in the design phase? (answers in percentage and quantitative are presented in the chart 8).

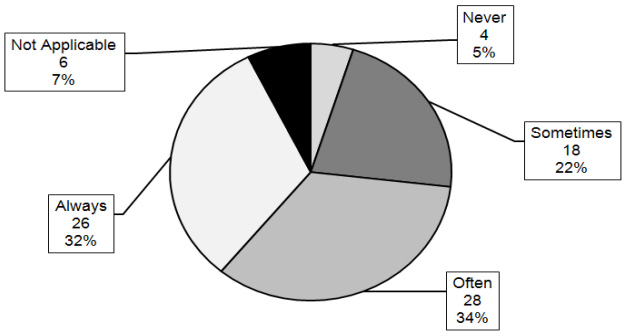

Chart 7. Integrating user preferences in the product development phase

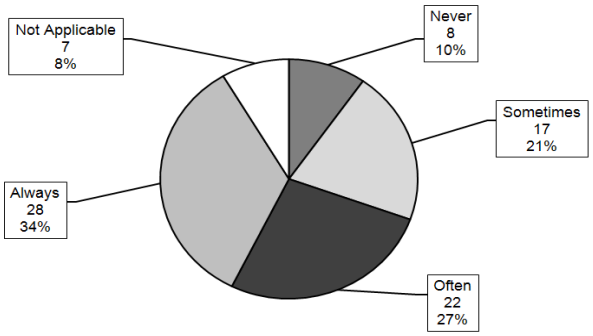

Chart 8. Integrating user preferences in the product design phase

It seems that most of our respondents at least try to incorporate the end-users preferences into the agenda of their research. In all phases of product development the answers "often" or "always" were in the scope of 60 to almost 70 percent (see Charts: 6, 7, 8).

Almost 70% of respondents declare that preferences are often or even always observed even during the initial phase of the work on the product – the research phase; a little bit less during the product development phase and the least of all (but not a few – about 60%) during the design phase. This may be explained by the fact that large number of our respondents seem to work in institutions where mainly the initial research is performed (universities).

9.3 Distinguishing male/female preferences in the interaction with end-users

Unfortunately, from the point of view of the main subject of our research, the institutions our respondents work for are not very often distinguishing preferences of males and females when interacting with end users and then, consequently, when working on their products.

Answers to the question: Does your institute / department distinguish between male and female preferences in the interaction with end-users (e.g. in end-user consultations by focus groups or/and demand surveys)? are presented in the chart 9.

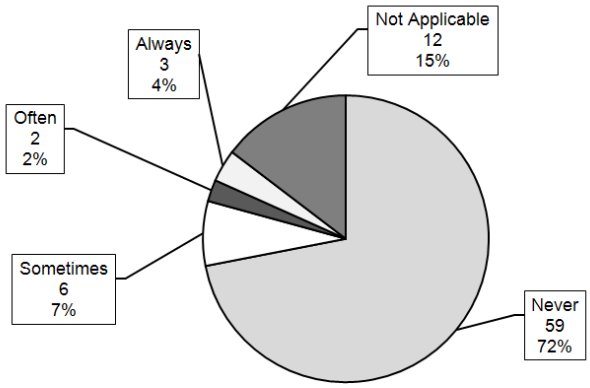

Chart 9. Distinguishing between gender preferences when interacting with end-users

As much as 72% of institutions never take into account gender differences, 7% take it into account at least sometimes, 15% of respondents reckon this question is not applicable for their institutions and only 6% of institutions take it into account often or always (see Chart 9).

Respondents who have not answered „never" in the previous question were asked the following question: Have these end-user consultations indicated differences in end-user preferences with respect to gender, i.e. do you get significantly different results from men and women?

According to the expectations of the author this question was answered by 23 respondents (sum of answers other than "never" - see Chart 9), of which only in 6 cases the respondents claim that consultations with end users indicated for differences in preferences between women and men. No such differences were discovered in the rest of cases. Result in percentage is presented in the chart 10.

Answers to the following question were expected from respondents who have provided positive answer to the previous question – it concerned 6 respondents.

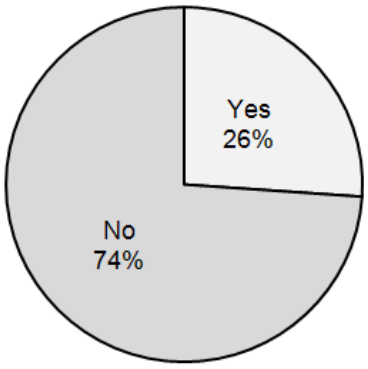

Chart 10. Differences in male/female preferences of the end products

Special attention was paid to the fact, whether differences in male/female preferences of the end products were spotted, what have been the practical consequences, if any, for the R&D and design process?

This question allowed multiple answers, that is why the number of answers could be greater than six – it was necessary to indicate the gender at which the products were aimed.

Collected answers are presented in the table 10. Of 8 answers, there was 1 case of resulting products targeted primarily on men, in 2 cases the results of consultations resulted in products directed primarily for women, in the rest 5 cases the resulting products were targeted at both sexes.

Table 10. Products aimed at particular gender and gender neutral

	Number of answers
Product(s) aimed primarily at women	2
Product(s) aimed primarily at men	1
Product(s) aimed at both sexes (=)	5

In the answer for the question: If products aimed specifically at women or men were developed, at which phase(es) were they made gender-specific? multiple selections were also possible what affected the results collected in table 11.

Table 11. Phases of aiming products at specific gender

	Number of answers
During the research phase	3
During the product development phase	1
During the design phase	2

The respondent, who has filled in all three options in the answer for the previous (Table 10), has indicated the most relevant research phase in the last question – the earliest phase. Other respondent, who has selected only one answer in the previous question (Table 10), selected only the option: “product(s) aimed primarily at women”, answering the last question as the design phase, what suggests that such product aimed at women will be created or is already created. It can be a ray of hope for the ladies.

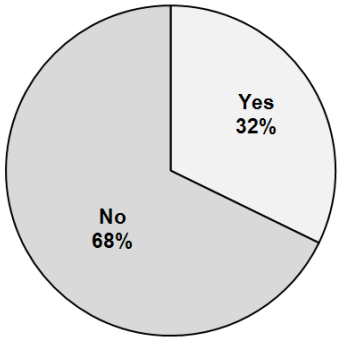

Chart 11. Meaning of consultations with end-users

Next question concerns respondents who have answered “never” in the question: Does your institution distinguish male and female preferences during the contacts with end-users? – there 59 answers to this question (results are presented in chart 9). It was meant to check whether, despite of negative answer, a researcher think consultations with end-users could have had any practical consequences for the development of the product(s). This question had 19 positive answers and 40 negative answers. Answers are presented in the chart 11. Therefore every third woman believes that consultancy with an end-user would have influence on the type of created product.

The following part of the paper presents the personal experience with gender-specific projects of question-

naired women, their participation and/or interest in gender oriented technological R&D.

9.4 Personal experience with gender-specific projects

This part of the questionnaire was aimed at personal experience of women – scientists with gender-specific projects. The following question was asked: In your experience, approximately how many of all product development projects at your institute/department have been gender-specific (i.e. aimed at either women or men)? Respondents were to determine the relevant, in their opinion, level. Reached results are presented in chart 12.

Apart from the values presented in the chart there were a small number of other answers that are collected in the table 12.

Only 68 of 82 respondents decided to answer the set of questions concerning the total share of gender-specific projects in their institutes. Of that 42 respondents (almost 2/3) declared that none of projects implemented by their institute has ever been gender-specific (see Chart 12). Only 13 of respondents (somewhat less than 16%) claimed that 50% or more of projects in their institutes had been gender-specific.

Table 12. Other answers in the question about gender-specific products/projects

	Number of answers
Not applicable	1
Information not available	1
Lack of an answer	12

Those who declared existence of gender specific projects in their institutes have also been asked how many of them had been targeted at females. Out of 61 respondents more than a half (38) could not remember any women-oriented project and only in 8 cases (13%) the share of such projects in total number of gender-specific projects has been not less than 50% (see Chart 13).

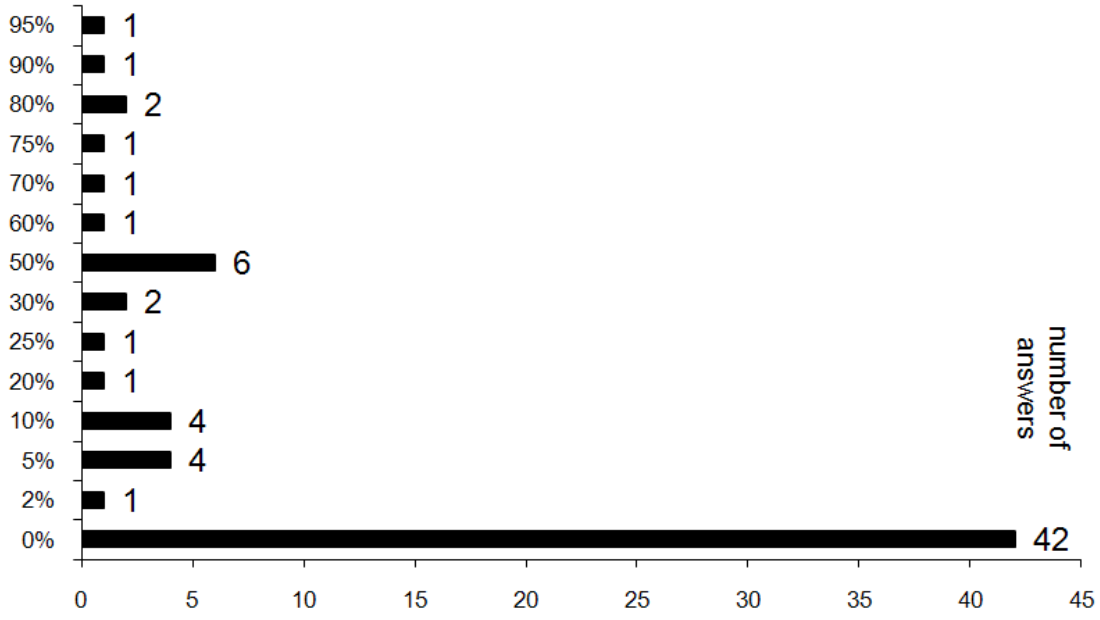

Chart 12. Percentage of gender-specific projects and the number of answers

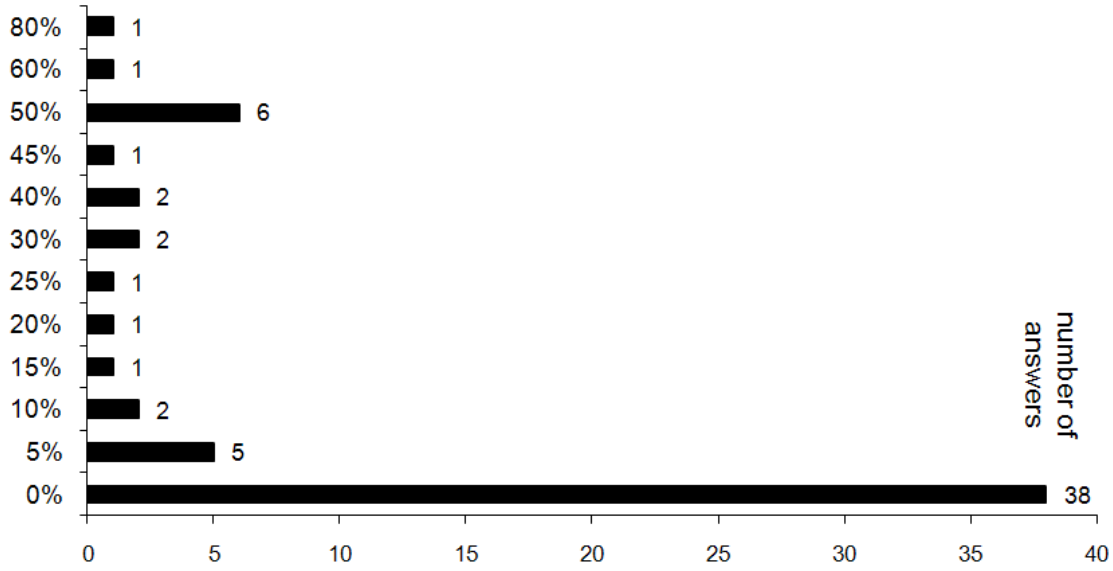

Chart 13. Percentage of projects aimed specifically at women and the number of answers

Similarly to previous questions some of the respondents provided non-standard answers that are collected in the table 13.

Table 13. Other answers in the question about products/projects aimed at women

	Number of answers
Not applicable	3
Information not available	2
Lack of an answer	16

Including the nonstandard answers it is possible to claim that not 13% but approximately 10% of respondents indicated that at least 50% share of female oriented products in total number of gender-specific projects. Such information is certainly not comforting for women.

The focus of the author was also on the fact whether the respondent showed interest and initiative towards projects/products aimed at specific gender. The question was: Have you ever personally proposed to management (or equivalent) a product development project aimed at a specific gender? Answers included several variants of answers according to the number of projects. Reached results are presented in table 14.

Table 14. Number of initiatives of the respondents

	Number of answers	
	Aimed at women	Aimed at men
No	75	
Yes, 1 project	3	0
Yes 2-5 projects	1	1
Yes >5 projects	0	0
	Other answers	
Not applicable	1	
Lack of an answer	1	

Large majority of our respondents have never proposed to their management any gender-oriented projects – 75 (almost 94%) out of 80 of those who decided to answer this question. Additionally one person reckoned this question as “not applicable”.

It means that only 5 persons (6% of all who answered) have ever proposed any gender-oriented project(s). Out of that: 3 have proposed one project (aimed at women) and 2 persons proposed 2 - 5 projects (aimed at women or at men). No one has ever proposed more than 5 projects. In case of this question the proportions are in favor of women.

Table 15. The acceptance rate of proposed projects (W – Women, M – Men, Resp. - Respondent)

	Resp. 1		Resp. 2		Resp. 3		Resp. 4		Resp. 5	
Projects primarily aimed at:	W	M	W	M	W	M	W	M	W	M
0 (all turned down)										
25%	+									
50%									+	+
75%		+								
100% (all accepted)			+		+		+			

The following question: "What has been the acceptance rate of your proposed projects (i.e. what percentage of the projects was approved by management to be initiated)?" was aimed at respondents who showed initiative in gender-specific project application. Multiple variants selection was possible in this question. Reached results are presented in table 15.

Information in table 15 concern 5 people, who have responded positively on the previous question, whereas there was more than 5 submitted projects. Table 15 presents the acceptance level for these projects – forwarding the projects to realization.

Gender oriented projects submitted by our respondents have mostly been accepted by decision making bodies (see Table 15). In 3 out of 5 cases all the proposed projects directed at females have been accepted for implementation. In case of male oriented projects the acceptance rate was 50% in 1 case and 75% also in 1 case.

One can conclude that although in general gender oriented project were relatively rarely proposed by our interviewees, but as soon as they were submitted most of them have been accepted for implementation by managements of related institutions.

Obviously, taking any conclusions one has to remember that we operate on very small samples here, so the resulting potential mistakes are huge.

Next question deals with personal participation of the respondent in the gender-related technological project. The question was: "Have you ever personally participated in a technological R&D project aimed at a specific gender?" – the emphasis was put on the word "participated". Results in percentage and numbers are presented in the chart 14.

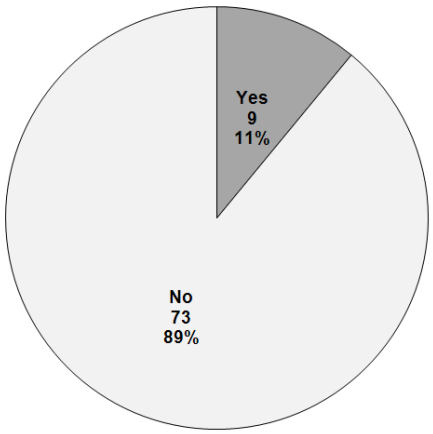

Chart 14. Participation in a technological R&D project aimed at a specific gender

Vast majority of our interviewees have never participated personally in any gender oriented project. Only 11% of those who answered the related question (9 of 82) have ever done so. On the other hand however these projects seem to have been relatively successful (see Table 16).

Taking into consideration the answers for particular acceptance levels (Table 16), chart 15 presents the percentage of projects resulted in a marketable gender specific product.

For 15 cases for both male and female oriented projects over 2/3 were at the acceptance level of at least 50% (see Table 16 and Chart 15).

Table 16. The acceptance rate of proposed projects (W – Women, M – Men, Resp. - Respondent)

	Resp. 1		Resp. 2		Resp. 3		Resp. 4		Resp. 5		Resp. 6		Resp. 7		Resp. 8		Resp. 9	
Projects aimed at:	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M	W	M
0 (all failed)											+							
25%								+	+						+		+	
50%	+					+							+	+				
75%					+		+			+								+
100% (all successful)			+	+														

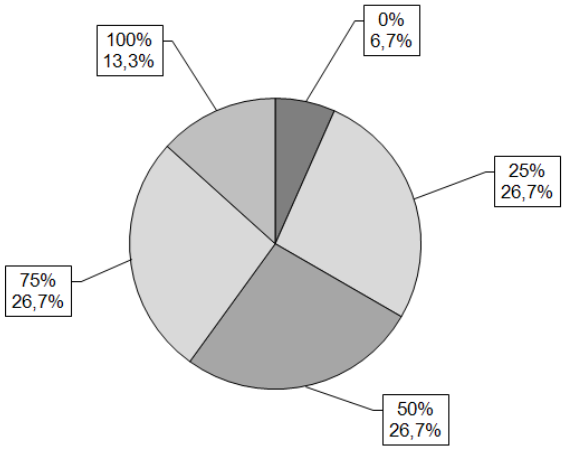

Chart 15. The acceptance rate of projects resulted in a marketable product

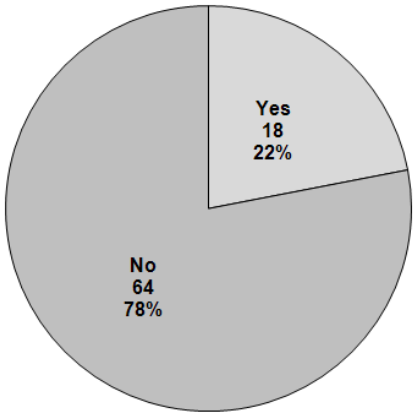

Chart 16. The share of respondents ever thinking about proposing a gender oriented project in their field of research.

The last question in our survey concerned the willingness of women researchers to propose a gender oriented project in their field of research (Chart 16).

Out of total 82 respondents who decided to answer the related question 18 (almost 22%) of them has ever thought about suggesting any gender oriented project in their field of research (see Chart 16). This is not a bad result and a good forecast for the future, because the current state in particular institutions, in terms of gender oriented projects/products, is much worse (what was indicated by the answers to previous questions).

In the next chapter summary of the research results and their analysis, in different scopes as well as their meaning for production management, will be presented. Moreover, the characterization of similar research performed among telecommunication scientists in Poland and China will be briefly presented.

10 Research result summary

Thus far I have reviewed the general results of our survey. They indicate for general relative scarcity of gender oriented research and general lack of interest in such kind of research among the surveyed women researchers. On the other hand, it seems that projects that actually had been proposed in most of cases have been accepted by the management of related institutions. It seems also that projects that have actually been implemented have rather been successful.

In this section I would like to look how the participation experiences and the level of interest of our researchers in gender oriented projects depends on their (i.e. researchers') selected characteristics. Hence I present our main results divided into three dimensions:

the field our researcher work on, type of the employer and the age group.

10.1 Field of research

The beginning of this chapter mentioned that the research was a part of bigger research that involved not only agricultural sciences. In general we have differentiated between 3 groups of respondents according to the field of their research: working in telecommunication sector, agricultural technologies and other sector. Majority of the questionnaires came from scientists from the field of agriculture.

In order to briefly compare the results from particular sectors it would turn out that the general level of interest in end-users preferences was the lowest in telecommunication sector with the average frequency of consultations at all stages of the work on the product development was only slightly higher than "sometimes". The research seems to be most often consulted with the end-users in agricultural technologies sector – the average indicator for this sector was rather high, meaning that end-users are predominantly "often" consulted. For other sectors, treated as the comparator group from the point of view of our research, the average indicator was between "sometimes" and "often".

- In telecommunication sector one observed also the highest number of "not applicable" answers at all analyzed stages of product creation [10]:
- 15% in research phase (with the second highest incidence of 5% for "other fields"),
- 38% in product development phase (with the second highest incidence of 11% for "other fields"),
- 15% in product design phase (with the second highest incidence of 11% for "other fields").

The rest of results of our survey broken by fields of research lead us to even more acute observations (see Table 17). It seems that gender specific projects are neither existing nor interesting in telecommunication sector. Obviously one can claim that such severe results are a consequence of very small number of observation we managed to gather for that particular sector. But one can also suspect that high refusal rate we encountered during our survey for this sector is a consequence of actual scarcity of gender dimension in this field of research.

The situation seems to be more optimistic from the point of view of our research in case of those working on agricultural technologies. It seems that there exists some interest in gender specific projects in this sector and mostly it is at least not smaller than in "other fields" treated here as a comparative group.

10.2 Type of Employer

Interesting results can also be obtained dividing our analysis according to the type of employer. Most of our respondents work either for Public Universities (53%) or Research Institutes (37%) and these will be the main objects of our comparisons. Some work also for Other Institutions (7%), only 3% of them work for Private Universities (see Chart 3). It is important to mention that part of the respondents had more than one job position; therefore table 18 includes the workplace which was listed as first (main). Selected results of survey divided by type of employer (institution) are collected in table 18.

It seems natural that on average user preferences are most often taken into account by research institutes, since creating of new products is the main objective of their research (Table 18). The answers for all stages of product creation were mostly "always" and a little bit less answers were "often", meaning that on average user preferences were monitored more than often. The answers for public universities were mostly "often" and a little bit less answers were "sometimes" and more or less 16% respondents indicated "always", so on average user preferences were monitored near "often" options for all stages of product creation.

It seems also that research institutes more frequently differentiate between gender preferences than public universities do (see Table 18 row 2). On the other hand however those working in public universities much more frequently admit that consultation on gender preferences could result in practical consequences for products developed (see Table 18 row 3).

Gender specific projects are much more frequent in public universities than in research institutes (see Table 18 rows 4 and 5) which, taking into account the result concerning differentiating between gender preferences, comes as a small surprise. On the other hand however researchers working for the latter have much wider personal experience of working in gender specific projects (see Table 18 row 6).

Table 17. Selected results of survey broken by field of research questionnaired women are engaged in
(source: column 3 - the author's calculations based on survey results; column 4 - [10])

1	2	3	4
		Agricultural technologies and other fields (without telecommunication)	Telecommunication
Distinguishing between male and female preferences.	Percent of affirmative answers.	13%	0%
Do you think that consultation on gender preferences could lead to any practical consequences for your research?		32%	0%
Average percent of gender specific projects in respondent's institution.		15%	0%
Has ever proposed to management a gender specific project?	Percent of affirmative answers	6%	0%
Has ever personally participated in any gender specific project?		11%	0%
Has ever thought about proposing a gender specific project?		22%	0%

Table 18. Selected results of survey broken by type of employer (institution) our respondents work for
(source: the author's calculations based on survey results)

		Research Institute	Public University
Distinguishing between male and female preferences.	Percent of affirmative answers	15,6%	11,1%
Do you think that consultation on gender preferences could lead to any practical consequences for your research?		15,6%	26,7%
Average percent of gender specific projects in a respondent's institution.		8,3%	16,9%
Has ever proposed to management a gender specific project?	Percent of affirmative answers	3,1%	6,7%
Has ever personally participated in any gender specific project?		6,3%	2,2%
Has ever thought about proposing a gender specific project?		21,9%	17,8%

Table 19. The views of women researchers on gender oriented research depending on age of respondents
(source: the author's calculations based on survey results)

Age group:	Percent of affirmative answers	<=30	31-40	41-50	51-60	>=61
Do you think that consultation on gender preferences could lead to any practical consequences for your research?		17%	39%	19%	20%	0%
Has ever proposed to management a gender specific project?		17%	4%	14%	0%	0%
Has ever personally participated in any gender specific project?		17%	0%	14%	8%	0%
Has ever thought about proposing a gender specific project?		17%	26%	33%	16%	0%

The share of those who do not have personal experience in gender specific projects but still ever thought to suggest such a project is quite big in both kinds of institutions, but bigger in research institutes (see Table 18 row 7).

These results seem to suggest than in more product and client oriented institutions such as research institutes where gender specific issues are more frequently taken into account when working on new products the incidence of gender oriented projects is lower than in more theory focused public universities. The level of interest in gender specific projects among the women researcher is however higher in more practically oriented research institutes.

10.3 Age

The attitude of women researchers towards gender oriented research also varies with age.

Results indicate (see Table 19), that, in all deliberated aspects, the youngest age group (<=30 years) the interest in gender oriented projects is the same and equals 17%. However, in this case the sample is too small (6 respondents) to treat this result as a common view.

The highest interest in gender oriented projects, in all aspects included in table 19, was shown by respondents from the 41-50 age group. Little bit worse results were observed in the 31-40 age group, although this group supports the end-user consultancy the most. In the age group of 51-60 the interest in gender oriented research drops to 0%, what is presented in the table 19. Such result indicates that these respondents were never offered any gender related project. This leads to a conclusion that such research and projects were of small importance in the early years of the respondents from this age group.

The worst situation takes place in the age group over 60 years of age. None of female researchers above the age of 60 has ever either proposed or personally participated in any gender oriented project. They have never thought about such a project and they do not think that any consultations on gender specific issues could results in any practical consequences for R&D work they are engaged in (see Table 19). This confirms the earlier assumptions about the lack of interest in gender oriented research in previous years.

10.4 General conclusions

In general one can conclude that although the institutes our interviewees work for tend to monitor the end-user preferences during their R&D activities, they very rarely distinguish between male and female preferences. The situation is especially severe in telecommunication sector where none of our respondents declared it.

In 8 of 11 cases recorded consultations on gender preferences have lead to development of gender oriented products, but only in 2 of them the product developed was directed primarily to women, in 1 case the product was directed primarily to men and in the remaining 5 cases products for both sexes were developed.

Almost 2/3 our respondents could not remember of any gender oriented project that had ever been implemented by their institute, although the total share of such projects is not negligible (15%). The projects implemented by the institutes our respondents work for are also rather rarely directed primarily at women (12% of total number of gender oriented projects on average).

As far as personal experience with gender oriented project of the women researchers we spoke to it is rather limited. Vast majority of them neither have ever proposed gender oriented project to their managements nor have ever participated in such project. One has to admit however that both the acceptance rate for proposed projects and success rate for implemented projects seem to be reasonably high.

The level of personal interest of women researcher interviewed in gender specific project can not be considered as high either.

In general, those working in telecommunication sector are completely uninterested in running any gender oriented research on their filed. The situation in agricultural sector, on the other hand, seems to be comparatively well.

It seems that although those working in product oriented research institutes are more experienced in running gender oriented research, the more theory oriented researchers working for public universities are also inclined to do it.

General level of interest in gender oriented research tends to fall with increasing age of researchers.

The author hopes that the research will encourage both the scientists and the management, from the companies employing our respondents, to have a habit of consulting the product end-users and develop more gender-oriented products and services.

The research was a part of a bigger research in Poland, China and Nordic countries. The research shows that, theoretically, men and women, who have even established a political party to protect their rights, in Poland have equal rights – the situation in China is much different.

We should remember that China is a huge country with large differences between regions and provinces. But in general, the female roles propagated in the advertisement culture are usually connected with girl friends, wives and mothers, highlighting their importance in the family and relatives, rather than their roles as professional scientists, precious for the state and society. Although, with economic development the educational level of women workers increases, still it is not high. Statistical data of 2004 year show that only 6,59% women workers have received the education of college or above (source [6]).

Low position in social hierarchy of Chinese women can be confirmed by the experience of the interviewers. Often the interviewers were not allowed in households when the man was not present. Interviewers were informed that nobody was home, even though few women were present. Women were not eager to provide answers when men were not present. In such circumstances it is difficult to expect gender-oriented research from Chinese scientists.

10.5 Meaning of the research in management sciences

The strategic objective of described research was to boost gender equality in technological R&D through promoting increased participation of women in such work. The study aimed at developing a better understanding of the gender issues in scientific research, both from the aspect of scientist as well as of end-user. Through analyzing the influence of gender roles, sociocultural contexts and stereotypes the study should improve the status of women in technological R&D.

Research included the whole Poland in its scope what contributed to the rise of awareness of the needs and expectations of end-users of products. The respondents were often in managerial positions what allowed them to take decisions and change the approach towards the designing or manufacturing of products and services.

One can wonder *to what extent is technology gender-neutral?* There definitely are products that are used both by men and women but can have different appearance and functions. Such example can be a mobile phone which would probably suit women better having a small mirror installed instead of e.g. computer games. It could have a nice shape and color what is not very important for male users. In agriculture some tools could be smaller and lighter as well as nicely designed to encourage female users to purchase. Men prefer to have multiple functions and plain colors e.g. in electronic equipment. Decedents should formulate some kind of consultancy with the end users and include their needs in some or all design and production phases. Sometimes it would require major technological

changes but take into consideration the market saturation it can be profitable in long term perspective.

Research was aimed at woman scientists in order to stimulate the participation of women in science and technological development and hoping that they would better understand the needs of other women. Even though currently the gender issue in scientific research in institutions was not relevant the research can change this situation – many respondents made such statement.

The research was performed also to draw attention to the small participation of women in public services management [8]. Such management includes such social and economical areas as: public health, public finance, infrastructure, public safety, education and culture. The single cases e.g. the president of Warsaw Hanna Gronkiewicz-Waltz or the selection of Katarzyna Chałasińska-Macukow for the president of Warsaw University, are not satisfactory. Drive towards equal rights for men and women as well as elimination of the „glass ceilings" is necessary e.g. through promoting women to top positions. Until now in Poland there was no case of a female parliament speaker or president. Unfortunately, „where policy is set, decisions are made and a culture is developed, women are lacking, making senior teams mono-dimensional and so impacting upon their ability to create strategies that meet their customers' needs" [1].

One can assume that monitoring of situation of women, handicapped people and ethnic minorities will lead to the „equal opportunities in employment" policy. In Poland this concept is relatively new and little known. In relates not only to women: "Equal employment opportunity policies are human resource management measures taken by companies, aimed at preventing discrimination and promoting equality in the workplace" [1]. However, the main objective of this concept is to counteract women's discrimination on the labor market by increasing employers' knowledge and interest in managing gender equality within companies' environment.

There are cases of enterprises that promote women in order to make the employment and promotion possibilities equal for both sexes. One of the examples can be the Avon Cosmetics Poland, which employs 72% of women and only 28% of men and the managerial positions are held by 68% of women and 32% of men [1]. Moreover, Avon organizes many events in order to improve the situation of women e.g. „The Entrepreneurial Woman" competition or „Great Campaign for Life", aiming to raise awareness and knowledge about breast cancer.

Described research will contribute to the increase of interaction between women scientists and end-users and technology providers will be encouraged to develop technical applications geared specifically towards women end-users.

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THE MEANING OF PROCESSES ORIENTATION IN CREATION AND REALIZATION OF THE ADDED VALUE

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Abstract: Characteristic of morphology and the identification of process category structure of are a crucial stage of its implementation within enterprises as well as it determines the final effects of processes realization, which is producing and realization of added value for market participants. In this paper author describe the essence of added value, its functions and factors that form this category in the understanding of the constant-flow organization that is set on realized processes. Performing analysis related to creation and realization of the added value, in the context of the basic aims of functioning organization of processes and establishing perception means and interpreting the creation of added value within the processes of customer and enterprise environment.

Key words: process, process organization, value, value added.

1 Introduction

One of the most essential categories, taken into account in enterprise performance assessment, is the added value. Concepts of the subject, well-known form the literature, explain its essence as well as are the basis for a content-related discussion. Due to the multi-dimensional and multi-aspect manner of the concept as well as the lack of solid measures, those theories are less useful in planning, operational and other management process for managers.

The main goal of this work is to try to order the issues connected with such categories as: process, process organization, added value and to indicate relation between them. Justification for this aim is the fact that creating management instruments should always be preceded by specifying the issue of given category, pointing out the source of its beginning, finding its receivers, stating the transformation that given category undergoes from the input resources into output resources as well as relation between this category and other categories.

Moreover, it should be noticed that there is a gap present both in improvement theory and in practice of management systems of processes, concerning the creation and realization extent of added value. This is why the following deliberations are justified:

- to describe the essence of added value, its functions and factors that form this category in the understanding of the constant-flow organization that is set on realized processes,
- performing analysis related to creation and realization of the added value, in the context of the basic aims of functioning organization of processes,
- establishing perception means and interpreting the creation of added value within the processes of customer and enterprise environment.

2 Process category issues in the aspect of added value

Among many different pictures and interpretations of enterprise activities in terms of market economy, a category of process and process based activities as well as process organization have a well established place. Chosen definitions of the process category are presented in Table 1.

Characteristic of morphology and the identification of process category structure of are a crucial stage of its implementation within enterprises as well as it determines the final effects of processes realization, which is producing and realization of added value for market participants, what is indicated by quoted definitions.

In general, regardless of what processes will be the object of the research - they should be treated as repeating, precisely defined course of activities, with clearly defined start and ending, determined by material and information flow, including basic and supporting activities creating the value from the point of view of customer and from the point of view of the enterprise.

Table 1. Examples of definitions of the process category
(source: the own study on the basis {1], [5], [11], [12], [21]; [27], [45], [46])

Author	Definition of the process
M. Christopher	Every kind of action or set of actions, within adding the value to initial resources and passed on to the product to the external or internal customer
J. Dangel	Chain of actions aiming at producing value (products or services), fulfilling customer requirements
T. Davenport	Structured arrangement of actions aimed at producing of specific value for individual customers or the market
M. Hammer	Related group of activities, which common result brings value for the customer
M. Hammer J. Champy	Collection of activities that takes one or more kinds of input and creates an output that is of value to the customer.
A. Kupczyk, H.Karolewska – Mróz, M. Czerwonka	Gathering mutually related resources and actions transforming input resources to output resources, creating value from the point of view of customer.
H. Striening	Series of actions with measurable resources and measurable added value

Table 2. Characteristic of process orientation
(source: [3])

Level	Features/Direction of change
Generating and transformation process	Connection of individually functioning spheres into a dynamic and integrated process (development, marketing, production, logistics, technology etc.)
Product development	Creation of cooperation process (cross-section) of enterprise functions, in order to properly prepare the product with regard to the responsibility in this matter
Internal and external relations	Including suppliers, retailers and customers (final users) in the product development process
Searching for consensus and optimal solutions	Utilization of process and negotiation abilities as well as solving conflicts within the team, in order to take optimal decisons
Creating management teams	Integration of work teams as well as enlarging mutual confidence and tolerance on the basis of process oriented work organization

This flow of goods and information implies creating a value for every market participant through transformation, linking producing spheres with usage spheres. Not only these processes, which create added value, in the result of the flow of goods, but also the ones who are responsible for its creating in the result of the flow of information, are included in it.

Change of the roles and the meanings of the category of process, noticeable in recent years, as well as the research on its influence on the effects reached by enterprises, refer to the problem of creation and realization of added value and, what is most important, added value for the customer as well as for the enterprises.

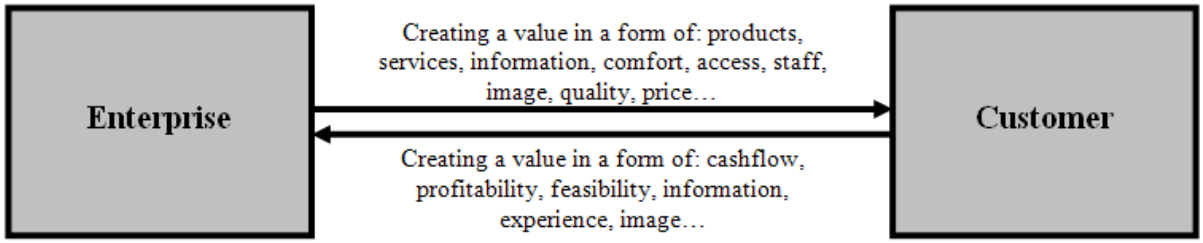

Figure 1. Value creation for customer and the enterprise
(source: the own study on the basis [44)

Process approach towards organization paradigms listed in the literature to organization, among which one can name changes in the way of thinking and activities in the area of formatting structure of creation and transformation value, product development, relations between suppliers and receivers, customers problems solving, aiming at systemized and synergetic solutions in sphere of identification and rationalization of costs as well as aiming at wider and effective usage of modern methods and tools of management [3] - they are the essential process orientation development stimuli.

3 Process Organization characteristics

The entity of change from the general approach towards process oriented approach in enterprise management is collected in Table 2. Basic assumptions being the foundation of processes orientation in the management as well as its role and meaning in the aspect of added value creation process for all participants of the market are determining new structure for the enterprise concept.

Enterprise organization perceived within process orientation will be defined, in the course of mentioned considerations, as structured net of dynamic processes creating the desirable added value for the customer and added value for the enterprise.

It can be assumed that foundations of process organization are the key determinant of enterprise transformation, therefore are the basis of identification of basic processes connected with creation of added value for customer as well as added value for enterprise.

Enterprise functioning success factor is measured by the growth of added value for the customers. There can be no added value for the enterprise without the added value for the customer (Fig. 1).

Added value of a enterprise is created by the customer, depending on product range and provided services that the customer is interested to purchase.

It is important to draw attention to the place and realization of the value creating process as a part of the process orientation of the enterprise.

Process orientation assumes horizontal flow of individual processes, realized within creating and realization of added value for customer as well as the added value for enterprise. Order and sequence of processes is conditioned both by with endogenic and exogenic factors, determining the selection of key factors of enterprise operations and its strategy as well as with factors determining possessing and holding competitive advantage of the enterprise in the market. Lack of precise identification of processes can leave crucial factors and processes beyond the analysis. Precise identification of process requirements for the organization should be performed from the point of view of the customer. Hierarchy of main processes from perspective of enterprise and from perspective of customer is presented in the Fig. 2.

Presented hierarchy of the main processes from the perspective of the enterprise and from the customer perspective, shows two approaches which condition each other. It pictures the field of the influence of individual processes on the most important areas from the point of view of given organization. Such processes distinction aids decision making about the allocation of individual processes in the enterprise, particularly in relation with creation and the realization of the added value.

Summing up, it can be accepted that the process orientation determines and stimulates not only transformation of the enterprise, but also is key determinant particular process identification, especially in the criterion aspect of creating the added value for customer and added value for the enterprise. Process approach towards organization management results from the need of the search of the new sources of creating and the realization of the added value.

4 Creation and realization of added value – determined meaning of keywords

The literature presents a rich examples of interpretation of added value. First reports originate in the second half of 18th century. Chosen definitions are presented in the Tab. 3.

Resulting from interpretations presented in the table, the development of the enterprise towards process organization causes that certain aspects of the category of the value are becoming obsolete and looses their meaning, however others are updated and become more important. The arrangement of the value was not and will not be a stable structure.

Regardless of the character of change, resulting from the character of processes organization, one can distinguish the most important functions of creating and the realization of added value, table 4.

Value of the process organization is determined through factors of creating and realization of added value for every market participant in the processes arrangement in the enterprise

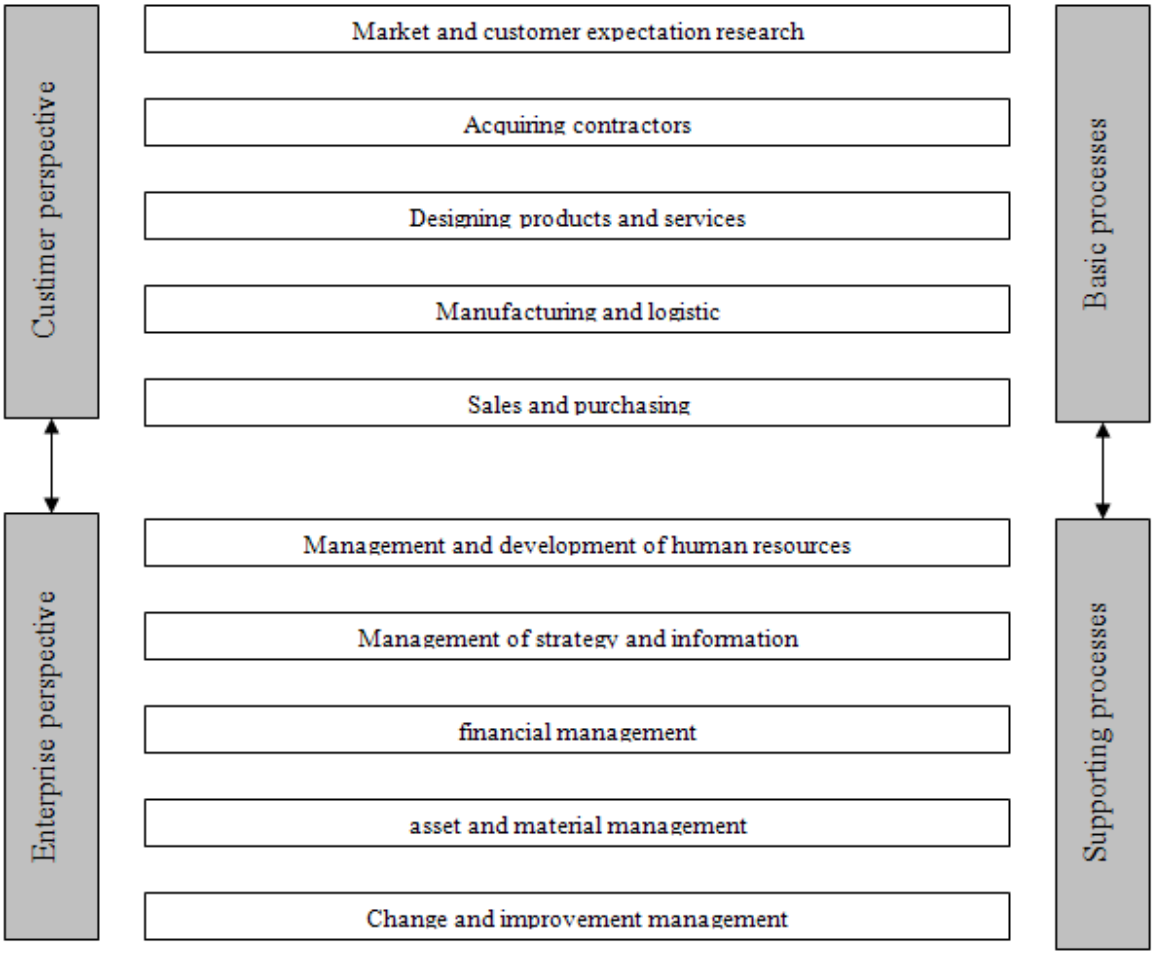

Figure 2. Main process hierarchy from enterprise and customer perspective
(source: - own study on basis: [10])

Table 3. Interpretation of value categories
(source: the own study on the basis [43],[7], [8], [9], [14], [15], [23], [17])

Author	Interpretation of the value category
Condillac 1776	Value of things is basing on their usefulness, which equal to the usage that one can do of it. We act according to their usefulness, we create less or more of them, it means we believe that they are suitable to use which we want to make of them. And this opinion is just called the value [*Trade and line in their mutual relation*].
La Trosne 1777	Products receive a new propriety in the social life, which is born from mutual relations, already existing between people. This propriety is the value. It inflicts that products become the wealth and, practically saying, there can not be too much of them, because overage surplus becomes the centre the receipt these which there is a lack of [*About the social income in the reference to value, circulation, industry and external and internal trade*].
C.K. Glover 1810	Value marks the probability that old customers will return to the old place even then, when there is no old trades folk or salesman left [*Valuations of Unquoted Shaves*].
W.S. Jevons 1871	Value depends on the extreme degree of usefulness. Regard this the value of the work is also defined by the value the product, and not the value of product by the value of the work. The value consists in the interchangeable relation, setting between one subject and another, between such this quantity of one, and such quantity of second [theory of the *political economy*].
Proudhon	Value is the degree, in which every elements of social wealth takes part in creation of the whole.
A. Smith	Value of a thing is based on work, necessary to its production (…). The value has two various meanings. From one side it favors usefulness of certain object, from the other side, the opportunity of the purchase of the different goods which possession of this object gives. This is so, the distinction of usable value and exchangeable value.
D. Ricardo	The value presents formal opinion of phenomena, processes and the results of manage, influencing the formation of their role and meaning in the social life, from the second point of view - it is the coefficient of the economic meaning of these phenomena, processes and results, deciding about the behavior of economic individuals and natural persons. Arrangement of value has many varied values, which concern its superior aims, self-assessment, different systems as well as individual own elements because of played parts and executed assignments, resulting from superior aim of given system.
J. Szczepański 1970	The value is any material or ideal object, idea or institution, real or imaginary object, in relation to which individuals or community pay respect, they attribute its important part in their life and they feel endeavor to his achievement as the compulsion [*The elementary notions of sociology*].
M.Scheler 1990	The value is all what is valuable in the definite situation and in the definite conditions of the given moment [*The problems of the sociology knowledge*].
M. Gołaszewska 1994	The value is defined in three significant dimensions: a) the good, that is the one which is valuable and it can make up the aim of human, b) the answer of the need (what lets human being to survive, live, develop and improve), c) general idea, having of the momentous meaning for man and society [*The fascination with the evil. Essays from the theory of the value*].
P. Kotler 1994	The value for the customer is the offered sum of usefulness that is the general evaluation of the ability of the product / service to fulfill his needs. Usability (usefulness) should be percieved as the collection of the propriety of the product / the service thanks to which it satisfies some needs [Marketing].

Table 4. Functions of creation and realization of added value
(source: the own study on the basis [43], [41], [42], [23])

Function	Meaning
Integration	It depends on inspiring, joining and focusing of human actions, their thinking, attitude and behavior within the enterprise. People that are integrated by certain values take and realize joint actions to fulfill those values.
Motivation	Is inseparably connected with the fact that enterprise has to be admitted as axiological being on account of creation or selection of certain values from environment. Any behavior determining or co-determining factor, in this case people that operate in this enterprise or its processes.
Protection	Relates to wealth possible to multiply by the enterprise and to value maximization, which possessing strengthen wealth itself.

Table 5. Worth determinants of enterprise processes - test of identification
(source: the own study on the basis [43], [23], [35])

Factor	Operation scope, meaning
Enterprise worth in the macoeconomic take	Economic cycle Interest rate
Enterprise worth in the scope of financial results	Return of investment Risk of investors decision
Worth of the enterprise in the scope of reorganization of assets and capital.	Canvassing Fusion Split Leverage buyout Stock emission
Worth of the enterprise listed on stock	$W = nP$ *W- market value of the enterprise* *n-number of stocks emitted by enterprise* *P- market price of one stock*
Worth of the enterprise not listed on stock	$PV = \Sigma_i (CFi / (1+r_i))$ *PV – present value of future financial income* *CFi – financial income in next years* r_i *– discount foot* Value of enterprise according to this formula is decided by the expected stream of the future incomes that the owner of the enterprise expects to reach in the considered temporary horizon. Flow of income consists of profit after taxation and depreciation. These two components create the supply of the money which the owner can freely administer.
Worth of the enterprise from an employee point of view	The level of individual wages. The level of net wage of an individual employee.
Worth of the enterprise from an investor point of view	Ability of generating future profits. Investor seeks such possibility to locate capital, which, with given risk rate, will guarantee him maximum return rate of invested capital, i.e. return in possibly shortest time.
Market value of the enterprise	It is estimated during market transactions. In can be only determined ex post. Before the transaction one can only try to estimate the price. It does not concern continuous transactions. Market value before the transaction can only be determined through analogy.
The value of enterprise in the aspect of the economic value of the enterprise	Ability of the enterprise to generate profits. It is reflected in the discounted net money streams (*Cash flow*).
Value of the enterprise as the living, economic organism	Results from functioning of a certain organizational form without the regard on the condition of financial resources. It reflects the synergetic effect, which occurs thanks to the existence of organizational structure, staff, abilities and the qualification of manageress, cooperative relationships, „*goodwill*" etc.

In the context of issues we considered, value category of enterprise is the dynamic and open arrangement of material, financial, personnel and mission elements, which are created in the consciousness of employee and the rest of the people, which are involved in the enterprise operations [43].

Value is a multidimensional and multiaspect category that is in a direct way connected with management processes instruments, determined by the market participants that it refers to.

Necessary condition of realization of all aspects, dimensions and category determining factors of the added value is to state the modeling rules, realization and improvement of processes in case of organization of processes.

From the point of view of usefulness of add value category to management of process organization should it should be determined on the level of realized activities in individual processes, on level of processes as well as in arrangement of realized processes in given organization. Such approach is presented in the Fig. 3.

Analyzing added value from such a point of view, it can be defined as a enterprise benefit gained by operation activities, processes and arrangement processes. The opinion of added value in this arrangement should be qualified in relation to main goals. To this extent it should be attached to the opinion of realization of the main aim of enterprise process, partial aims realized by individual processes in this range (the component of main process) and the activity component of processes.

5 Processes Taking Part in the Creation of Value

The Idea of modeling and the realization of processes is transforming initial resources into final resources, providing the largest added value for all participants of the market. The example of such an approach is presented in point 2, the essence of the category of process, proposed by M. Christopher [5], *process is every kind of the action, where the value is added to initial resources and passed on to the product to the internal or external customer.*

However, does the added value means the same from a point of view of the customer (*external customer*) and from the point of view of the enterprise (*internal customer*)?

Answer to this question pays the attention to goals, for which realization of the process was qualified. The classification of aims in the customer scale and in the scale of the enterprise is presented in the Fig. 4.

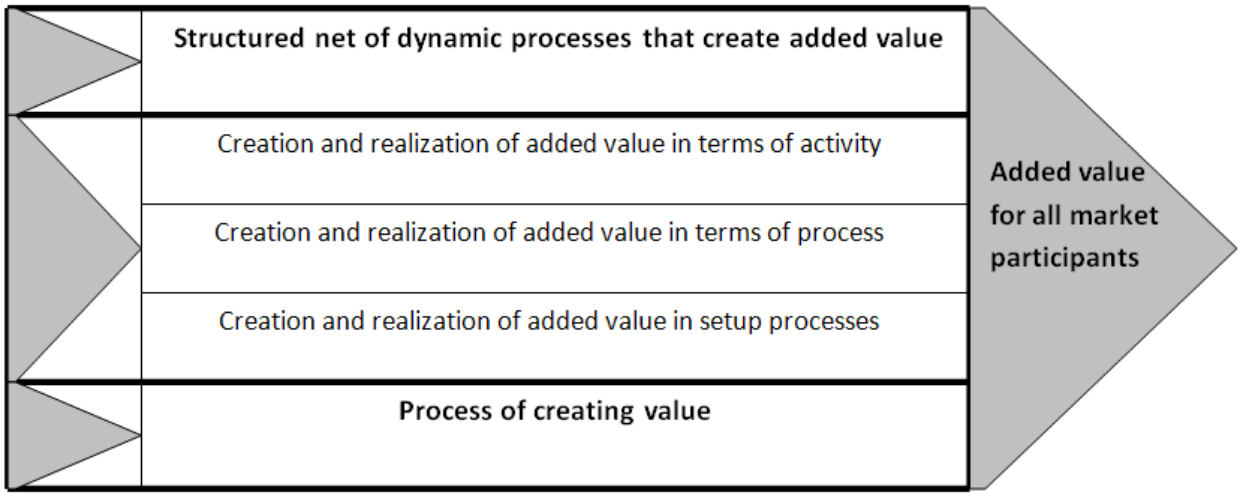

Figure 3. Process of creating added value in activities, processes and in process setup
(source: self elaboration)

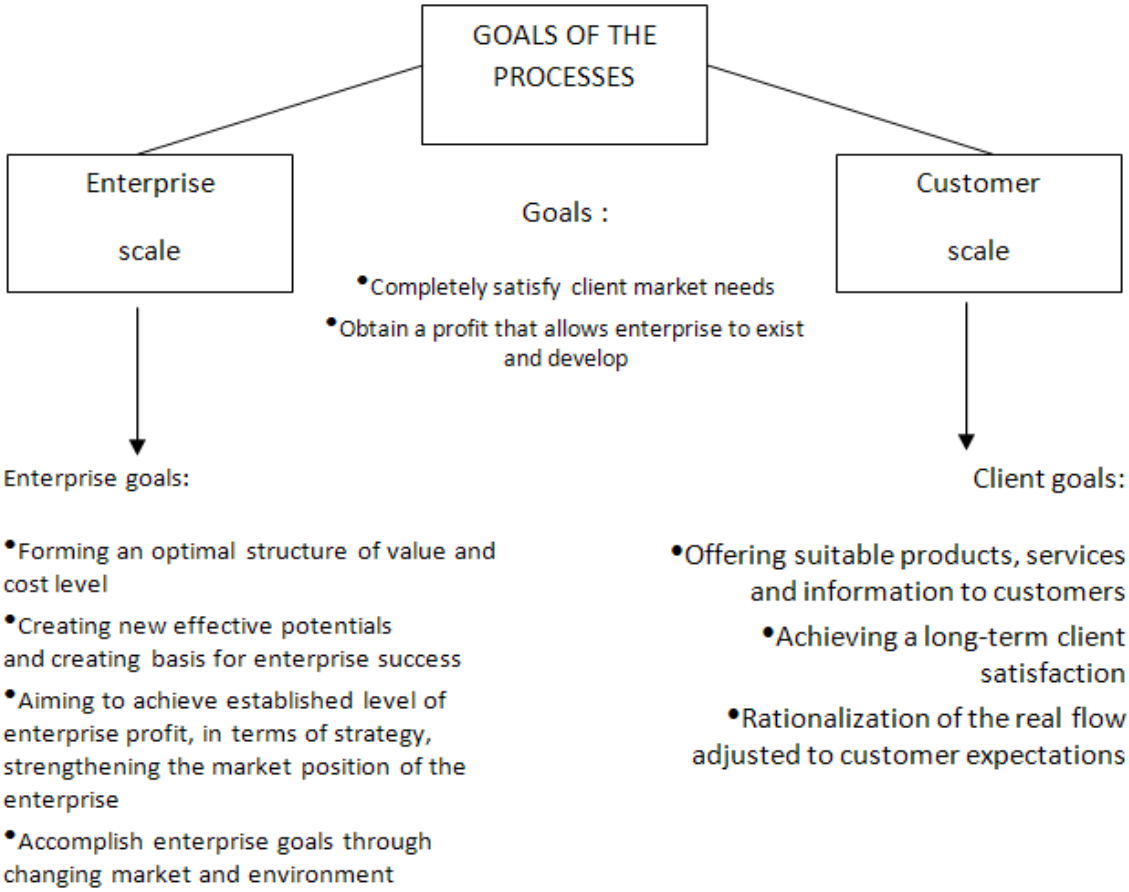

Figure 4. Processes goals
(source: the own study on the basis [3], [22], [30], [31])

The knowledge of processes aims is an essential stage in identification as well as determination in significant extend final effects of its realization, which are generate and realize added value for market participants. Which part of the totality of added value realized through enterprise goes directly into processes that generate and realize added value and on which growth we can rely on while realizing the concept of process organization?

This question leads to the show of the way of perceiving, interpreting the creation of added value in processes. The process analysis in term of creation and realization of added value is presented in the algorithm, Fig. 5.

Evaluation of processes in the aspect of creation and delivery of value add require the answer on two key questions: if the process can be eliminated without any damage for advantages achieved by the customer? and whether the process can be eliminated with no harm for cooperating processes? If answers on both questions are negative, it means that the realized process is directly connected with creation and the realization of the added value. However, if the answer is affirmative, the most probably we have to deal with the process not creating the added value. Not every processes which do not directly create the added value, are the processes needed to be removed from the structure of the process chain of the enterprise. To mark correctly this group, we should use auxiliary: Is this process indispensable? Does customer expect it? Does it improve the efficiency of operations? Is it indispensable for the business activities?

Negative answers on this set of questions convince us about lack of relationship of studied process with creation and realization of added value, they are the superfluous processes. However, if at least onto part from them, we can are answer affirmatively, it marks this, that process is indirectly or relatively connected with creation and realization of added value.

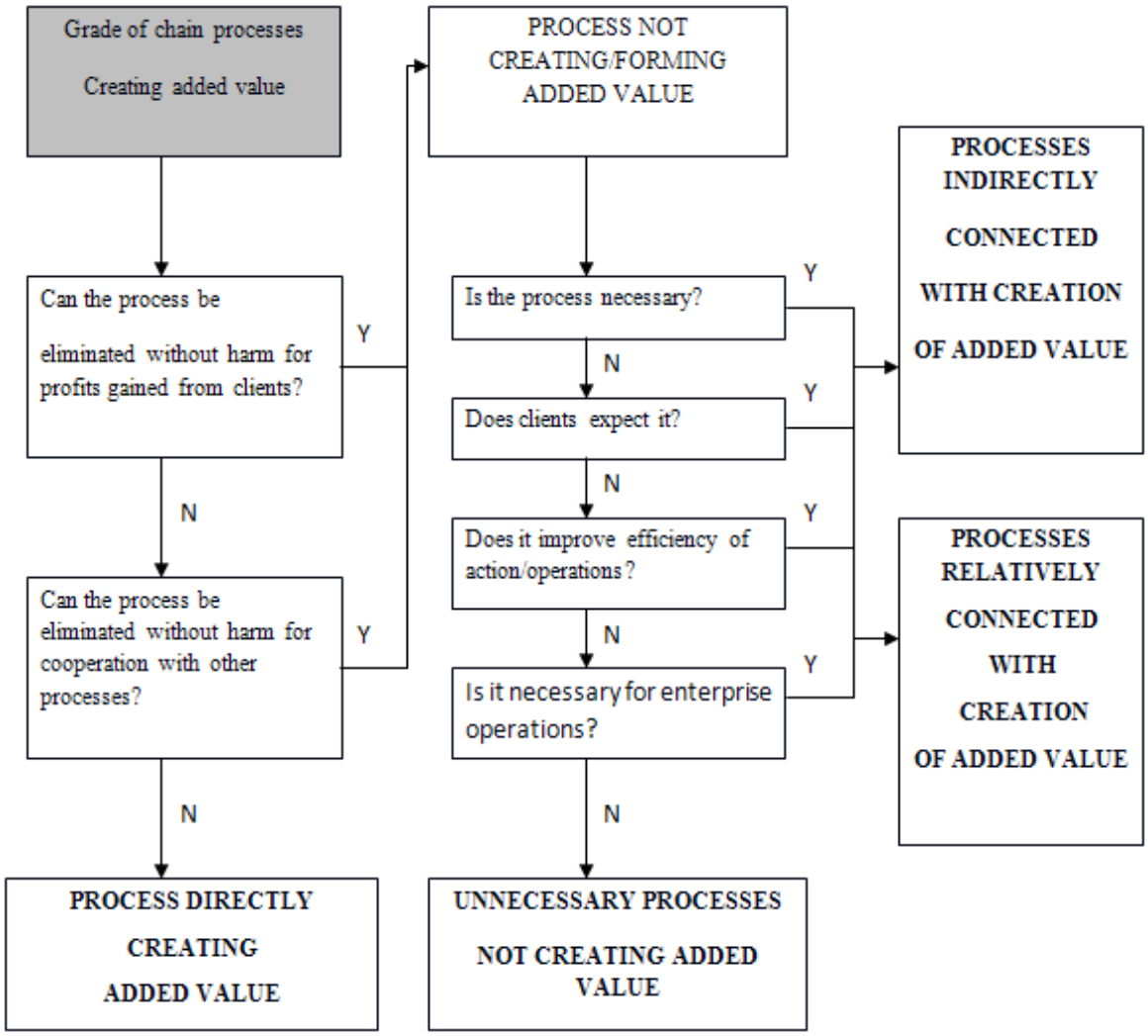

Figure 5. Algorithm of process evaluation in relation to creation and delivery of added value
(source: the own study on the basis [26])

Interpretation of algorithm can be proposed by P. Blaik followed by P. Schuderer processes division on [3]:

- processes directly creating added value, characterized by direct and close relationship with customers - primitive processes, basic processes among which it is possible indicate:
  - main processes, beginning as well as finishing (by contacts with customer) on market, creating and delivering suitable, from point of view of customer, values and goods in form of product,
  - auxiliary processes, provoke through main processes as well as necessary for itself existence, in somewhat smaller degree connected with wishes and expectations customers,
- processes indirectly creating added value, characterized by indirect relationship with customers - so-called secondary (minor) processes, which - helping directly processes to creation added value - they are the cause of reason enlargement this value,
- relatively connected processes with creation of added value, showing relative relationship with customers - so-called third-rate processes, in considerable degree, especially in the temporary and factual relatively connected, are "distant" from primitive processes,
- processes not creating added value, not showing any relationship with customers - so-called potential symptoms of waste.

The test of the classification of processes in the aspect of creating the added value according to received in the algorithm foundations are presented in Table 5.

Table 5. Processes division on account of input in creation of added value
(sources: the own study on the basis [3], [5], [11], [13], [18], [19], [25 - 29], [33], [37 - 40], [46])

Process influence on creation of the added value	Types of processes
Processes directly creating added value (Basic processes)	- the realization of the customer orders - the realization of the customer logistic service - offering additional values for the customer - the minimization of costs leading to decrease price of the offer of products and services - accepting as well as dispatch of products across realization of transport processes, of load, storing, packing and labeling products - the assuring required level of the customer logistic service
Processes indirectly creating added value (supporting processes)	- analysis and prediction of logistic situation on market - identification of customer preferences and expectations in range of logistic service - identification of logistic segments of market - formulation and development of logistic strategy - forming a set as well as structures of components of logistics - mix - aim identification and elaboration of logistic customer service realization basis - dispose instructions of orders realization and customers orders - steering the flow of products by working out the course of transport processes, trans-shipment, storing, packing and labeling products - protecting shopping processes quality as well as sale of products - protecting quality of service processes - protection and development personnel qualification in range of competence in forming and realization of logistic processes
Processes relatively connected with creation of added value (third-rate processes)	- protection of abilities as well as potentials of creation added value - research and development of logistic infrastructure - development of information technology and computer science - formation and provide for of the relations and the report with surroundings - taking care of waste, packaging's, damaged products in economical way - protection of sale as well as realization of revenues - protection of financial aspects of logistics (realization of customers orders)

Division of the processes in the aspects of their influence on creation and realization added value is shown on the map of creation and delivery of added value for every market participants, see Fig. 6.

Building basic of a map of creation and realization of added value is to comply two dimensions of values, including the enterprise aspect and customer aspect, as the bases of signify two dimensions of creating and the realization of the added value. In right up corn are those symptoms of processes activities, which are directly connected with creation and realization of added value. Right hand bottom corner shows minor processes, indirectly connected with creation and realization of added value, which helping processes directly creating added value and while they have an impact on it, they lead to enlargement of it. Left hand up corner of map are processes relatively connected with creation of added value, showing conditioned relationship with customers in considerable degree, in temporary sense and factual, situated as "further", from primitive processes, more essential from point of view of enterprise operations. Left hand bottom corner are the processes not creating added value, not showing any relationship with customers, defined as potential symptoms of waste.

Mapping processes in the shape of creating a realization added value can directly contribute to the proper allocation of individual processes in enterprise. Does proper planning out processes on the proposed map give the answer on the questions which contribute processes to the market success of the firm directly? and which of them have an influence on the customers satisfaction level from bought goods or services.

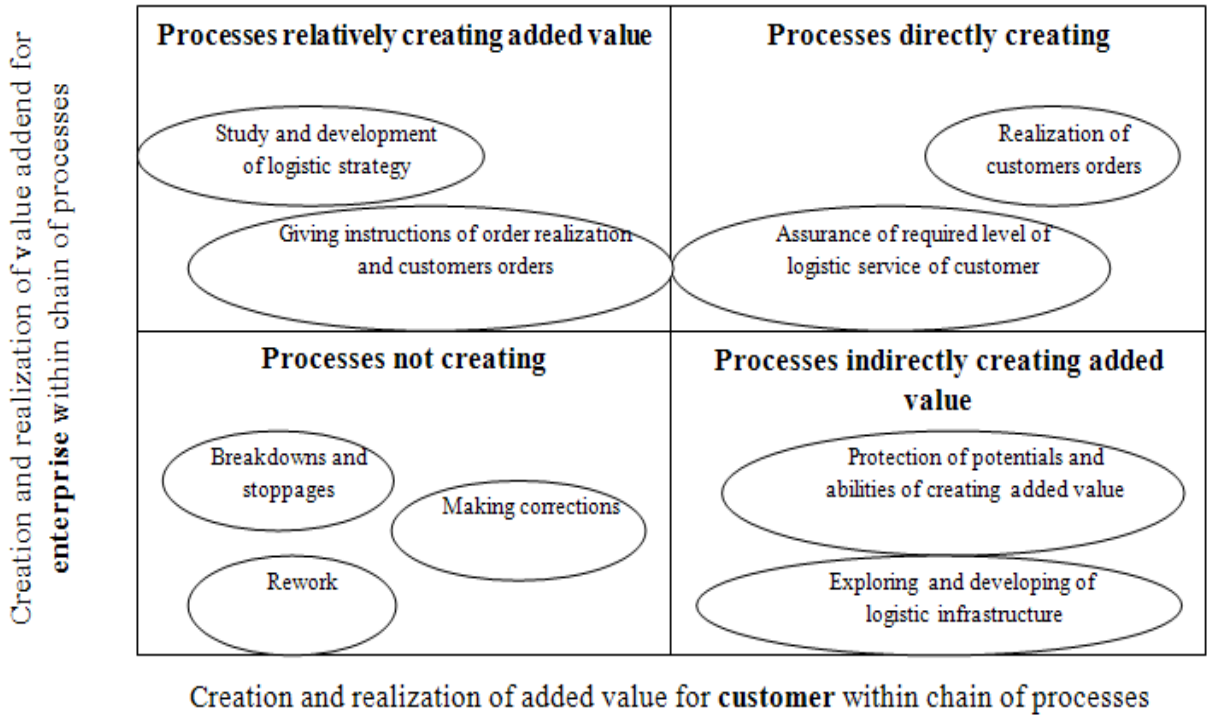

Figure 6. The map of creating and delivery of added value for all participants of the market
(source: the own study on the basis [26])

Presented classification of basic processes in the context of their influence on creating the added value does not take into account one from two groups of the chain of the Porter value, which is, directly processes creating value, which without a question are so-called auxiliary processes. Not placing them in the table is because its undisputed influence on creating added value for the market participants

Auxiliary processes begin from the contact with the customer on the market and also finding there their realization. They characterize oneself somewhat smaller relationship from expectations and customers preferences. Their essential feature is that, that they relate first of all to delivery, adapting and preparing resources, materials, cooperative elements, semi manufactured articles, etc., in the definite spheres of flows, are also connected with the realization of tasks and action in the so-called pre-production sphere and within the assembly action [3], whereas they are the indispensable condition of existence and the realization of the main processes.

The basis of such a point is proposed chain of creating and delivery of the added value, schematically introduced in the Fig. 7.

Above mentioned proposal of the chain of creating and delivery the added value include the individual integrated with each other chains of logistic processes, productive and remaining processes, which aim is to produce and realize added value for all market participants. It is proper also to pay the attention to the fact, that the growth of the added value created by next processes, maybe stimulated thanks to the using so-called synergetic effects, understood as the difference among the total effect of creating added value within the chain processes, among which co-operation sets up, and the sum results of creating added value by isolated processes, among which the co-operation does not step out [20].

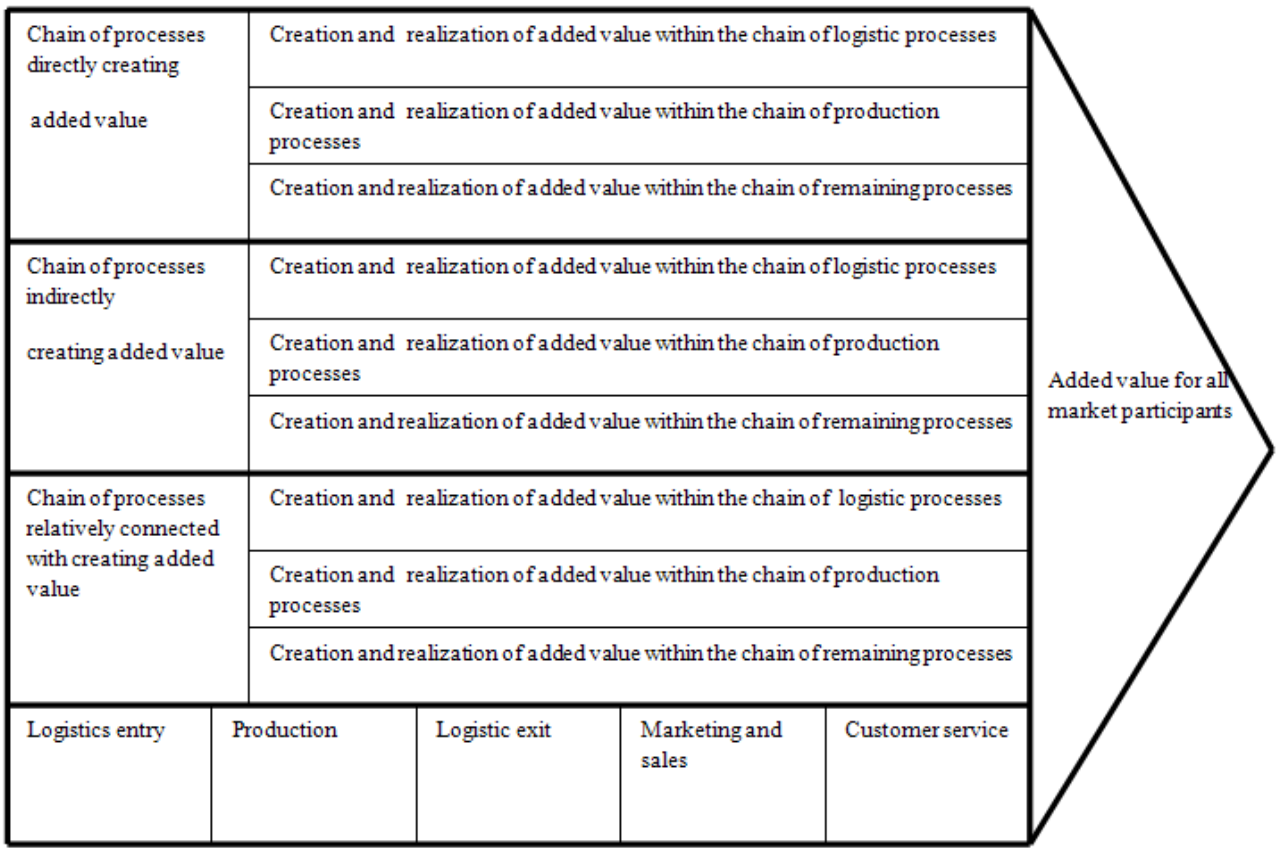

Figure 7. The structure of the chain of creating and the realization of the added value with the regard of logistic processes *(source: the own study on the basis [2], [7], [25], [27], [36], [17])*

6 Summary

Undertaken attempt of systematization of issues connected with creating and realization of added value in the understanding of the process organization indicates fact that the added value category is a multidimensional concept with many aspects that are directly related to the processes management instruments, determined by all appropriate market participants.

Regardless of what processes will be the object of analysis in the context of creation and realization of the added value, they should be treated as repetitive, precisely defined activity process, with clearly defined beginning and ending, determined by material and information flow, including basic and supporting activities creating the value from the point of view of customer and from the point of view of the enterprise. This flow of goods and information through the transformation implies generating the value for all market participants linking the sphere of production with the sphere of usability.

Research performed in recent years indicates the change of the roles and the meanings of the category of process. In the context of effects reached by the enterprise the matters connected with creation and realization of the added value have a significant meaning, including added value for the customer and added value for the enterprise.

Paradigms of process approach in organizations described in the publication are becoming the stimuli of process orientation and became the basis to reveal its essence.

Process orientation determines identification of particular processes, especially in the aspect of creation of added value to the client as well as well to enterprise. Process approach to organizational management results from a need of looking for new sources of creation and realization of added value. Necessary condition in realization of all aspects, dimensions and elements that determine the category of added value is the elaboration of modeling rules, realization and stimulation of processes as a part of the process organization.

Evaluation of added value created and realized within process organization should be quantified with regard to set aims. It should refer to the evaluation of the main goal accomplishment, partial aims realized by individual processes and the activities of supporting processes. The knowledge of processes aims is a crucial stage of identification and it determines, to a considerable degree, the final effects of its realization, which is producing and realizing added value for the market participants.

In the scope of determining the vision, interpretation and creation of added value within the customer and enterprise processes an algorithm to classify processes into: directly creating added value, indirectly creating added value, relatively creating added value and non-value adding, so called potential waste sources, was presented. Described algorithm is a basis for process allocation in the aspect of their influence on creation and realization of added value on a map of creation and provision of added value to all market participants. The map was created by the paper's author.

Value adding process mapping can directly contribute to more precise knowledge about processes within the enterprise. Layout of the processes in the proposed map allows determining, which processes directly contribute to enterprises market success and which of them have the biggest influence on customer satisfaction.

The summary of presented deliberations is the proposed chain of creation and provision of added value. Proposition of the added value creation and provision chain includes particular integrated logistics, manufacturing and other chains which aim at creation and providing added value to all of market participants. Special attention was drawn to the fact that increase of the added value created by following processes can be additionally stimulated with the use of the synergy effect, defined as the difference between the global value added effect in the process chain, with interrelated processes, and the sum of value added created by single processes that are not connected with each other.

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MANAGEMENT INFORMATION IN ADMINISTRATION SYSTEMS

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Abstract: Management information is the basis for decision making. The essential meaning of the management information is noticed in the administrative systems, through the analysis of the character and usefulness of the management information, as legal information that is published in the form of internal and external legal acts. Specification of the legal acts, connected with the activities of the administrative unit, requires undertaking of certain methodology of the conduct. Process approach, based on the specification of the processes realized in the administrative unit and related legal acts, is suggested. Case study related to a faculty at the University is an example of the use of presented proposal.

Keywords: data, information, decision making, management system, administrative system, management information.

1 Introduction

Organizational functioning (i.e. industrial organizations, service companies, public administration units), requires making decisions:

- within short time,
- taking into account multi-dimensional character of decision area,
- on the basis of management information, required as a result of data analysis.

Management information, as any other information, is a result of data interpretation and belongs to one of categories of information resources (p. 2). Management information, being a basis for decision-making, must have particular features, such as i.e. (p. 3): topicality, reliability, content usefulness, diversified level of detail, completeness and selectivity. Because of the character of management information use, its presentation form and distribution become highly relevant.

Gathering the analyzed data and obtaining management information from it requires using management information systems, viewed as set of methods, techniques and tools which support making business decisions (p. 4). Data for the analyses may be stored in spreadsheets, databases and data warehouses. Spreadsheets enable simple reporting. Data gathered in databases and data warehouses are subject to, apart from reporting, analytical processing and exploration.

When analyzing the usefulness and character of management information in administration systems (p. 5), a relevant meaning of management information in this field is observed with regard to legal information, published as external (p. 5.1) and internal (p. 5.2) legal acts.

Specification of legal acts connected with organizational activity requires adopting a pre-determined action methodology. A process approach is suggested (p. 6) which consists in specification of processes realized within the unit and legal acts connected with them. Process description should include such elements as: process name and ID, process realization goal, legal basis (specification of internal and external acts), additional sources of information, process owner, process participants, process initiation, process realization procedure, commentary (including know-how with regard to the process), accompanying documents and information on data actualization.

An illustration of the presented proposal is the case study (p. 7) related to a university faculty.

2 Information resources

Information resources[1] include: data, information and knowledge. These notions lack unambiguous descriptions.

[1] "Resource – this concept is used especially often to generally describe means necessary for obtaining a goal. Resource (fr. ressources), may refer to money or time in terms of availability. Resources play vital role in just-in-time production systems. Notion of resource – similarly to the notion of system – is also used as synonym (or mental abbreviation) for precisely enough described realities, which may be used for the purpose of goal realization. Resources are used to build up systems. In systems, also, the resources are processed." (Krupa T.: Elementy organizacji. Zasoby i zadania, p. 14, Warszawa WNT 2006). A special kind of resources are the information resources.

Data is defined, among others, as:

- observable features (characteristics) of real and abstract objects or phenomena,
- external stimuli perceived by living organisms through senses: sight, hearing, smell, taste or touch,
- ordered series of symbols, saved on a storing device, representing text, numbers, images and sounds,
- bitstreams saved on electronic storing device,
- data name and value.

Among the issues connected with information resources processing, one of the following definitions is assumed, according to which data are an ordered series of symbols, saved on a storing device, representing text, numbers, images and sounds.

Data sets are not equal to possessing information. Data acquires useful value, in the sense of information value, after its primary interpretation, result of which is information. This new information also takes form of data.

In many cases data sets have considerable volumes (mega- or even terabytes), contain detailed data, which, prior to interpretation, require processing and complex analyses. In this case, subject to interpretation will be the data processing results and not the source data.

Interpretation is influenced by:

- available dataset,
- interpretation ability, resulting:
  - in case of technical devices, from data interpretation algorithms ascribed to them,
  - in case of people – from such factors as, i.e.: knowledge and the already possessed information concerning the problem described by data, experience and interpretation skills of person or team who carry out the interpretation,
- type of interpreting object:
  - in case of technical device, interpretation of different datasets is performed in accordance with the same algorithm. Therefore, it is a repetitive process and it can be assumed, that interpretation result is objective,
  - in case of interpretation performed by human, the interpretation results may be influenced by personal features, beliefs, moral and ethical values.

Results of interpretation, that is information, are saved to data storage devices. A set of saved information may be treated as data interpreted for obtaining further information. It may be assumed, then, that data and information are not distinguished by the way they are saved to storage devices, but by their usefulness and way they are used by the recipient. If the record is understandable for the recipient, decreased his unawareness, does not require further processing and analyses and is useful for making decision, that means information was obtained. In the opposite case, record has to be treated as data, which should be further processed, analyzed and interpreted in order to acquire use value.

Knowledge is the ability to use information. Knowledge is a combination of experience, information, expert insight, which ensure fundaments for developing and implementing new experiences and information. It comes from and is used by the minds of people who have this knowledge. In organizations it is often placed in documents or data repositories, but also in methods and models of conduct, processes and norms.[2]

In case of business activity or organizational units functioning, knowledge is the ability to use information and make decisions concerning purposeful tasks realization (Fig. 1).

Currently, with the use of available information technologies, the problem is not data and information gathering, but their proper selection, analysis and transformation into knowledge, which supports taking right decisions. Issues of decision making are related, among others, to the availability of information referred to as management information.

3 Management information

There is no single unambiguous definition of management information. The area of its use, purposefulness of obtaining, attributes, sources and forms of processing are, however, pointed to.

Management information is usually information useful for managers in running a company, making decisions concerning company functioning which enable maximum profits and minimum costs, the best, fixed position in the market, winning new and keeping old clients. It is information on current status and prognoses concerning the company and its environment. At present, management information is given most attention in industrial and service companies.

[2] Davenport T. H., Prusak L.: Working Knowledge: How Organizations Manage What They Know. Harvard Business School Press, Boston 1998.

Figure 1. Information resources and purposeful actions

When information is treated as basic resource, necessary in the decision making process, the management information should be available in the right time and place and should possess particular attributes, among which the most important are: (a) topicality, (b) reliability, (c) content usefulness, (d) diversified level of detail, (e) completeness, (f) selectivity and (g) non-standard character. The meaning of these attributes was described below.

(a) Topicality

Management information is a result of interpretation of data, which, in business reality, undergo constant changes. It is necessary to ensure current data actualization. This criterion is often not met due to:

- dispersion of data among different data sources,
- data redundancy[3],
- lack of procedures of data actualization or lack of their realization.

Together with data actualization, management information actualization is necessary, which is a result of the former.

(b) Reliability

Data which undergo interpretation must reflect the facts, which they describe. Incorrect data distort the reality and may lead to wrong decisions.

(c) Content usefulness

Scope of the passed on information should suit the scope of competences and responsibility of information recipient.

(d) Diversified level of detail

Managers usually make use of information prepared on the basis of data of given aggregation level. In justified cases information of higher level of detail should also be available, in order to determine the causes of situations that occurred or suggested prognoses.

(e) Completeness

Management information, dedicated to a given post, should completely characterize the problem related to the decisions to be taken. It should also contain historic information, current status and prognoses.

(f) Selectivity

Management information selectivity refers to following the rule, according to which this should be information necessary for taking decision with regard to a problem that is currently being solved. It should refer to a particular problem area. Both lack of and excess information are harmful.

(g) Non-standard character of management information

Business activity is characterized by competitiveness, which requires non-standard actions and non standard decisions and, subsequently, also non-standard management information. There might be a case, when two competing units have to make decision based on the same data. Competitive advantage may be the management information derived from data. The fact it could be different in both cases may result from using different data analysis tools and adopting different analysis algorithms.

If both units have the same applications for data processing and data analysis, which takes place in situations when commercial software is used, the following elements may be used for competing:

- different specification of information needs,
- defining different enquiries to the data analyzing system,
- ability to use the obtained information.

These three elements are independent from the information technologies which are used, depending only on human skills.

[3] Redundancy – excess, multiple repetition of the same data value in a database. It is unwanted, because: (a) additional memory is occupied by repeating data, (b) in case data value should be changed, the actualization would have to be carried out multiple times.

Important meaning for management information have: (a) form of presentation of management information, (b) standardized presentation, (c) distribution of management information and (d) form of communication of management information.

(a) Form of presentation

Management information is usually presenter in form of reports which include tables and charts and, in justified cases, also supplemented by commentary. The usefulness of report is influenced to high extent by its editing: table structures, types of charts and their colors, legible commentaries and structure of report elements. Report elements are viewed here as single pages of a printed report, screens or presentation slides.

(b) Standardized presentation

Standardized presentation gains importance in case of repetitive decision problem. Repetitive decision problem does not imply identical information within the report. Usually they are different, but their identical structure enables comparison of phenomena which take place and provides additional information, which result from observation of changes in time and under influence of previously made decisions. Set of reports, information about the decisions made and observation of decision results enable gathering knowledge about the analyzed problem area and constitute a case study for future decision processes.

(c) Distribution of management information

Distribution of management information requires determining its users and pointing to forms of communication of information. Recipients of management information may be the people directly responsible for taking decisions in the problem area, which the information concerns, or persons, for whom it may serve as a supplementary information.

(d) Form of communication of management information

Information may be passed to the interested people in paper or electronic form. Each form is useful in different conditions. Printed form is advisable in two situations.

First of all, when discussion about the information included in the report is expected. Printed form enables precise analysis of the report, making remarks and corrections even before the discussion. During discussion this form enables each person to have individual access to particular report elements and simultaneous observation and analysis of a few report elements.

Secondly, paper form is used for archiving paper reports, which makes access to them independent from access to IT system or possibility to read from electronic storage devices. Usually, for the purpose of archiving, both printed and electronic version of report are kept.

Electronic recording enables structuring and ordering reports according to the adopted criterion, which could be i.e. date of issue, problem area, information recipient. With electronic recording it is easier to manage the set of management information, flexible information access (i.e. through internet) is assured, the possibility exists to set information access rights for particular recipients or groups of recipients.

In order to gather and process data as well as to perform its interpretation, in the course of which management information is obtained, due to considerable volumes of data and complex interpretation algorithms, management information systems are used.

4 Management Information Systems

Management information Systems (Business Intelligence) are described as set of methods, techniques and tools for supporting business decisions with the use of available information resources.

Tools which support elaboration of management information include, among others:

- spreadsheets,
- reporting and analysis systems in transactional databases,
- reporting and data analysis systems in data warehouses.

Spreadsheets are one of the simplest tools, which enable obtaining management information. For example:

- with the use of possibility to define formulas and their free parameterization as well as rich set of standard functions, spreadsheets enable construction of behavior models for the researched problem fields. Management information will be obtained through observation of chosen values, after performing in spreadsheet calculations for following sets of parameters,
- second form of spreadsheet use is data reporting. In this case, for the data saved in two-dimensional tables, reports may be constructed with the use of:

- simple and advanced filtering,
- summary reports,
- pivot table reports.

Currently, most data is saved in databases[4], which constitute an integral part of IT systems. Databases usually have character of relational databases[5]. Their management systems are equipped with tools which enable data analysis through construction of reports, definition of queries in SQL[6] language, construction of additional data structures and their analysis.

Confrontation of requirements connected with data analysis against possibilities offered by relational databases points to some limitations of their use for obtaining management information:

- there is a necessity to construct complex queries to databases in SQL language, which requires knowledge of language as well as database structure (tables and their content, relations),
- multi-criterion queries make use of data from many tables, which makes it necessary to perform operations on these tables, that require considerable number of data transmissions between external and operational memory, resulting in slower system functioning,
- relational databases are usually used for realization of current transactions[7] (thus, are called transactional or operational). As a result, in order to run analyses it is often necessary to use a database copy or to run them in time when transactions are not being serviced,
- operational databases most often gather data from 60 to 90 days, whereas prognostic analyses require historical data dating back 5 to 10 years,
- transactional databases are used for storing detailed data, however, they lack aggregated data (i.e. sales in different periods: day, week, month, year – or with regard to particular regions or client groups, etc.).

The problem of data availability for analyses was solved by construction of so called data warehouses.

According to the definition by Bill Inmon[8], warehouse is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process. Interpretation of the above mentioned definition is as follows:

- subject orientation means that the warehouse gathers data that gives information about a particular business subject, on the contrary to process orientation used in case of transaction databases,
- integration means that data warehouse gathers data from various data sources and merges them into a coherent whole, i.e.: their names, formats and sizes,
- time-variance means that all data, which is entered into warehouse, is identified with a particular time period, from which the data comes (so called time marking), which enables sequencing data according to time and carrying out analyses from the historic point of view as well as determining trends and prognoses,
- non-volatility results from the fact, that data within data warehouse is not actualized, which means they are not changed after having been entered into warehouse (access to data is read-only and change may only refer to incorrect data); admission of warehouse with new data takes place periodically, which enables to gather them in practically any time period (i.e. 5-10 years).

Solution based on data warehouse:

- uses existing transactional databases, which are a basis for functioning of transaction processing systems (OLTP)[9], spreadsheets and all other data sources required for running the analyses,
- gathers data in data warehouse,
- data in the warehouse is subject to analyses with use of tools for interactive analytical data processing.

[4] Database is a physical record of data values - defined, together with their structure, within logic model. Data is stored in form of records (i.e. record with data of an employee), made of fields, each of which stores value of single piece of data (i.e. surname, name, date of birth). Depending on the relation, which may exist between records, relational, hierarchical, network and object database models are constructed. (Ostrowska T.: Relacyjne systemy bazodanowe. Podstawy projektowania i eksploatacji. OW PW, Warszawa 2002).

[5] Relational database is a database, in which records containing data are stored in two-dimensional tables and there may exist 1:1, 1:n and n:m relations between records of different tables. Records are identified through unique, within a table, record ID, so called primary key (Ostrowska T., ibid.).

[6] SQL (Structured Query Language) is a language, with the use of which it is possible to: define database model, update data values within the base (enter, change, delete), formulate queries in order to find in database the datasets implied in the query. (Ostrowska T., ibid.)

[7] Transaction is a sequence of operations which modify data stored in database. Each time either all operations of a transaction must be carried out or none of them. (Ostrowska T., ibid.).

[8] Inmon W.H.: Building the Data Warehouse, Fourth Edition, Wiley Publishing Inc., Canada 2005.

[9] OLTP - OnLine Transaction Processing.

Main goal of establishing data warehouse is to separate transactional systems from analytical systems, which in practice means separating operational and analytical activities.

Information obtained from data warehouse arises as a result of performing: (a) exploration or (b) analysis of data gathered in it.

(a) Exploration of data

Exploration of data is based on use of statistical methods and AI methods, which enable revealing unknown dependencies between data gathered in the database. It is described as process of knowledge discovery from data (KDD)[10], which may consist in:

- verification of hypotheses, which is applied in situations, when it is assumed that certain relationship between data exists and it is expected that this assumption will be verified during the analysis,
- discovering knowledge, which consists in data analysis and expectation of finding a relationship between data, which was not determined so far.

(b) Analysis of data

Data analysis takes place with use of software for interactive analytical data processing (OLAP)[11]. Data is prepared for analysis by being submitted to aggregating operations. Next, depending on the required management information, datasets for analysis are defined. Interactive charakter of OLAP tools enables active participation in analysis through choice of analyzed data and formulation of queries.

5 Management information in administration systems

Discussion, polemics, projects and IT solutions with regard to management information usually refer to obtaining and using it in industrial and service companies for making business decisions. It has to be pointed out that:

- apart from production and service companies there is also public administration[12],
- in organizations[13] (i.e. companies, public administration units), apart from organizational units[14] which directly contribute to production of good or service, there are also administrative units.

In Poland the structure and functioning of public administration[15] is determined by Code of Administrative Proceedings[16], which regulates proceedings in cases solved on the basis of administrative decisions. Code of Administrative Proceedings determines proceedings in such fields as, i.e.: solving cases, serving of a decision, summons, initiation of proceedings, presentation of evidence in proceedings, organizing proceedings, suspending proceedings, passing decisions and resolutions, reaching compromise, lodging complaint, appellation, complaints and motions.

Administrative units in different kinds of organizations deal with i.e.:

- employee matters, regulated by Labour Code[17], in which rights and obligations of employees and employers are described; this regulations define among others: basic rules of labour law, forms of employment, control over compliance with labour law, labour relations (making labour contracts and their termination, contract expiry), employee remuneration, prizes, distinctions,
- financial statements of organization, which are regulated by rules referring to particular groups of organizations, i.e.: Act on Public Finance[18] is aimed at organizations from public finance sec-

[10] KDD – Knowledge Dicovery in Databases.

[11] OLAP – OnLine Analytical Processing.

[12] Public administration is formed by organs created in order to fulfill collective and individual needs of citizens, who function within the society. Role and scope of functions of public administration depend on the political system of a country. Public administration in democratic countries consists of government and local government administration. In totalitarian countries public administration which functions in accordance with arrangements of current political directorship is established.

[13] „… what is understood under the term organization is, depending on the context, the activity of organizing, a system resulting from such activity (or even a spontaneous formation), configuration of its inner relationships, or, lastly, the object organized in such a way itself." (Kotarbiński T.: Traktat o dobrej robocie. p. 107, Ossolineum 1973).

[14] Organizational unit – separate part of an object, that is the organization.

[15] In accordance with article 5 § 2 point 3 and article 1 point 2 of Code of Administrative Proceedings, organs of public administration are: ministers, central organs of government administration, organs of local government units as well as other organs and subject brought to life ipso jure or based on agreements concerning settling cases solved on the basis of administrative decisions.

[16] Statement of Prime Minister of October 9, 2000, with regard to consolidated text of Code of Administrative Proceedings (Journal of Law, 2000, No. 98, pos. 1071).

[17] Act of June 26, 1974, Code of Labour (Journal of Law, 1974, No. 24, pos. 141).

[18] Act of June 30, 2005, on public finance (Journal of Law, 2005, No. 249, pos. 2104).

tor[19], which does not include companies, banks and partnerships following commercial law, which are regulated separately in this area,
- administrative-financial consumer service, with regard to clients who are recipients of products and services, which may be exemplified by services provided to students (who use the service during didactic process) by dean's offices; guidelines for this service are included, among others, in: university statute, byelaws of studies, Code of Administrative Law.

It is characteristic for administrative-type of units that:
- processes realized in them have the character of data processing,
- results of their activities are decisions and documents.

Processes realization and their results are determined by legal information, which has character of management information. This information causes that:
- the decisions taken are compliant with law in force,
- documents which are prepared are consistent with the standards set,
- processes are realized in accordance with legal acts which define them.

Legal information is edited in form of legal acts. Set of legal acts has hierarchic structure, in which the acts of lower level are subordinate to higher level acts. Subordination, which, at the same time, points to formal relations between acts, results from including in legal acts an obligation or right to issue a lower level legal act (so called delegation). Higher level act may precisely describe the content of a lower level act issued on its basis or describe this content in a more general way, by only suggesting the content or aim of issuing the act. Hierarchical structure obligates to actualize all lower-level legal acts in case of changes introduced to higher level act.

In case of Polish legal acts, hierarchical structure is formed (according to the importance in hierarchy) by: constitution, acts, ratified international contracts, ministers' decrees, followed by lower level acts, which are a consequence of delegations included in higher level acts.

In case of organizations with hierarchical structure, internal legal acts may also build up hierarchical structures, if they include delegations for formation of lower level acts. An example may be the dispositions of university chancellor, which include delegations for issuance of legal acts by deans of particular faculties.

Taking into consideration the place, where legal acts are issued, they may be divided into:
- external legal acts (5.1), issued outside the organizational units (constitution, acts, ratified international contracts, ministers' decrees) and, with regard to given organizational unit, also legal acts issued by superior units,
- internal legal acts (5.2) issued within the organizational unit in form of dispositions, decisions, circulars and other, issued by persons authorized to issue legal acts in a given unit.

5.1 External legal acts

Use of external legal acts requires: (a) identification of external legal acts, (b) their appropriate popularization and distribution, (c) appropriate reaction to actualization of external legal acts and (d) evaluation of results of the introduced changes.

(a) Identification of external legal acts

Identification of external legal acts connected with all areas of organizational unit's activity is not an easy task and requires adoption of a specific methodology. It is suggested to use process approach[20], which is also used in other situations (i.e. while designing IT systems and databases). According to this approach, the basis for all design activities is the specification of processes realized within the organization. Next, for each of the processes legal acts connected with it should be identified and their metrics should be precisely described (metrics should contain data on legal act including: full name of the document, date of issuance, source of document content).

When searching for legal acts connected with a process, one should take into account they may:
- define the process,
- define documents used during process realization or documents, which are results of process realization,

[19] Sector of public finance includes among others: government and local government administration, budgetary units, universities, independent public healthcare units, state and local government owned cultural institutions, Social Insurance, Polish Academy of Sciences and its subsidiaries, other state or local-government legal entities created on the basis of separate acts in order to perform public tasks.

[20] Reference models in business processes management. Collective work, edited by T. Kasprzak, Difin, Warsaw 2005.

- determine conditions for process realization,
- determine the method and form of decision-making, decision results or situations which accompany decision.

If legal acts form a hierarchical structure, which results from granting delegation in higher-level act for issuance of further lower-level acts, then it is recommended to specify the hierarchical dependence between legal acts, which enables to follow changes in case of actualization of higher-level acts and take adjusting actions.

(b) Distribution and access to external legal acts

Distribution of external legal acts most often takes one of the following forms:

- sending all new legal acts in electronic form directly to their potential recipients - in this case recipients are being informed about all new legal acts, may choose and store in their electronic archives those legal acts which directly concern them or make a print, which can stay in the internal archive or may be handed in to appropriate addressees, who are responsible for taking action resulting from the new legal act,
- sending internet addresses (links) to potential recipients, which grant access to content of documents; in this case the interested parties have access to content of documents, may read or copy them and attach them to their information resources, or print them and hand over to the interested people/parties,
- publishing legal acts on internet sites with limited or unlimited access to their content,
- printing legal acts and their distribution to interested parties,
- printing legal acts and making them available on sale (i.e. Journal of Law),
- letting legal acts to be printed in magazines, clients of which are also potential recipients of the legal acts which are printed.

In order to follow the rule concerning databases of not-allowing data redundancy, making multiple copies or prints of documents should be avoided. If documents are published on Internet sites[21], then one suggested solution is to create a document metrics library and establish internet addresses to their content. Unfortunately, this solution brings about some risk, source of which may be the lack of access to internet in some required times, malfunction of computers or network, change of documents' addresses (example of such situation is presented in the case study, p. 7).

(c) Actualization of legal information and its results

Polish legislation is unstable. This results from the necessity to adjust our law to the changing environment or the EU solutions.

Many external legal acts are subject to amendments, new legal acts appear. In many cases it is justified to appoint in organizational unit a plenipotentiary for management information. One of his tasks will be to follow changes in external legislation and actualization of internal legal acts.

(d) Results of legal changes

One change of the law in force equals, in many cases, a hard-to-foresee chain of consequences. A result of changes may be i.e.:

- reorganization of process, if it is defined by the legal act,
- change of forms, reports, reviews and other documents,
- necessity to issue new internal legal act or their amendment and realization of resolutions included in them,
- changes in decision processes,
- changes in computer programs, which realize the guidelines included in legal act,
- necessity to establish procedures which will neutralize consequences resulting from new law,
- necessity to elaborate procedures of switching to the status defined by legal act.

5.2 Internal legal acts

Internal legal acts, which are created inside of organizational units, usually take form of decrees, decisions, circulars, which may be assisted by attachments, which are their integral part, containing: procedures, rules, regulations, instructions, forms, registers, etc.

In each organization, if this is justified, people should be appointed, authorized and obliged to issue internal legal acts and elaborate rules of: (a) creation, (b) archiving, (c) distribution of internal legal acts.

[21] An exemplary system for publication and archiving of legal acts is the Internet System of Legal Information (http://isip.sejm.gov.pl), in which legal acts available in Journal of Law are published (their consolidated texts and bibliographical descriptions).

(a) Elaboration of internal legal acts[22]

Rules of elaborating internal legal acts concern:

- process of document elaboration, i.e.:
  - appointment of coordinator of legal act elaboration and determination of his competences,
  - appointment of person or team for elaboration of legal act design,
  - appointment of people responsible for giving opinions about legal act's content, among whom there may be specialists from the field which the act concerns as well as representatives of social organizations and labour unions, if, because of the scope of matters covered by the regulation, it is justified from the point of view of their entitlements,
  - appointment of person responsible for reviewing the act from legislative and editorial point of view.
- rules determining document content and edition, i.e.:
  - document should contain particular title, legal basis, content-related regulations as well as changing, transitory, adaptation and closing regulations,
  - document content usually takes form of articles, paragraphs, sections, points and letter of law (in case of big legal acts, such as codes, also volumes, parts, sections and chapters are introduced),
  - document page structure may be determined (format, margins, fonts, space between lines),
  - it is advisable to define document symbols, document numbering and moments when the numbering is reset, i.e. with the beginning of each academic or calendar year.

(b) Archiving of internal legal acts

Internal legal acts should be subject to archiving in accordance with a procedure, which should point out:

- person responsible for running the archive,
- place for storing documents,
- form of archived document (paper, electronic),
- organization of electronic archive, including structure, nomenclature of folders, files with legal acts and their attachments,
- method of running internal legal acts' registers.

Place of storing a document, the content of which is constituted by legal act, should always be known. This is important in case of legal acts' amendment, which requires access to former legal act or its fragments. Access to former acts allows to determine the legal status which was in force in a given moment of time.

(c) Distribution of internal legal acts

Internal legal acts should be:

- handed to people, who they directly concern. Depending on the arrangements - in paper or electronic form, whereas in case of personal matters it may be paper form with necessity to confirm the receipt,
- made accessible for unit's employees. Which is most often realized through publishing their content on corporate-portal's sited, with limited access for people from outside the unit.

6 Process model and legal information

Process approach is used in many areas, i.e. connected with functioning of organizational units, design of IT systems and databases.

Analysis of processes enables to point out the processes of key meaning for the company, identifying so called 'bottlenecks' (process fragments in which, for example, delay in process realization occurs, costs rise or too high use of resources takes place) and fast adoption of corrective actions.

Analysis of information resources connected with processes and procedures of their processing allows informational integration of company through implementation of IT systems and databases, which support realization of many processes.

Orientation of company on processes leads to change in management: from functional, aimed at activity of functional areas (departments, organizational cells), to process management aimed at achieving goal. This allows concentration on activities, as a result of which a particular end-effect in form of a good, which may be a product or service, comes into existence.

In case of this approach the realization of goal, and not realization of particular units' tasks, is important. If the goal is defined by a set of measurable parameters, unambiguous evaluation of its achievement is possible.

When modeling and analyzing process, actions and resources are taken into consideration which take part in creation of end effect. Detailed analysis of organiza-

[22] Prime minister's decree of June 20, 2002, Rules of Legislative Technique (Journal of Law, 2002, No. 100, pos. 908).

tion functional areas, its structures and other elements, which do not have direct influence on goal realization, is omitted. Process may be realized in many units of a given organization and should not be limited by its structure or organizational management structure. Key role in process approach is played by so called 'process owner', and not department directors. Process owner is responsible for the course of process, manages the whole team of people appointed to realize the process, who might be employed in many different units. In such case it is necessary to precisely define scope of responsibilities and competences of both units' directors and process owners.

Process approach is advisable also in administration units. This results from the following facts:

- administration units may be viewed as service providing units,
- clients of these organizations value product, which is a result of administrative activity, in form of a document, project or decision, and not the realization of tasks by internal administration cells,
- all products may be precisely described (excluding time parameter), which enables evaluation of services provided to clients,
- because vast majority of services in this area are connected with data processing, the process approach makes it easier to design IT systems which support functioning of administration units.

During process modeling, among others, the following items are taken into consideration:

- process structure, viewed as sequences of activities of operational and decision character, with process logics - which determines conjunctional and alternative dependencies between sequences of activities as well as cyclical series of activities - taken into consideration,
- resources engaged into realization of particular tasks (these resources may be classified as, i.e.: input and output resources, transforming and transformed resources);
- specification of information resources, which constitute basis for determining content of databases for IT systems that support process realization, is especially important,
- conditions for process initiation and its particular activities,
- time, cost characteristics of activities, etc.

Level of modeling detail depends on type of process, model purpose and form of use.

As a result of experiences with construction of process models in administration units and their usefulness in organizational functioning, it is recommended to complete the models with legal information and knowledge, especially tacit knowledge[23], connected with each process. In works carried out by the author the following model of process description was adopted:

<processId> Name of process

<processeId> is a process tag/identifier used for processes structuring and identification of particular processes. *Name of process* should be communicative and unambiguously point to the process.

A. Process realization goal

Determining goal of process realization consists in defining end effect of all of its constituent activities. Effect might be a good in the form of product or service. Evaluation of end effect may consist in binary description (yes/no) or requires comparison with formerly given characteristic or product model, which in this case must be defined as process realization goal.

B. Legal basis

Each process requires specification of legal information source, content of which may be the base for determining process realization, form of accompanying documentation or process result.

Vast majority of legal acts are published on web pages and may be accessed only with the knowledge of their internet address. Due to the fact that certain number of documents (forms, instructions, some of internal legal acts) should only be located among organizational unit's resources, as well as in order to become independent from network accessibility, library of legal acts was created, in which files with all legal acts and documents connected with processes can be found. In order to grant access to legal act both in the web and in library of legal acts, specification of a single legal information source consists of three elements:

- document symbol, reflecting name of the file, in which legal act is saved in library of legal acts,
- full document name, for file content identification,
- hyperlink to the content of document.

[23] With regard to accessibility and codification possibilities explicit knowledge and tacit knowledge are distinguished. Explicit knowledge is codified, can be stored and processed, is rational and objective. Tacit knowledge is personal, stored in its owners' minds, hard to process and formalize, intuitive and subjective (Grudzewski W. M., Hejduk I.: Zarządzanie wiedzą w przedsiębiorstwie, DIFIN, Warsaw 2004).

C. Additional information sources

Additional information sources are sources in form of paper or electronic documents, excluding legal acts, content of which may influence process realization.

D. Process owner

Each process should have an owner. It is a person who controls process realization and is responsible for its appropriate effect. Owner may be an active process participant or only its owner.

E. Process participants

Process participants specification enables to point out human resources required for process realization or units participating in the process. It may be used for determining roles fulfilled by the participants, their competences and tasks within the process.

F. Process initiation

It is vital to determine what causes initiation of process realization. It may be a particular event, given moment in time.

G. Procedure

Process procedure should define method of process realization, that is: point out activities and their sequence, including decisive actions. Procedure may be presented, for example, in descriptive form or in form of a scheme.

H. Commentary

Commentary should be a record of knowledge, especially tacit knowledge concerning process realization. It should be an approach towards recording know-how[24]. Its author may be the process owner or people who take active part in process realization. Commentary should derive from experience of people who realize given process.

I. Accompanying documents

Under the term 'accompanying documents' one should understand:

- forms, which are processed in course of the process,
- reports, which should be process realization results,
- documents which justify process realization.

J. Information on data actualization

Data should be actualized. Actualization date enables evaluation of up-to-date character of data previously taken from the system.

Illustration of the above mentioned remarks and proposals is the case study presented in point 7.

7 Case study

7.1 General Information

Design of legal information system was created for a faculty at university. The university is formed by a dozen or so faculties, each of which has from a few hundred to a few thousand students.

Faculty, as a basic organizational unit, consists of organizational units in form of institutes and departments.

In the university there functions a central administration and faculty administration at each of the faculties, which is formed by: faculty secretariat, dean's office for studies and students, economic department, administration and technical department.

At each faculty such processes are realized as: didactic processes, processes of student and employee service, technical processes related to maintenance of laboratories and conservation of faculty property, financial and accounting processes and a number of processes resulting from statutory responsibilities i.e.: realization of research works, reporting, internal quality processes (ensuring quality of teaching, ensuring quality of scientific research, employee evaluation system, quality management system in central and faculty administration, system of internal financial control and internal audit).

Appropriate course of processes requires obtaining legal information. Vast majority of external legal acts are legal acts created by Ministry of Science and Higher Education. Superior legal acts in the university are university statute and byelaws, including, above all, studies byelaw. These acts are approved by university senate by means of senate resolutions.

Bodies which have the right to issue internal legal acts are the university rector and chancellor (decrees, decisions, circulars) and directors of basic organizational units, that is – deans (decrees, decisions). Internal legal acts also include senate resolutions and resolutions of faculty councils.

[24] Know-how is viewed as the ability to perform something; it is the knowledge of particular persons and whole organizations; this knowledge never becomes completely public good, is hard to codify and pass on, usually constitutes competitive advantage of a person or organizational unit.

There is a considerable number of internal legal acts. Table 1 presents information about the number of decrees and decisions issued by rector and number of senate resolutions in years 2006 – 2007 – 2008.

Table 1. Number of internal legal acts

Internal legal acts	2006	2007	2008
Rector's decrees	34	49	58
Rector's decisions	61	116	176
Senate resolutions	140	266	391

All legal acts are available on university websites. The problem is to bind legal acts with processes realized in the university.

Analysis of IT program infrastructure of the university's organizational units enabled the author to formulate the following conclusions:

- university organizational units use a number of applications which mainly enable to gather or process factual type of data and information, i.e.: financial-accounting applications, employee data administration applications, applications which support dean's offices,
- applications support functioning of units in particular functional areas,
- legal information (acts, regulations, decrees, bye-laws, etc.) which is basis for process realization, is stored in many dispersed information sources in both printed and electronic form,
- there is no system for legal support of units with regard to processes realized by them.

7.2 Scope of research

While assuming that process realization is based on legal information, which, for each process, should be available at the right place and time, and in form which enables reading it by process participants, the following works were carried out:

- processes realized at university faculty were identified; special attention was given to processes connected with didactic processes and employee and student service (economic-financial processes and reporting processes were not considered),
- legal acts connected with processes and sources of their content were specified,
- library of required legal acts was established,
- trial implementation of the project was carried out, creating:
  - prototype of database system for management information,
  - hypertext structure, the frame of which is constituted by processes specification.

7.3 Results

(a) Processes

Processes connected with didactic processes and employee and student service were identified. Processes were classified in eleven categories. Classification criteria was the object which the processes referred to. Overall 324 processes were identified (Table 2).

Table 2. Process classes in organizational unit – faculty

Class	Number of processes in given class
P1 – candidate service	32
P2 – individual student service	59
P3 – collective student service	13
P4 – Ph.D. student service	41
P5 – studies service	32
P6 – postgraduate studies service	10
P7 – employee service	35
P8 – employee accounts	28
P9 – technical processes	12
P10 – administrative processes	42
P11 – unit organization	20
total	324

(b) Exemplary process specification in P3 class:

P3. COLLECTIVE STUDENT SERVICE

P3.1. Organization of Occupational Health and Safety trainings for students

P3.2. Organization of medical examination

P3.3. Collective insurance of students

P3.4. Organization of choosing specialization

P3.5. Organization of choosing elective courses

P3.6. Registration process (per semester / annual)

P3.6.1. Management of semester protocols

P3.6.2. Management of semester grade lists and student credit books

P3.7. Organization of interim projects and thesis projects

P3.8. Organization of teaching of foreign languages

P3.9. Alumni classification

P3.10. Official/Ceremonial distribution of diplomas

P3.11. Management of semi-annual fees

P3.12. Byelaw of Student Culture and Education Fund

(c) Specification of legal acts for each process

In the next stage each process was ascribed legal acts connected with it. Exemplary specification of legal acts, connected with student deletion from the list of students:

- Byelaw of studies at WUT, § 24
  Byelaw of studies defines situations, in which student can be crossed out from the list of students.
- Rector's decree (WUT) No. 28 of 7 September 2006 concerning model form of decision about deletion from the list of students:
  - attachment 1: decision form,
  - attachment 2: comment on the decision model form.

  Rector's decree introduces a model document, in which decision concerning student deletion from the list of students is placed, as well as instruction on edition of the decision.
- Act of 27 July 2005, Law of Higher Education, article 190, Journal of Law, 2005, No. 164 pos. 1365
  Law of Higher Education Act is a superior document with regard to the Byelaw of Studies.
- Prime Minister's statement of 9 October 2000, consolidated text of act – Code of Administrative Proceedings, Journal of Law, 2000, No. 98 pos. 1071
  Quotation of Code of Administrative Proceedings results from the fact that decision about deletion of student from the list of students is an administrative one, which enforces specific way it should be delivered to the addressee.
- Resolution of Minister of National Education and Sport of 18 July 2005, concerning documentation of studies, Journal of Law, 2005, No. 149 pos. 1233.
  Reference to this particular resolution results from the fact, that deletion from the list of students must be registered in the documentation concerning individual student's course of studies.

(d) Specification of legal acts connected with the analyzed processes

During analysis of all the identified processes it was found that 227 legal acts are connected with them, such as: minister's decrees, internal acts issued by the rector, resolutions and stance of senate.

Full specification was made from the point of view of type of legal acts and year of publishing. For each document containing legal act, the following items were reported:

- document symbol, which is the name of file with document content, stored in the legal acts library (symbol was marked with bolded font),
- full name of document,
- parts of legal act (i.e. paragraph, point), which are vital for given process,
- hyperlink to the source of document content (hyperlink was underlined).

For example:

- RM_2007.87.583
- Decree of Minister of Science and Higher Education of 27 April 2007 on signing by the Bank Gospodarstwa Krajowego (state owned bank) with other banks contracts which determine rules of using means from the Student Loan and Credit Fund.
- Journal of Law, 2007, No. 87 pos. 583

Table 3 presents list of types and numbers of legal acts from a given category.

7.4 Exemplary process description

In accordance with the presented proposal of process model, an exemplary process model was placed below:

P2.9 Granting leave of absence

A. Process realization goal

Granting leave of absence, which includes: preparation of decision, actualization of documentation of student's course of education, informing student about the decision.

B. Legal basis

- the first document:
  - JL_2005.164.1365_act_law_of_higher_educ
  - Act of 27 July 2005, Law of Higher Education, article 172
  - Journal of Law, 2005, no. 164 pos. 1365

Table 3. List of legal acts' categories

Legal act category	Time period	Number
Minister's decree	2005 - 2008	42
Rector's decree	2000 - 2008	95
Rector's circular	2006 - 2007	8
Rector's decision	2005 - 2008	13
Senate resolution	2003 - 2008	39
Senate stance	2006 - 2007	4
Various documents, current	1997 - 2008	26
	total:	227

- the second document
  - D_byelaw_of_studies_wut
  - Byelaw of studies at Warsaw University of Technology, § 17
  - http://www.pw.edu.pl/Uczelnia/Przepisy-i-zarzadzenia/Regulaminy/Regulamin-Studiow-w-Politechnice-Warszawskiej-obowiazujacy-od-01.10.2006-r.

C. Additional information sources

Szypulska-Czkwianianc L., Utrysko B.: Vademecum prodziekana ds. studiów. Przepisy i zasady dobrego postępowania. Warszawa, OW PW 2008

D. Process owner

Head of dean's office

E. Process participants

Vice dean, dean's office employee, student

F. Process initiation

Student applies in written form for a leave of absence in dean's office

G. Procedure

- Student delivers the application for leave of absence to vice dean. Attached to the application are: credit book and documents which justify the application. These are, above all: statement of medical committee in case of sick leave, confirmation of being qualified for student internship or other studies – in case of circumstantial leave.
- Vice dean makes a decision within 2 weeks from lodging of application document (one week is advised); vice dean may ask student for an interview before making the decision.
- Dean puts the decision on student's application and in case of:
  - positive decision: dean's office employee puts appropriate note into student's file, credit book and IT system, as well as informs the student about the decision (e-mail, telephone, word of mouth),
  - negative decision: dean's office employee prepares notification about the decision in written form and passes it to the student against receipt or sends it by means of registered letter.
- Student has the right to appeal from the vice dean's decision to the vice rector within 14 days from decision receipt. This appeal is lodged in dean's office.
- Dean passes student's appeal and his stance with regard to the matter to vice rector's secretariat within 7 days from lodging of the appeal.

H. Commentary

- Sick leave

Basis for granting of a sick leave is statement of authorized medical committee. Student has the responsibility to deliver this statement within 7 days from its date of issuance. Granting of leave of absence should take place (including actualization of student's file and credit book) within 14 days from delivery of medical committee's statement. Leave of absence is granted for the whole registration period concerned by committee statement. Dean's office should inform about granting leave of absence the teachers of courses attended by the student. Credits obtained in the period covered by the statement of incapacity for studying, before the decision about granting leave of absence, remain valid. Subjects studied in this period, which were not passed, may be re-sat without paying fee. If student attended classes or took part in examinations after the leave was granted and did not pass, taking particular course once again requires paying a fee for re-attending the course.

- Random leave

This leave is granted by vice dean on basis of student's application justified by serious circumstances, which make the attendance in classes impossible in such

a long period, that obtaining a pass becomes impossible. Student should apply for such a leave as soon as random reason occurs. Leave is granted till the end of registration period. If student attended classes or took part in examinations after the leave was granted and did not pass, taking particular course once again requires paying a fee for re-attending the course.

- Circumstantial leave

This type of leave is connected with student's absence at the University because he is doing studies in another unit or takes part in an internship. Leave is granted on basis of student's application, if vice dean considers the studies or internship purposeful from the point of view of student's development. The application should be made by student not later than one month after beginning of the semester. Leave is granted for the registration period. Within this period student does not take part in classes or examinations at faculty.

In the same category the bylaw names also "other justified causes". This should be understood as causes, which do not result from random reasons, but from burdening the student with activities in the amount which makes it extremely hard to meet the responsibilities connected with studying. This may be, for example, fulfilling elective functions in student organizations. When granted such a leave, student maintains the right to enroll for and attend classes. Not passing the registered classes, however, requires paying for re-attending them.

- Unconditioned leave

Each student who passed at least 2 years of bachelor studies or at least one year of master studies has the right to suspend studies for a period of one year (or twice for one semester). In order to do this, student lodges an application to vice dean not later than in the last day before start of classes in the semester of the planned leave. Granting of leave is automatic, if the student obtained registration for the period of leave. Participation in classes during unconditioned leave requires vice dean's agreement and should be allowed only in exceptional cases.

Commentary

No other leave than sick leave should be granted from the date which is earlier than the date of lodging of application by student. In particular, granting of random leaves at the end of semester should be avoided. Circumstantial and unconditioned leaves are only granted at the beginning of semester.

Participation in classes and obtaining passes during leave: from definition, leave is a period of absence at university. However, the byelaw states that only in case of unconditioned leave starting-point is the lack of possibility to participate in classes during the leave. As, when student is on the leave, donation for education costs is not obtained, it is suggested that re-attending classes should be payable.

I. Accompanying documents

- student application for leave of absence – form: forP2.9_studentLeave.doc,
- documents which justify the application, i.e.: statement of medical committee in case of sick leave, confirmation of qualification for studies or internship in case of circumstantial leave.

J. Information on data actualization: 28 III 2009

8 Summary

The carried-out analyses proved non-standard character of management information with regard to such units as university. In this case, it does not result from the necessity to make non-standard decisions, but from the necessity to make decisions based on non-standard legal information.

Almost each process is connected with one or many internal legal acts – acts which are issued by university rector or department director (dean). Therefore results the difficulty of introducing a single standard system for supporting university functioning for many universities. The research allowed conceptualization of system which combines organizational unit's processes with legal information and knowledge about processes.

The obtained result, which constitutes basis for the system, requires further supplements and being re-adjusted in order to be useful for its users. Implementation trials were carried out, creating:

- prototype of database system of management information, with particular consideration given to legal information,
- hypertext[25], frame of which is the process specification.

[25] Hypertext is organization of data in form of independent nodes connected by hyperlinks. Node is an element of hypertext and

When comparing the solutions, the following facts were taken into account:

- system must be user friendly and easy to use,
- process owners should be able to edit commentaries, which are viewed as sources of tacit knowledge,
- continuous actualization of all system elements is required.

Solution based on database system is a much formalized solution. It requires using specific database management system, defining data structures, preparing user application for operating the system.

Associations, which exist in the structure (many-to-many, i.e.: between processes and legal acts, between processes and participants) require professional operating of system.

Use of hypertext is the easiest technique of connecting process models with appropriate legal acts.

Assuming that each process model and each legal act are saved in separate files, use of hyperlinks enables us to indicate mutual connections. Also, internet addresses of legal acts may be used.

This solution, however, is connected with the threat of lack of access to network, liquidation of document source or change of address.

Preparation of hypertext is treated as prototype of legal information system for the analyzed area, in which specification and ordering of processes and legal information were carried out.

Within further works an approach will be made to apply Content Management System (CMS) [26], which would enable obtaining an internet-based solution, giving access possibility to many users, mainly to all process owners and participants.

Independently from the adopted technical solution, system usefulness depends on the up-to-date character of its constituent information resources, which requires their constant actualization.

contains hyperlinks to other nodes. This enables connecting nodes and creation of network structure.

[26] CMS – Content Management System – content management systems are used for management of Internet sites' content. Usually they consist of an application for content management and application for content presentation. Information presented on a site is stored in a database. When referred to, information is collected from database and presented in accordance with the prepared graphical template.

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INTEGRATION AND AVAILIBILITY OF DATA – PARADIGMS AND APPLICATIONS

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Abstract: The problem of modern organization is not only information gathering but also its appropriate distribution within an organization. It is difficult to meet without appropriate computer based information system. The paper deals with making data available in computer based system for management purposes. There are discussed advantages and disadvantages of the Internet technologies from business process point of view.

Key words: information system, data sparing, Internet technologies, business process, system integration.

1 Introduction

One of the key challenges, in the knowledge based economy, is the ability to allow others to use gathered data. Differentiation of used forms and tools of data sharing is performed according to the data type. Dynamic development of Internet technologies creates new possibilities of cooperation.

Financial and organizational limitations, present in IT projects, make the traditional methods insufficient in current problem solving and analysis and designing of business IT systems. The critical limitations are [1]: project budget, task realization deadlines and system users' IT awareness. In terms of personal or economical data sharing, legal limitations have to be taken into consideration.

Informational needs of the users are not likely to be determined without performance of detailed analysis and the elaboration of the enterprise's IT system modernization project. The system should be created according to future tasks and not current operations. Elaboration of such system consists of 90% of organizational activities and only of 10% of IT activities [2]. Determination of the needs and requirements of users can prove difficult, even with the performance pf such detailed analysis, as users usually relate to the current situation. Adjustment of IT systems, which support the data integration and availability processes, to the dynamically changing needs of the organization in this scope is the condition of their usefulness.

2 Informational system of the enterprise

Current Business IT Systems are not created from scratch with the use of programming tools but rather through the adaptation of selected software to the needs and requirements of the users. Together wit the development of programming abilities the disproportion between the functionality of IT system and the functionality of the software, whose database was used to elaborate the system, increases. Concept of system functionality, in this article, is defined as what the system does, or should be doing, regardless to how it is doing it [3].

Informational system is the network of relations, whose centers are the elements of the organization and its environment that take active participation in data exchange and their relations describe the information exchange channels. However, in the scope where the data is processed with the use of computer hardware, it is treated as an IT system.

Functionality disproportion is connected with the mechanism inbuilt in the software that allows adjustment of the functionality of IT system to the needs of the enterprise. They can be divided into two groups according to the system functionality modification possibilities. First group consists of configuration tools, which are used to introduce the functionality settings defined in the software. Second group consists of 4GL languages, which allow defining new system functionalities [4].

Advanced adaptation mechanisms allow adjusting the system, to the needs of a user, at three levels. First level is serviced by the regional representative of the manufacturer, which introduces modifications that adjust the system to the specific regional conditionings. Second level is serviced by the IT system provider, usually partners responsible for the implementation of the system.

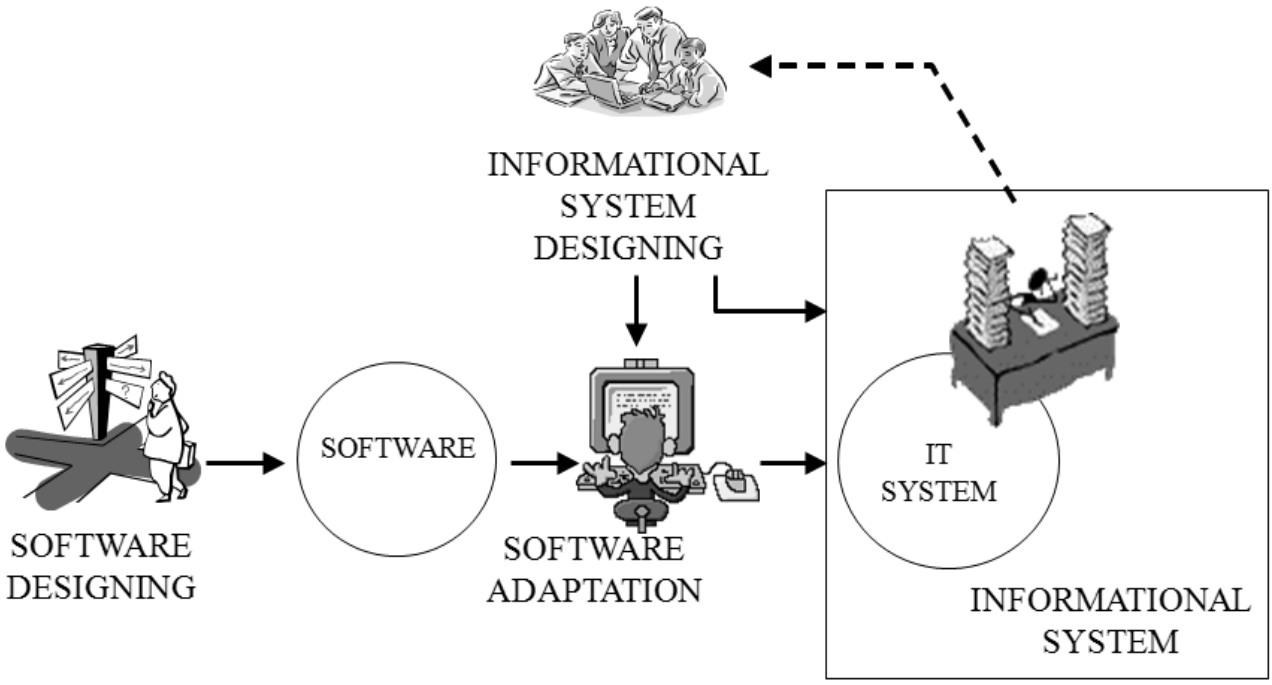


Figure 1. Functionality disproportion
(source: self elaboration)

Moreover the system is equipped with solutions that allow the user to adjust the system, in certain degree, to individual preferences e.g. settings of the look and content of particular dialogue windows.

3 Data sharing system

Information is the data put in a context in the process of its interpretation, which can have statistical or analytical character.

Data is a grammatically defined symbol sequence. In the IT system it can be represented through bits, bytes, records, tables, files. In the semiotic aspect the interpretation can be realized in the syntactic (structural), semantic (significative) or pragmatic (utilitarian) aspect [2]. It is presented in the following example. The sentence below, according to the type of aspect, can be interpreted as true or false:

- computer turns off the user,
- user turns off the computer.

According to syntactic aspect both statements are true. All words included in the sentences are built of set grammatical symbols. However in the semantic aspect the first sentence is incorrect, because it makes no sense. Key to the interpretation is the knowledge about the surrounding reality.

Due to this knowledge one can evaluate the correctness of the relations between particular parts of information and bestow them with meaning. Giving meaning to the information is a human domain [5]. Basic features of information in the system approach are:

- actuality: compliant with the actual state, considered according to given situation,
- accessibility: possibility to access information in given time and place,
- confidentiality: limited access to the information according to the authorization level of the system user,
- possible to process: possibility to apply technical resources for the gathering, storing, processing and sharing of information,
- completeness: there is no need to use other sources in order to provide information useful for the user.

Criterion to distinguish information subset, necessary for management, from the information collection is the possibility to decrease the uncertainty of taken decisions as well as the organization activities [6].

Organizational resources availability is an example of such type of information. Information sharing sys-

tem for management purposes is an informational system connected with the managerial information sharing system processes. In this elaboration the data sharing process is the collection of procedures and activities, which are used to realize business goals in the organization, as a part of a context determined with the organizational structure that defines roles and relations between them.

They can be realized through one or several organizations that have both formal and informal interactions. There are two types of processes in such systems:

- information gathering processes, which are responsible for gathering and introduction of the information to the sharing system,
- information access processes, which define the way the user is given the access to information.

Lack of direct succession of events between gathering and information access processes is typical. If considering the degree of interactivity as a criterion, one can perform a division of considered system types into ones with single-directional and double directional information flow.

Example of considered system type can be the conference room time-booking system for the needs of the didactic process. Limitation of the complexity of the system in the considered system type, into the elements necessary to understand the essence of the processes, was made in order to clarify the example

Figure 2 presents the conference room availability information gathering process. Availability plan is introduced into the system, which allows the users to check the availability of particular conference rooms.

Information gathering and access processes integration tool, in the scope of three-layer integration architecture (presentation, business logic and data layers) [7], is a database system. However, at the function integration level, the integration is realized through the use of CASE tools.

Using IT technologies allows limiting the interaction between a person, or people, sharing the information and its receivers.

There are systems, in which information sharing users take part in the data access process e.g. as experts that answer submitted inquiries. Implementation of such solutions aims at improvement of information sharing processes in order to make the information access more effective and clear.

It creates new possibilities in organizational activities with participants that are authorized for individual activities.

Data sharing systems can be divided into direct and indirect. In direct systems every inquiry has a relevant individual answer. However, such types of computerized systems, which provide the answer without help of a human, exist only in theory.

In practical applications one can find systems searching for experts who provide answers or, so called, artificial direct systems that are based on FAQ mechanisms (Frequently Asked Questions).

Functioning of indirect systems in based on knowledge base browsing and using of e.g. full-text search, identification of hierarchical classification. Assuming the level of interactivity as a criterion, it is possible to divide the systems into:

- single-direction data flow systems (passive data sharing) – realized on the basis of HTML technology. They allow the transferring of particular content to the user e.g. IT enterprise can share the information on the methodology of IT project realization. Shared information is of static nature,
- two-way-direction data flow systems (interactive data sharing) – allow the users to input data into the system e.g. in the conference-room availability system the user can input information about booking a certain room. In such systems the data is subjected to dynamic changes. Changing of shared information is related to their updating by the people who share particular information and creation of new information as a result of system user's activity (information receivers) connected with gathered piece of information.

Keeping the IT systems, which support data sharing processes, adjusted to the dynamically changing needs of the organization in the age of knowledge-based economy is a condition of the information usefulness.

One of the barriers of implementation of considered systems is the use of traditional technologies for designing dedicated IT systems. Therefore this is the reason for the elaboration of new designing technologies.

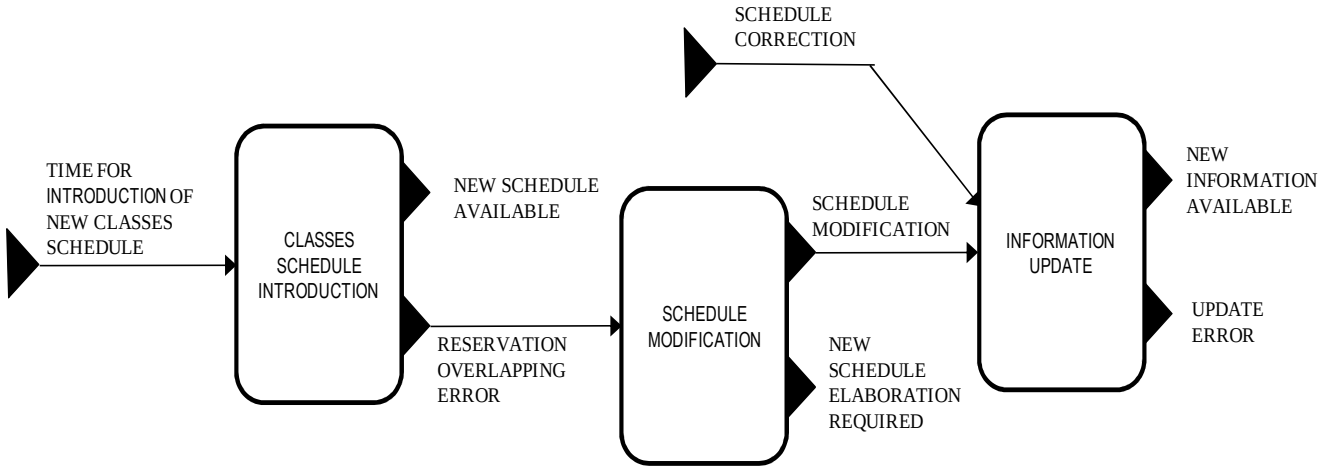


Figure 2. Conference-room availability information gathering process

4 Data sharing

Data sharing is the determination of data accessing rules and the process of their realization, which allows transactional data processing (in predicted time and completely finished) in the IT systems as well as access rules management, what assures safety and continuity of organization's activities. Data access can be realized with the use of traditional and modern tools, which should be selected according to the character of data sharing processes. Benefits connected with the implementation of modern technologies that support these processes are still not appreciated by small and medium enterprises. Major source of data exchange in such enterprises is still only the email.

There is a series of complex solutions for data sharing in the limited understanding of the concept, which is indicating that it is only a computer software program allowing data access. They allow the access to data recorded in databases and spreadsheets, their analysis and visualization based on a web service or access directly from within the traditional windowed application through special components.

In the organizational grasp of the problem one should look at the data sharing as a communication process between the person requiring specific data and a person or people that possess it. Three types of data sharing can be distinguished:

- read-only data,
- data subscription,
- data for selected users,
- data on demand.

Data access cannot be realized freely. One needs to take into consideration e.g. legal limitations: personal data protection, economical data sharing, public information access or civil legal contracts.

5 Data sharing tools

Everyone knows about the possibility to gather particular information in a telephone conversation. Development of modern information sharing tools results in the decreasing popularity of traditional communication means such as telephones.

Interactive dialogues between a human operator and computer are a novelty e.g. through self-service voice technologies based on the VoiceXML technology.

Table. 1. Benefits and challenges of telephone usage

Benefits	Challenges
• Direct contact with the information receiver	• Necessity for people to synchronize the conversation in time

5.1 SMS/MMS

SMS (Short Message Service) is a method of sending text messages in GSM networks. It enables to send a 160 digit message to a given phone number. Sending longer messages is realized through division into several shorter messages. Messages are sent from a GSM telephone or from the Internet through SMS Gateway.

If particular phone number is outside of reach, the message is recorded in message transferring centre and resent when given number becomes available. The successor of the SMS format is the MMS (Multimedia Message Service). It allows transferring messages that include multimedia content such as: text, graphics, sounds and video files.

Table 2. Benefits and challenges of SMS/MMS usage

Benefits	Challenges
• Data access through mobile phone	• Limitation of message length to 160 digits

5.2 Internet mail

Internet mail is a common and broadly used tool of information sharing. Conference websites publish the emails of the conference organizers. Potential conference participants contact the organizers through given address. Such type of communication deals with the problem of synchronization of interested parties in time.

Table 3. Benefits and challenges of email usage

Benefits	Challenges
• Easy exchange of information • Possibility to deal with a matter in suitable time • Possibility to share information too many people at the same time	• Lack of confirmation of information receiving from the receiver • Limitations on the size of sent files and attachments

5.3 Web service

It is crucial for IT technologies to be most flexible and applicable in as many IT systems as possible, from the point of view of the technology providers. On the other hand in elaboration of particular system's prototype, only the final product and its usability are relevant.

Enterprises focus on selected technologies, which allow them to reach the highest possible competitiveness level. Figure 3 presents an example of web service architecture.

Website access requires use of a computer with internet browser and access. Rankings hosted at ranking.pl indicate that Microsoft Internet Explorer is the leading product in terms of internet browsers. Firefox and Opera internet browsers are becoming more and more popular with 30% of the market. Properly designed website needs to include the differences of functioning of these products. HTTP server is responsible for the resource access requests. Apache technologies are leaders in this product category. PHP script language is a common logical engine for such appliances. It is important to point out the ASP.NET technology as a leading technology for website design, which starts to exceed other technologies with its NET Framework engine in the 2.0 version.

Table 4. Benefits and challenges of Website usage

Benefits	Challenges
• Information access is possible with a computer connected to the internet • Possibility to transfer multimedia content • Access to website content through internet browsers	• Differences in the functioning of internet browsers • Replenishment of the website with information that is up-to-date

5.4 RSS Channels

Information channels is the communicate headlines transferring technique based on the XML. Functioning of this system is based on RSS files (Really Simple Syndication) present at the server. Files are read by the RSS reader. User downloads the news titles together with their short descriptions and links to full messages placed in WWW websites. It is a simple way of reading and uploading information in the Internet that allows browsing through information form many sources (channels) in one application without the necessity to browse through many different websites. In order to use RSS one needs to install proper reader, which can be made as a plug-in to an internet browser or as a separate program.

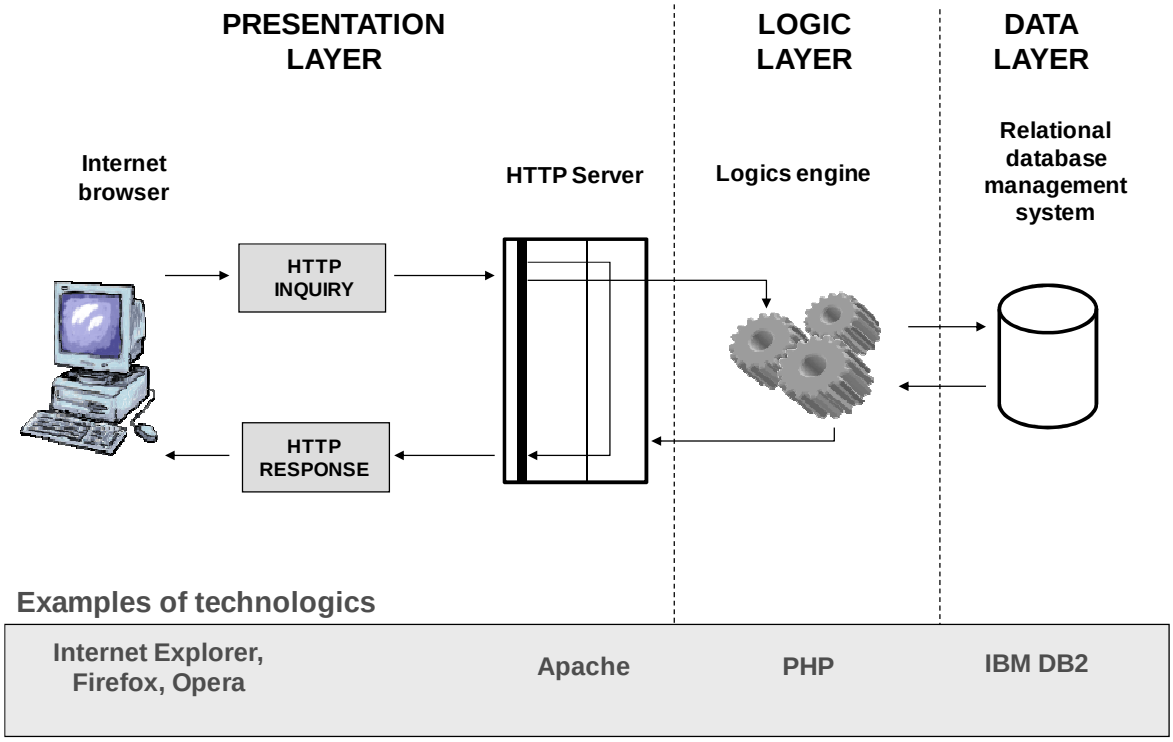


Figure 3. Example of website architecture from technical perspective
(source: [11])

Internet Explorer browser, in version 7, has a built in RSS service. Atom is a new open standard developed by IETF (Internet Engineering Task Force).

Table 5. Benefits and challenges of RSS channels usage

Benefits	Challenges
• Automatic creation of information lists form different information sources • Internet connection capacity saving through downloading of pure information	• Scope of information possible to access through RSS

6 Use of internet technologies

Using internet and telecommunication technologies requires certain knowledge and abilities. "Polish IT in European Union" report, published in 2003 and summing up work of the 3 Congress of Polish Information Technology [8], indicates that the realization of IT endeavors depends, first and foremost, on the people involved in these activities and in a lesser degree on the used technology and IT tools.

There are several causes of IT project failure, apart from lack of software engineering usage, dependent on the customer:

- lack of composition of the future project in the business process of ordering enterprise or institution,
- lack of professionally prepared specification that corresponds to real needs (that is the basis for ordered project) or forging of the specification according o given designer as a result of corruptive activities,
- lack of proper knowledge and abilities to define assumptions and project receipt in the team,
- lack of knowledge and project, quality and risk management standards or even encouraging the customer to abandon them in order to reduce cost,
- lack of engagement and proper supervision fro the high management,
- selection of the designer on the basis of the lowest price and not the team skill evaluation and the functionality of offered solution,

- lack of proper motivation and training of the system users.

The following failures were listed from the side of the designer:

- lack of ability to evaluate risk of performance of selected project,
- lack of responsibility for undertaking unrealistic tasks and acceptance of improperly prepared user requirements,
- price dumping or corruption activities used in order to win the bidding,
- lack of professional preparation of the team to realize the project (recruitment of the team after signing of the contract),
- lack of knowledge and standards in project management,
- lack of designing team work coordination abilities,
- lack of teamwork coordination abilities with the ordering team,
- lack of communication within the designing team and with the external environment,
- hiding the true level of project progress (hiding the obstacles and difficulties) from the management responsible for ordering the project,
- underestimation of doubts of common system users.

It was confirmed that the technical competences of young people with the use of IT tools, including internet, are usually very high. However, there still is a lack of common and effective model of text resources usage, provided by the new medium. Moreover, even the research on the model of such activities is not performed. Abilities to use the tele-informational tools by the Polish society are often high, although this phenomenon is not common. However, it should be said that the level of education in this field in Poland is not satisfactory.

According to the IT development strategy for the years 2004-2006 [9], by the Polish government, computer and internet skills are evaluated on the basis of: ability to write and print out a letter in a text editor, ability to send and receive electronic mail, ability to use internet browser and ability to search information in the internet. Such level of abilities is definitely insufficient for the creation of informational society. It is crucial to undertake actions that will speed up the IT competence improvement of Polish society in the scope of modern tele-communicational technologies usage. It is one of the goals of the Polish IT development strategy till 2013 [10]. It should be indicated that the lack of development of proper skills will result in lack of demand for electronic services and digital content, what can lead to the digital exclusion.

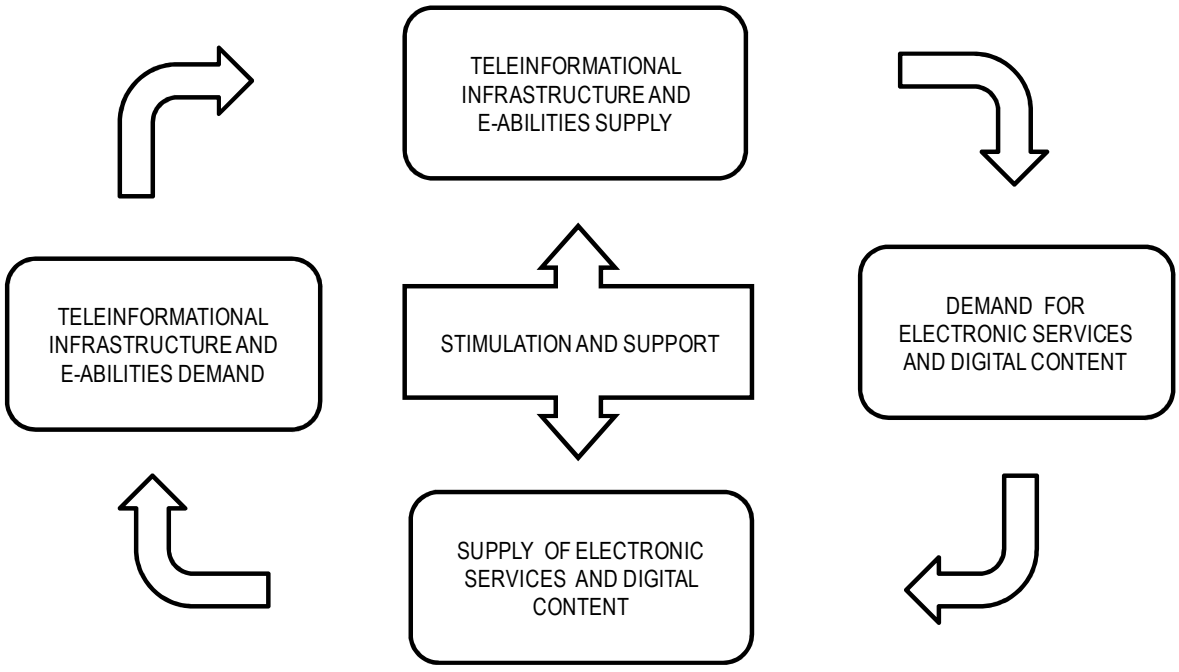


Figure 4. Areas of activity stimulating the IT development process
(source: Directed strategy of IT development in Poland to 2013)

In 2007 the Pew Internet & American Life Project performed a research in the American market and published the results in a report "Typology of IT and telecommunication technology users" [12]. It concerns, among others, the sharing of private content in the web, posting comments to news published in the internet, creation of websites or downloading the content from the Internet.

The result revealed that sharing copyrighted content in the Internet is not common. It is important to point out that this phenomenon varies in different groups. Report creators divided IT and telecommunication technology users in the following groups:

- Group 1: contributing to 8% of researched population is the most active group of the internet society,
- Group 2: contributing to 7% of researched population are the people using internet to connect with others and access internet content,
- Group 3: contributing to 8% of researched population are people who have experience with internet technologies,
- Group 4: contributing to 9% of researched population are people using internet technology at work and at home, usually to increase personal productivity,
- Group 5: contributing to 10% of researched population are people who actively use mobile equipment and facilities provided by application designed for such hardware, although these people do not connect their personal productivity increase with the use of such equipment,
- Group 6: contributing to 9% of researched population are people investing in IT and telecommunication technologies but who are not able to use such technologies,
- Group 7: contributing to 8% of researched population are people who posses only few devices allowing to use IT and telecommunication solutions but feeling competent using such applications and would make more use of such facilities if provided access to such technologies,

Table 1. List of internet users' activity in the scope of personal content sharing
(source: [12])

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9
Sharing the effects of personal work in the net	55%	38%	20%	18%	14%	12%	9%	4%	4%
Posting comments to the information published in the net	55%	39%	22%	12%	0%	8%	8%	4%	3%
Creation of websites for personal use	45%	24%	14%	12%	6%	6%	2%	1%	2%
Creation of commercial websites	40%	17%	13%	9%	8%	4%	4%	1%	2%
Downloading of internet content for personal use	30%	19%	10%	8%	4%	4%	2%	3%	2%
Sending and receiving SMS messages in mobile phones	93%	49%	36%	42%	94%	19%	14%	12%	12%
Sending text messages through internet communicators	73%	57%	45%	38%	47%	25%	18%	16%	16%
Paying for access or downloading of digital content	50%	46%	26%	20%	23%	13%	9%	5%	5%

- Group 8: contributing to 15% of researched population are people with basic access to informational technologies nut using it occasionally and not treating it as an important element of their lives,
- Group 9: contributing to 11% of researched population are people who do not see the benefits of access and usage of IT and telecommunication technologies,
- Group 10: contributing to 15% of researched population are people without access to modern IT networks.

Over 70% of respondents claimed that modern IT technologies allow them to be more accessible to others. Almost 80% of respondents feel that these technologies have more potential than currently used. Half of the respondents indicated that they need training in the scope of uses of modern technologies. Table above collects the combination of internet and other activity for particular researched groups.

7 Business processes categories

Possibility to support business processes and especially their automation through the use of IT and telecommunication technologies are strictly connected with their character. Process support with IT solutions can be divided according to their possibilities into the processes oriented at: integration, human or content. Basic characteristics and examples of processes typical for particular categories are collected in the table below.

Implementation of IT tools supporting different process classes requires flexible infrastructure. Other solutions should be used in case of fully automated systems, in which the role of operator is limited to the introduction of input data such as e.g. customer order or granting a loan. Determination of process class is critical in order to select the elaboration method that has the biggest chances of success.

Table 2. Business processes categories
(source: elaborated on the basis of Exploring key facts about business process management with IBM WebSphere software [13])

Process categories	Basic characteristics	Examples of typical processes
Integration oriented processes	• Fully automated processes • Usually with integration of the person servicing the exceptions or taking decisions	• Order realization • Provision calculating system
Human oriented processes	• Human work based processes • Decisions made by human • Human-human interaction • Automatic tasks frequent appearance	• Granting loans • Purchasing products and services
Content oriented processes	• Tasks requiring document content interpretation by human • Weak connection between the documents and the process • Process controlled by the status of works over a document	• Sending and processing of documents or messages, • Browsing and acceptance of documents

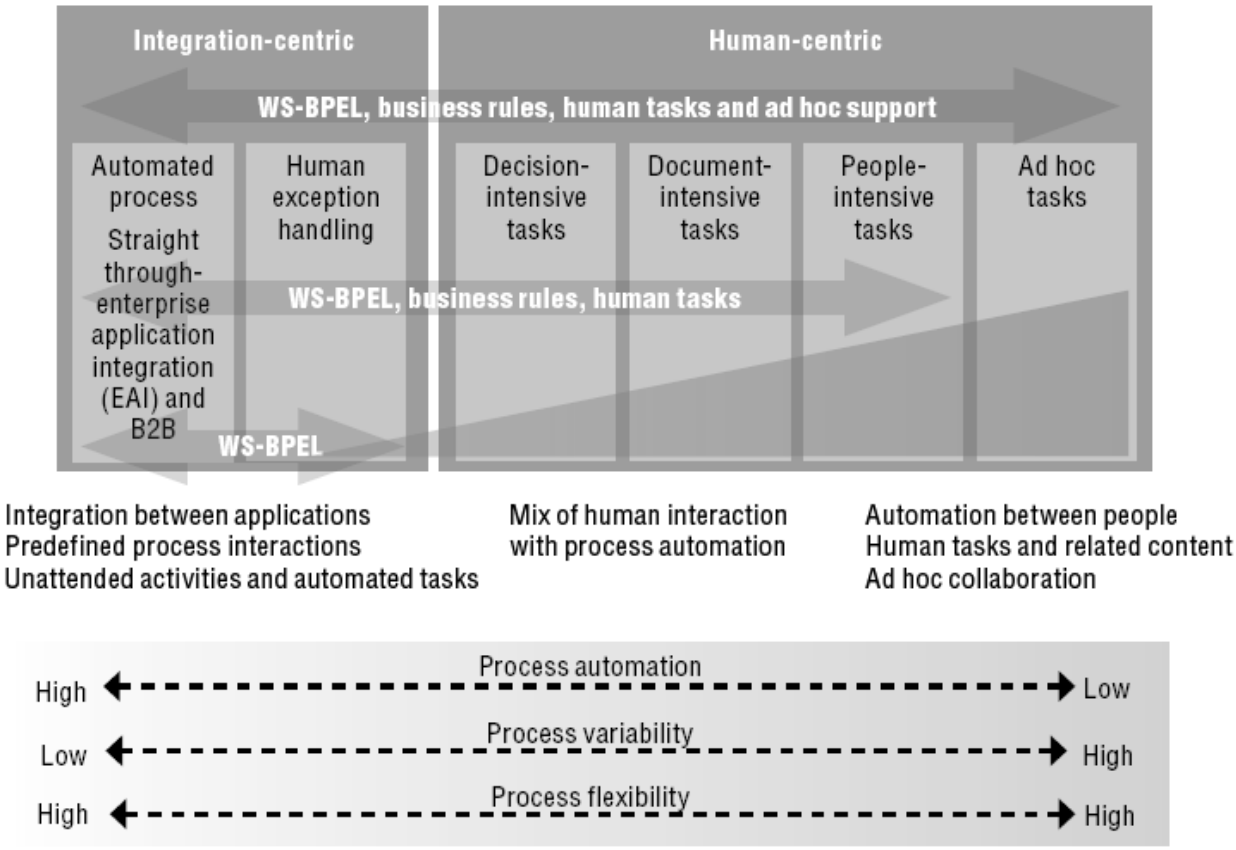


Figure 5. Spectrum of BPM scenarios using WebSphere Process Server
(source: Exploring key facts about business process management with IBM WebSphere software)

8 Integration oriented processes

Fluent integration and the ability of automatic data interchange between the tasks realized by the IT system and the ones in the control of a human operator are characteristic for this type of processes. Firstly they connect system applications and services into one entity that supports reaching of business goals. Currently there are few IT solutions, which can help to solve such types of business issues. Most of the processes oriented towards integration requires human interaction in the area of exception handling and key decision making.

9 Human oriented processes

Human oriented processes connect the activities of organization's participants, realizing particular tasks, into one entity. The way the IT tools allow to cooperate is crucial for the process development effect, with the assurance of full transactional nature of the process. Quick and easy particular task realization progress data access is required, what implies the necessity to equip the IT systems with a user friendly interface. Possibility to sort and set priorities to particular tasks and assign particular human resources is required. Many human oriented processes require the possibility to integrate different systems is required from the start of the system elaboration or in terms of its development in order to increase the automation or effectiveness of work.

10 Content oriented processes

Generality of document content oriented processes requires a significant engagement of a person who can interpret the data. There are dynamic changes in this area, due to the continuing process of replacement of paper documents with electronic documents and forms.

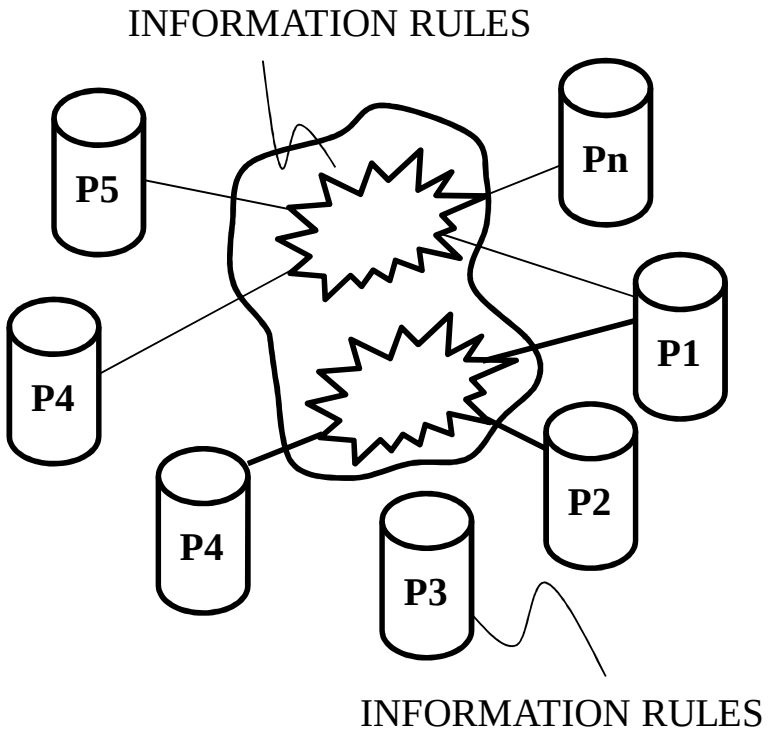


Figure 6. Integration of IT processes
(source: self elaboration)

11 Data integration and sharing processes

One of the basic assumptions of extreme programming is that it is more profitable to create small subsystems and then integrate them, rather than elaborate large and complex systems. Two aspects are present here. Fist one is the integration of processes that were identified at the stage of system creation and their integration level is determined.

Logical data model is created for particular subsystems and next the models are integrated before starting of the creation of application at customer side. There is, so called, data structure freezing, in the area of mutual data, which is later modified only due to significant reasons. Such approach is inconvenient and the desired solution is the possibility to modify data structure in any moment of system creation process.

Key to reaching of desired flexibility in the scope of data structure is the use of system architecture that favors such modifications and approach based on prototyping, where the prototype is created as a result of model transformation into the source code and SQL scrip that defines the database. Having the N version of the database and the desired structure (N+1 version) it is possible to define the transformation process from the N state to the N+1 state. Performance of such activities does not usually cause technical problems. In some cases such as e.g. transformation of a discount for a single product to a discount for a group of products has an irreversible character so that it is not possible to return from the N+1 state to the N state.

Transformation of the application form the customer side for it to use the new data structure is much more difficult. Sometimes the scope of the modification is so considerable that the only efficient solution, form the perspective of the customer and the provider, is to elaborate the customer application form the start. With the approach based on generation of new source code from the system model one is equipped with a tool to solve such implementation issues methodically. Used model structure should allow the determination of the scope of necessary modifications in relation to the changes in data structure and its processing. Proposition of such type of structure is presented in the following chapter.

Data integration is the connection of format and subject heterogeneous data collections as well as data storages in a way to assure their semiotic (syntax, semantic and pragmatic) effective sharing. There is no universal

solution for enterprise IT process integration issues. However it is certain that the enterprise will not be able to undertake effective decisions without effective activities. It is necessary to determine its scope.

Maximal process integration results in stiffening of their adjustment to new business conditions. Such situation usually takes place when dealing with integrated IT system that is supporting the processes. Low integration level integrates in the decrease of the information system efficiency. Following forms of integration are popular:

- system integration – deals with communication between systems,
- application integration – deals with application cooperation,
- business integration – deals with economical processes integration.

Integration precedes the data sharing in IT systems. It is possible to select one of two solutions: integration broker or integration platform. The lack of integration strategy results in, so called, integration web. Integration processes and data sharing are cause-related activities that are aimed at data gathering and allowing access to the data to authorized users. It can be realized through one or several organizations, which have both formal and informal interactions. The basic elements are: people sharing the data, data sources, data receivers, rules and access authorization, data sharing process integration rules and regulations.

If taking the integration level as a criterion it is possible to perform considered division of these processes into single-direction and two-way-direction data flow.

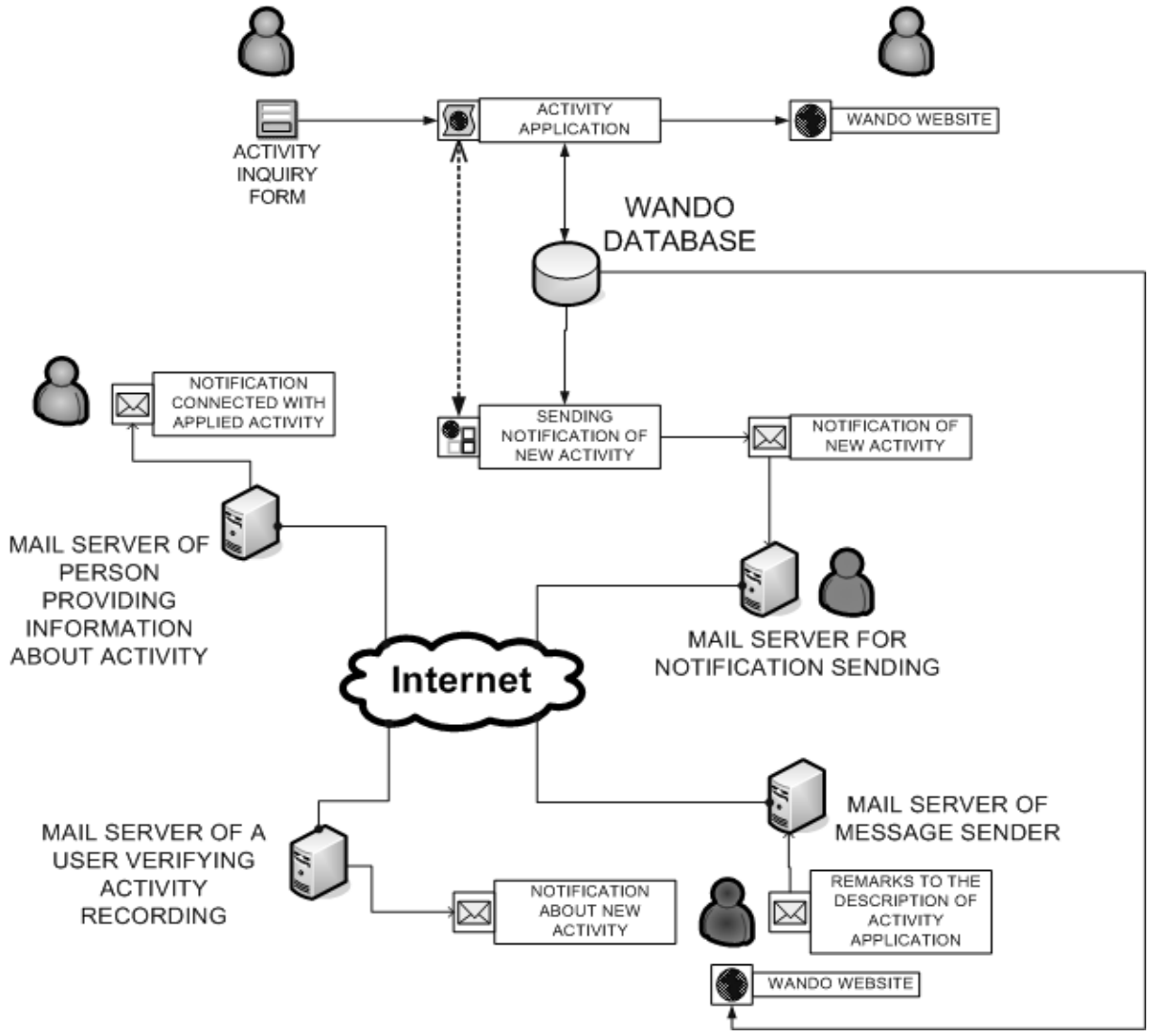


Figure 7. Example of integration architecture with the use of electronic mail
(source: self elaboration)

Database system is the integration tool, for data gathering and access processes, in the take of three-layer integration architecture (presentation, business logic and data layers) [14], at the application integration level. CASE tools are used to realize the integration at the level of function integration.

If taking the type of possessed data as a criterion it is possible to divide the data sharing processes into direct and indirect. In direct systems every inquiry has a related individual answer. Totally computerized system that would be able to provide such answer without the help of a human being exists only in theory. In practical applications one can find systems searching for experts who provide answers or, so called, artificial direct systems that are based on FAQ mechanisms (Frequently Asked Questions). Functioning of indirect processes is based on knowledge base browsing with the use of e.g. full text search, indexing or hierarchical classification.

When speaking of integration processes and data sharing it is impossible not to consider the IT system architecture. It is important for the architecture to be flexible and allow creating different types of software from the perspective of the technology provider, because it expands the number of potential customers. However from the perspective of the creation of a particular system only the final product is relevant. Performed research indicates that particular providers of IT systems focus on selected technologies, which allow creating the final product with the highest possible usage value. Enterprises decide to use certain database systems, which will cooperate with their product, due to economical factors.

Figure 7 presents an example of integration architecture for the creation of databases dealing with professional activity of scientific personnel. This architecture supports the human oriented processes with the use of electronic mail. Main advantages of such approach are the relatively low technological requirements. Main disadvantage is the relatively high work and time consumption as well as the result relating on the people engaged in the processes to a considerable degree.

12 Data transformation

Transformation is the data processing process that does not modify the source data – in typical data processing processes it is common to transform the data collection from one state to the other, without the change in data structure. In the transformation process data is collected from the source, processed and transferred to the destination structure. Practically there usually is a need for manual completion of target data structure. Data structure transformation with small modifications of their information scope is an activity that takes place in:

- database structure change – takes place during modifications of exploited software or migration to other systems,
- linking of not physically connected subsystems with common tables – supporting of enterprise activities with dedicated solutions might require it systems from different suppliers. therefore it is essential to elaborate a common interface between these systems,
- data transformation form logical data structure to the physical table implementation – realized with importing or exporting of the data from or to the system,
- introduction of new data to the database – differences between the data presented to the user and the logical data model in the database can be present due to the data model normalization process. Such situation might be encountered during the increase of user interface effectiveness (defined as the amount of data that the user is able to introduce with particular user interface organization) and organization of such interface in a non-normalized manner. Normalization is performed automatically. Possibility to transform non-normalized data into normalized data is a necessary condition in such type of activities.

Relational database or an external data set can be the source data collection. Relational database is a data structure collection, used for data organization and storing. Basic data unit in the *relational data model* is the atom, indivisible, e.g. document metrics. Atom data sets of the same type are defined as domains. Domains are organized into tables in a way to minimize the data redundancy according to data normalization requirements. Relations (integration reference) are defined as presence of particular data in the table that is dependent on the content of another table. Every table should be equipped with a primary key that allows unambiguous identification of a particular table row (entity integration). SQL (Structured Query Language) language is usually the standard interface for such applications.

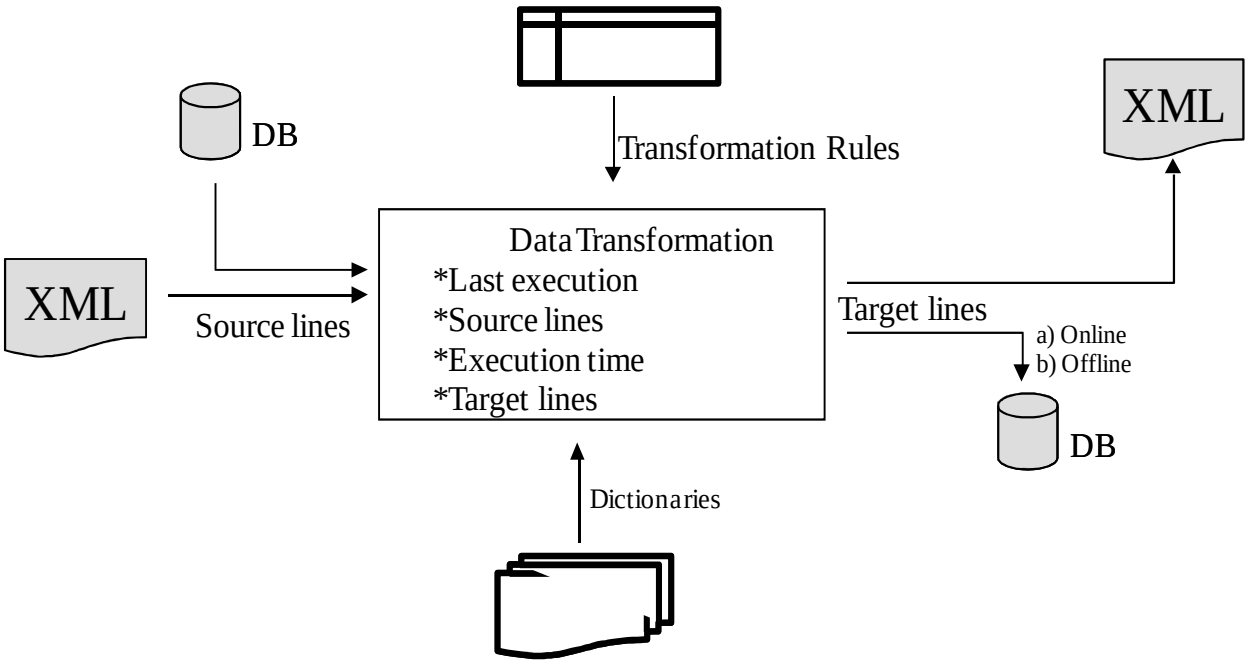


Figure 8. Data transformation
(source: self elaboration)

It should be noted that all data collections, which cannot be processed together with the database with the use of SQL language, are the *external data sources.*

Currently the data recording standard in such collections is the XML [http://www.xml.org/]. Such data collections are used for the data interchange between

different systems. *Dictionary data* can be used in the process of transformation. There are two areas of their usage. First one is the verification of data correctness in selected data areas. Second one is the change of domain set that is included in data structures. Data mapping rules, from the input to final data structure, are determined with *data transformation rules*. Flexibility of the defining process decides about the practical possibilities of the data transformation process.

In the first step the data is taken from the input and transferred to a spreadsheet layout with a homogenous column structure. Input column mapping into output data takes place n the second step. In practice data acquiring requires preparation of several perspectives.

Preliminary data processing according to their transformation process is realized at the perspective level.Directing the data towards the exit is performed by dedicated mechanisms. Logical variable values, which are the switches for the data transferring performance to particular exit, are set in the first step. After the finishing if the data directing for selected input line it is possible to return to data transformation and another redirection of data collection (variables at collections).

13 Relation models

Relation model describes the universal solutions possible multiple usage and the correctness of solutions included in it must be documented. They are the basis for creation of dedicated model and characterize with general usability, adaptability for particular conditions and consistence and transferability [15]. Relation models are defined at a certain level of abstraction. They do not provide concrete IT solution but are rather an inspiration for one. Such model can be created on the basis of an existing or planned business process. Main partial elements of such model are:

- graphical representation of activities and relations between them together with additional data. The basic element of activity representation is the task that is at the lowest level of work at presented diagram. Connections are represented in the diagram as arrows connecting particular activities,
- business positions – all kinds of documents, products, parts, components, minerals or chemical compounds processed in the activities,
- resources and their consumption as well as their assigning, with consumption rate, to particular tasks.

Process flow diagram is supplemented with starting points (indicating the beginning of the process), finishing points (indicating the end of the process) and flow finishing points (indicating the end of a certain flow).

If the flow reaches the finishing point during the performance pf the process it is immediately stopped, even if other performed flows are present in the process for the time being. However, flow finishing points is just a visual marker inside the process and indicates the end of a certain flow.

Process flow path can consist of many alternative and parallel branches. In case of alternative ramification, the flow is realized through one of the available branches, usually selected in a decision process.

The following objects are used in the division of the process into alternative and parallel realization paths:

- decisions: process elements that allow division of the flow path into alternative branches,
- ramifications: process elements that allow division of the flow path into parallel branches,
- merges: process elements that allow merging of the alternative branches,
- connectors: process elements that allow connection of the parallel branches.

In case of complex processes that are not possible to identify with one level of abstraction, sub-processes, which are a separated part of the main business process represented at certain abstraction level as a single element, are used.

All processes can have any layout of the elements, which does not bring limitations, placed in the diagram. Example of a process with a free type of layout is presented in the Figure 9.

Process course layout is an alternative for such process layout. In the course layout the process flow is presented in a way to enable focusing of the role, resource, organizational units, places and classifier values usage of the activities as part of the flow.

Visualization of process courses helps to identify the unnecessary exchanges between the elements in different rows. This also leads to the elimination of bottlenecks and redundancy.

From the perspective of process analysis it is crucial to determine the distribution of selection of particular flow branches. For example is receiving an inquiry from an internet user generates cost equal to 10 PLN and receiving an inquiry in the paper form generates the cost of 50PLN – both for the distribution in the figure above and 100 performances the total cost will equal 3 000PLN.

It is obvious that if the distribution is altered and 80% of inquiries are submitted via internet, we will reduce the cost to the level of 1 800 PLN.

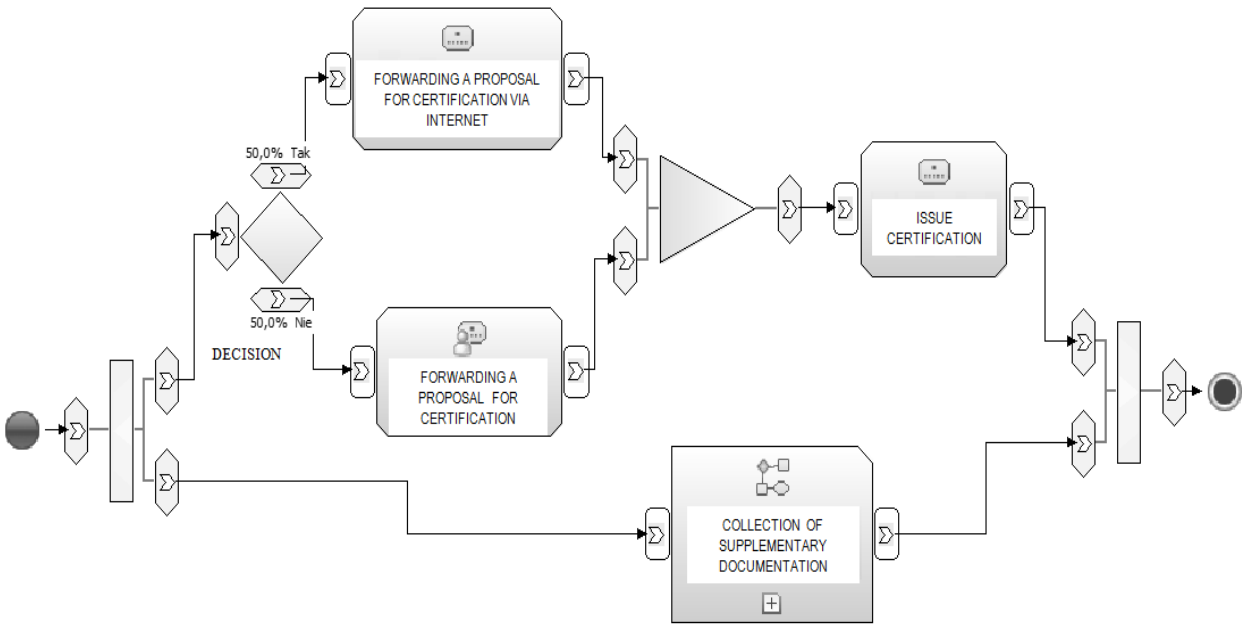
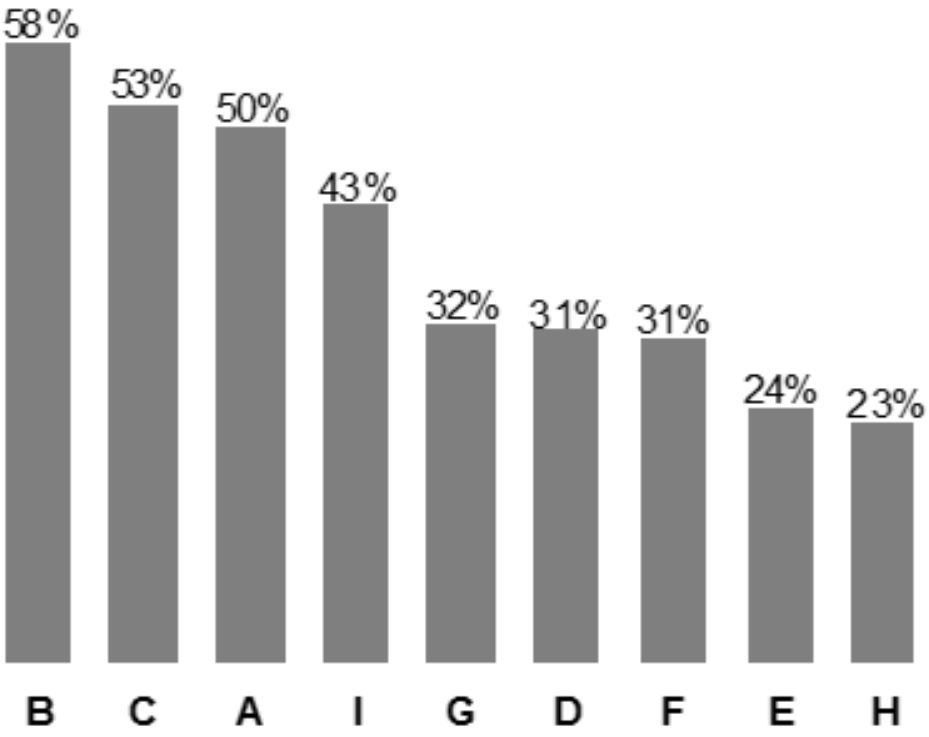


Figure 9. Example of process flow model
(source: self elaboration)



Legend:

A. information on current events (expos, conferences, exhibitions, branch events),
B. current information (news),
C. articles,
D. guidebooks, lexicons,
E. case studies,
F. questionnaire results,
G. branch curiosities,
H. book reviews,
I. links to related pages.

Figure 10. Questionnaire results in the scope of knowledge base components usefulness
(source: www.e-marketing.pl\badania\ankieta.php.htm)

Relational model is a specification of all important process elements and their relations, defining the rules of its functioning, created as a result of many project analyses (relating to identical or similar issues), applicable as a tool that aids problem solving in relation to the problem it was elaborated. It is based on a certain number of consolidated concepts and experience from earlier projects. Creation of such model requires methodology and software aiding the knowledge synthesis process.

Sharing process model should answer the following questions:

- what scope of dynamically modified data will be published in the website,

- what actions are necessary for the realization in order to assure the topicality of provided data,
- what should the system architecture be like in order to support data sharing.

14 Internet as a source of information

One of the main activities undertaken to create the informational society is the popularization of internet access through the telecommunication infrastructure development.

As a result a constantly growing number of internet users can be noted. Imperfection of the internet knowledge base organization is a major limitation for the users, preventing them from gaining desired information. Internet and its content is discovered by the users pragmatically. Creation of individual internet and available content usage models is a result of such approach.

Attempt to capture the qualitative aspects of internet usage was undertaken by the www.e-marketing.pl website. Around 75% of website receivers have over one year of experience with the use of internet, what can be deducted from the data published at the website. This factor definitely influences the results of performed questionnaires.

Interned usage model formulated on the basis of such results is relating to the quality of the usage of this tool by the society that contributes to the creation of informational society. Majority of the content available in the internet decides about its attractiveness.

Everyone can find some piece of information that is of value to her or him. Therefore there is no single model of usage for this technology. Around 180 respondents have answered to this questionnaire.

Over a half of the respondents indicated articles and current news as useful component of a knowledge base. Less than 25% of respondents see case studies and book reviews as an irrelevant component of knowledge base. Content searched in the interned is different for particular users.

Effective usage of internet resources is limited by a lack of efficient cataloguing system. Increasing number of indexing servers (browsers) complicates even more the sorting of information. It leads not only to a decision – how to search?, but also - where to search? In this area the questionnaire had over 300 responses. Imperfection of the internet knowledge base organization is a major limitation for its users.

Various browsing systems limit these issues to a certain level. However, the biggest weakness of such websites is providing links to obsolete and non-existing websites, several links to the same address and results not compliant with the inquiry. This is a result of an open nature of internet so the disturbances pointed out by the users should by treated as unfavorable but inevitable.

15 Summary

Data sharing and integration issues in management systems are always present, where there is an information exchange process between groups of people. Maintenance of channels' availability and topicality is becoming more difficult with the growing number of channels. However, implementation of telecommunication technologies allows dealing with such issues. One should bear in mind that mere elaboration of the solution is not sufficient.

Business processes designing is necessary. It is definitely connected with the redesigning of the processes currently existing in an organization.

Using modern IT technologies is not the only success factor – change of organizational culture is crucial. Organizational participants need to take active part in the process and be willing to share data with other participants.

Currently there is no model in the web that would allow sharing the effects of one's work and gain benefits form this process. It is necessary to undertake research leading to the determination of the influence of particular technology on the effectiveness of processes in the enterprise.

The main issue to resolve is the identification of possible telecommunication solutions application for the prototypes of IT solutions that are to be implemented.

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ENTERPRISE MANAGEMENT AND REGULATION OF ECONOMIC ACTIVITY: THE CASE OF INSURANCE

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Abstract: Modern enterprise is functioning in a market space in which it is subjected to the whole network of intervention tools in the form of economic regulations. These regulations limit the freedom of its economic activities impacting the business models in use, its internal organization, management systems and, last but not least, its market value. Degree and strength of regulatory intervention is highly differentiated in various countries, depending on the cultivated social and economic model. It also varies depending on the area of economic activities in different groups of enterprises, according to the current perception of its systemic significance. Especially strong regulatory interventions are currently applied for financial institutions.It is because they are threatening the existence of the whole system via the systemic risk they are able to generate**.**The article explores principal challenges and issues facing the insurance operations and relates them to the enterprise management**.**

Key words: regulation, supervision, quality of regulation, costs of regulation, intervention powers.

1 Introduction

Modern enterprise is functioning in a market space in which it is subjected to the whole network of intervention tools in the form of economic regulations. These regulations limit the freedom of its economic activities impacting the business models in use, its internal organization, management systems and, last but not least, its market value. Degree and strength of regulatory intervention is highly differentiated in various countries, depending on the cultivated social and economic model. It also varies depending on the area of economic activities in different groups of enterprises, according to the current perception of its systemic significance. Especially strong regulatory interventions are currently applied for financial institutions. This takes foremostly place due to the fact of recognizing their activities as systemic significant.Additionally it is also a result of their business model based on wide utilization [1] In the social understanding it is a form of intervention into the shape of relations that take place between different subjects. It determines the type of activities and behavior of these subjects through the modification of existing spontaneous patterns.

Regulations can be obligatory, their source is the public authority, or voluntary, their source is the initiative of interested subjects. In such case one speaks of self-regulation or auto-regulation.

[1] Surdej A. – Determinanty regulacji administracyjno-prawnych w oddziaływaniu państwa na gospodarkę, Published by AE Kraków, Kraków 2006, p. 9.

of debt. resources (trust property) for financing of their transactions. Progressing economic globalization leads at the same time to a situation in which more regulation is accompanied by globalization of applied regulatory solutions. Therefore it leads to inter alia increased regulatory risk due to the replacement of diverse norms and standards with uniform solutions.

This article focuses on the analysis of the sources of current regulatory explosion with relation to the insurance markets, highlights basic regulatory areas, discuss main regulatory challenges and finally provides some thoughts on the issue of cost of maintenance of existing regulatory regimes.

2 Definitions

Regulation (lat. regulatio) is defined as arrangement through submission to norms, rules and regulations.

Modern social and economic systems tend to increase the use of different regulatory instruments as well as to replace the voluntary regulations with obligatory regulations. This contributes to the increase of the legislative role of the state. One of the important premises of this phenomenon in the global approach is the observed economic activity and social security privatization process.[2]

[2] Gilardi F., Jordana J, Levi - Faur D. – Regulation in the age of globalization: the diffusion of regulatory agencies across Europe and Latin America, Institut Barcelona d'Estudis Internacionals, 1/2006, p. 4.

Contrary to the popular belief it does not lead to deregulation and higher market freedom but to the creation of numerous regulations and supervisory and regulatory institutions. The number of regulatory agencies that operate in the seven economic areas in EU and Latin America(telecommunication, energy, market competition, capital market, food industry, pharmaceutics and natural environment) increased fifteen fold, in 1960 – 2000, from 10 to 150 . The most rapid acceleration of the creation of these institutions took place in the last decade of the XXth century, when the number of institutions tripled.

Process of regulatory explosion is accompanied by the increasing technocratization, which is based on the delegation of regulatory authorities from politicians and government structures to regulatory agencies and technocartes.[3]

Both of these phenomena can be explained through the relation of national economic and social activity privatization with the increasing dependence of the state on private capital. It triggers the need to create stable institutional structure, with more expert than political structure, for them.

Another cause can be the progressing regional integration processes, in which regulations and regulatory agencies are the part of the integration process.

For example, European Union created, as part of the commitology system, over 300 various committees (advisory, managing and regulatory) that have essential impact on the legal and economic order of the community.[4]

Another explanation is the globalization of the regulatory standards as a result of economic globalization and the trans-boundary imitation effect.

Regulations consist of sets of standards of different kinds (legal, economical, market related) as well as the rules of their introduction (regulation process). They determine, together with regulatory institutions, the regulatory order in given jurisdiction. Standard is understood as a set of requirements that deal with certain area. It is a kind of "regulatory atom .

Between the listed elements of the regulatory order there exist mutual linkages. For example the content and form of accepted standards is dependent both on the regulation process itself and the character of the regulatory institution. Regulation process influences not only the content of the standards, but also the regulatory institutions themselves, which need to adjust to its requirements. On the other hand, these institutions influence the organization of the regulation process.

Table 1. Total number of committees present in the EU commitology system in 2004 and 2005
(source: Report from the Commission on the working of committees during 2005, COM/2006/0446 final)

Political sector/symbol	2004	2005
Enterprise (ENTR)	29	32
Employment (EMPL)	6	6
Agriculture (AGRI)	30	31
Energy and Transport (TREN)	39	38
Environment (ENV)	35	32
Research and Technological Development (RTD)	3	3
Informational Society (INFSO)	9	10
Fisheries and Maritime (FISH)	3	3
Internal Market (MARKT)	11	10
Regional Policy (REGIO)	2	2
Taxation and Customs (TAXUD)	10	10
Education and Culture (EAC)	9	7
Health and Consumer Protection (SANCO)	13	15
Justice and Home Affairs (JLS)	10	13
External Relations (RELEX)	3	3
Trade (TRADE)	11	12
Enlargement (ELARG)	2	3
External Aid (AIDCO)	9	8
Humanitarian Aid (ECHO)	1	1
Statistics (ESTAT)	7	8
Budget (BUDG)	2	2
Anti-Fraud Office (OLAF)	1	1
TOTAL	245	250

[3] Gilardi T, Jordana J, Levi – Faur D. – Regulation op. cit p. 3.

[4] Commitology determines the European Commission cooperation system with special committees that consist of representatives of particular EU countries. Its main goal is to assure national control over the work of the Commission.

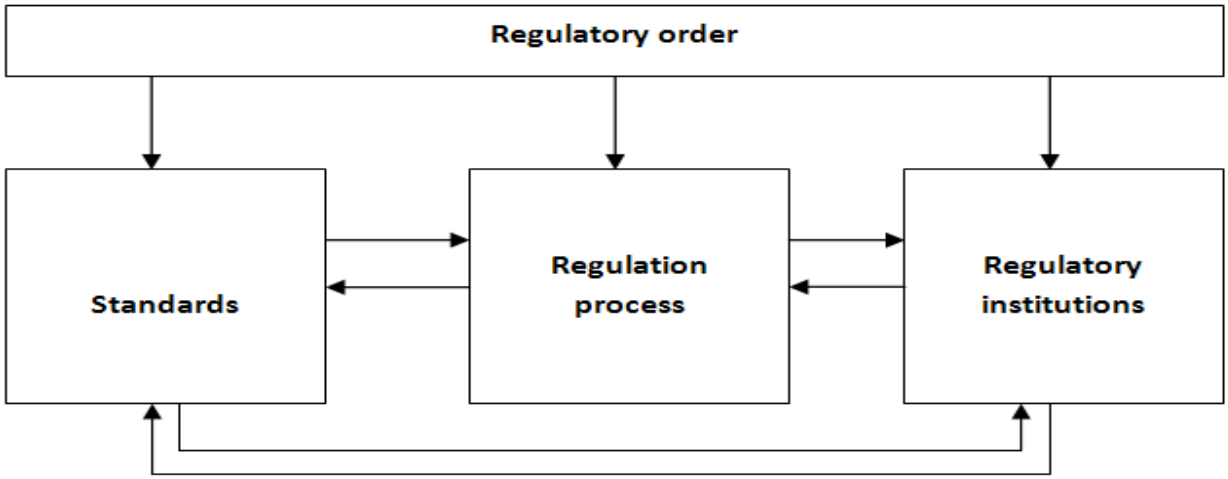

Figure.1 Elements of the regulatory order
(source: self elaboration)

Regulations co-exist with the activity of market mechanisms. In many cases regulations replace market standards and mechanisms. In other cases, quite contrary, regulations create market that could not have emerged in any other way (e.g. through introduction of the obligation to acquire certain qualifications, determination to compliance to perform certain roles, necessity to acquire certain equipment etc.).

3 Basic theories of economic regulation

The basic premise of the regulation in the market economy is the existence of many flaws and imperfections that lead to market failures.

List of such imperfections includes especially:[5]

- existence of monopoly, which limit the existence of competition and damage the market balance. This can lead to limitation of supply, product scope and inflated prices of products that leads to the transfer of income from non-monopolized areas and consumers to the monopolists,
- existence of externalities, which means that the actual manufacturing cost is lowered through moving it out of the scope of the manufacturer, e.g. through disposing of waste into natural environment, what causes lowering of the manufacturing price and excessive consumption, thus deforming the market,
- existence of information asymmetry, which means different level of access to information of different participants of market transaction, what leads to the contract unbalance. It damages the mechanisms of effective market mechanisms,
- lack of service availability, meaning the necessity to assure supply of particular services even if it is not cost-effective for the manufacturer but is profitable for the consumers (e.g. transportation to destinations difficult to reach or at certain hours with lowered demand for this service),
- unfair business practices, which can occur due to usage of the dominant market position or use of illegal activities,
- inequality of legal relation participants, due to the economic potential inequality of the subjects that leads to the temptation of abuse from the stronger subject to gain unjustified profits,
- necessity to coordinate activities to reach certain goals in situation when individual subjects are unable to reach them. It includes e.g. creation of technical operation infrastructure such as databases, networks etc., technical standards, educational devices etc.

Market failures became the basis for the formulation of the basic theoretical construction to justify the use of economic regulation – the public interest theory.[6] According to the theory, regulation should be perceived as a strive to accomplish social interests and the regula-

[5] Nieborak T. – Aspekty prawne funkcjonowania rynku finansowego Unii Europejskiej, Difin, Warszawa 2008, pp. 26 – 27.

[6] Hantke - Domas M – The public interest theory of regulation: non-existence or misinterpretation, European Journal of Law and Economics, No. 15, 2003, pp. 165–195; Goran P., Hagy T. - Theories on the economics of regulation. A survey of the literature from European perspective, European Journal of Law and Economics, No. 4, 1997, pp. 337 – 370.

tory activity as aimed at their achievement. The theory assumes that the regulator will be neutral in the realization of the public interest and that it is able to neutrally determine it. According to the theory regulation enables the realization of the three following goals:

- protection of strategic interests of the society,
- effective allocation of resources,
- increase of the market mechanisms effectiveness.

This theory is criticized by the proponents of the economic regulation theory, which claims that most of the regulations do not serve public interest but, on the contrary, favor the interests of the groups that are the subject of regulation. This is the result of, so called, regulatory capture, with actual subordination of public interest to private business. [7] Regulation, instead of being enforced to economical subjects to protect the realization of public interest, becomes a service sought by these subjects that is usually bought by them. As a result, according to the theory, the regulator becomes the prisoner of the regulated subjects.

Main thesis of the school of economic regulation can be summed up as follows:

- regulations are introduced only in the areas where there are considerable benefits that can be overtaken by pressure groups,
- their shape is reflected by the political forces relations between the benefactors that gain from the regulations.

The school of economic theory of regulation in effect underlines the necessity of deregulation of the economy and subjecting it to the mechanisms of the competitive market.

4 Quality of economic regulations

Final results of applying regulation depend on the quality of the regulation. Proper regulations can only be created in the conditions of properly organized regulatory process. It is properly organized only if all interested subjects can participate in it and when they can present their statements and arguments as well as formulate proper legislation solutions during the process. Therefore the regulation process cannot be performed in a hurry. It needs to have the necessary time for analysis, evaluation and reflection. At the same time the regulation process needs to be transparent, so that all of the participants have equal access to the information it produces and are informed about the position of other subjects.

As for the substantial quality of the regulation the following four aspects should be crucial:[8]

- *regulatory adequacy* – relevance to economic reality. Proper regulation must be based relevant interpretation of reality and deal with its basic aspects,
- *regulatory impartiality* – a situation when regulations do not create privileged states for any of market subjects, thus assuring free competition in the market,
- *regulatory proportionality* – a situation when regulatory solutions used are adjusted to the scale of the problem. Therefore such solutions do not lead to excessive interference in the market mechanisms, used business models, customs etc. what at the same time reduces the cost of using them,
- *regulatory stability* – avoidance of frequent changes in obliging regulations, because it introduces uncertainty of activity conditions for the market subjects and increases the cost of regulation.

The quality of financial sector regulation, including insurance sector is, since 1999, subjected to external evaluation by International Monetary Fund and The World Bank as part of the Financial Sector Assessment Program (FSAP). One of the components of this Program is the Report on the Observance of Standards and Codes (ROSC), in which these institutions perform the evaluation of application of global International Association of Insurance Supervisors standards by the analyzed countries. Such reports are later transferred to national authorities together with recommendations to undertake necessary activities.

5 Definition and subject of insurance regulation

Insurance regulations are the collection of standards currently in force for the whole insurance market as well as particular insurance institutions and their relations with the external environment (supervisors, brokers, investors, customers etc.). They determine the minimal requirements towards undertaking that perform or plans to perform insurance activities.

[7] Economic regulation theory and regulatory capture are mainly associated with an American economist G. Stigler, winner of the Nobel Prize in economics in 1982.

[8] Skipper H.D, Klein R.W. – Insurance regulation in the public interest: the path towards solvent, competitive markets, Centre for Risk Management and Insurance Research, Georgia State University, Atlanta, Georgia, August 23, 1999, pp. 23–30.

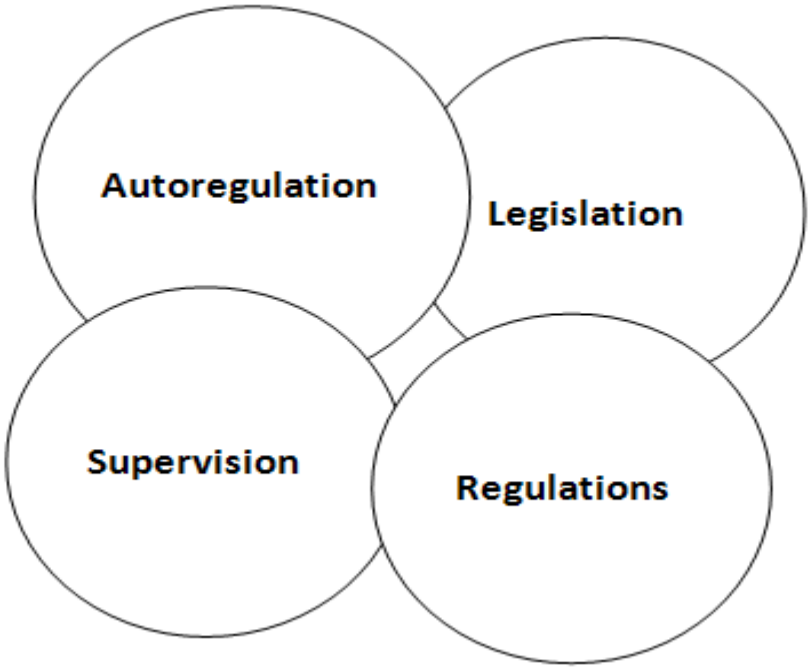

Figure 2. Regulations – basic relations
(source: self elaboration)

It takes the form of various legal and administrative acts (e.g. in Poland these are acts, regulations, orders, recommendations, decisions etc.). Therefore, most of them are connected with the legislation activities of the nation. Thus they reflect the legal culture of given country, which directly transfers to its regulatory culture.[9] One should not identify the insurance regulations strictly with the legislation activities. Creation of regulations is also performed by the insurance supervision institutions, both through formalized decisions and used supervisory practice (so called "soft regulations").

Public and legal regulations can be also supplemented with self-regulatory practices (e.g. best practice code) and customs originating from the insurance environment. They usually have more significant role in mature markets and these markets where liberal economical policy is introduced. Basic relations in this field are presented in the Figure 2. Insurance regulations consist of three basic components:[10]

- *regulatory order* that determines who performs the regulatory activity, rules of creation, implementation and expiration of regulations (regulation process), subject of regulation and the set of rules, regulations, norms and standards in force for the insurance activities,
- *supervisory order* that determined who supervises the insurance market and institutions as well as describes how is it attached and what competences it has,
- *market safety networks* that determine scope and market and its participants protection from the insolvency of insurance companies and regulates the compensation connected with results of possible bankruptcy.

These regulations deal with to sets in the subjective approach: on one hand the horizontal relations – mutual authority and obligations of market relations subjects (insurers and insured), regulated with the civil law, and, on the other hand, vertical relations – authority and legal obligations of market relations subjects and the nation, regulated with the public law. In both cases the interference of the nation, which will influence its final state, is possible.

6 Premises and goals of insurance regulation

Premises of the insurance regulations usage are possible to derivate directly from existing theoretical regulation constructions, especially from the public interest theory. This theory assumes that market mechanisms

[9] Nieborak T. – Aspekty prawne… op cit, p. 21.

[10] Por Financial sector regulation: issues and gaps, IMF, August 4, 2004, p. 9.

in their pure form lead to reaching a worse social result in comparison with the situation when these mechanisms are corrected through legal and administrative activities of the nation. It focuses mainly in counter activities towards market failures for the following threats:

- *systemic risk* – risk of economic system collapse due to insurance companies crisis. This can lead to significant negative macroeconomic issues due to the lack of necessary insurance protection or the deficit of trust for insurance companies,
- *risk of bankruptcy* – meaning cancellation of undertaken insurance contracts, what can result in negative micro-economic consequences for the insured and other creditors (e.g. injured parties),
- *risk of calamity* – meaning accumulation of considerable insurance pay-offs, what can overwhelm the strengths of the insurance system. The result of such events would be major negative consequences in both micro and macro level.
- *asymmetry of information* – situation in which the sides of the insurance contract have different information about each other, insurance product and the contract. Leveling of this information base, which sometimes favors the insurers (e.g. the information about market demand) and sometimes favors the insured (e.g. the knowledge about one's risk profile), can be a premise to undertake certain regulation activities.
- *moral hazard*, temptation of embezzlement, is the reduced caution in the activities of the insured after concluding the insurance contract and their tendency to hide crucial information, which can negatively influence the conditions of the insurance contract, from the insurance company. This can lead to the higher level of loss and reduced reliability of the insurer.
- *adverse selection of risk*, unfavorable selection of risk due to information asymmetry, what leads to increased risk of insurer's bankruptcy.

Insurance regulations aim to reach certain goals, which, according to modern regulatory tendencies, should be declared publicly to allow the possibility of social supervision over the shape of their regulation and the supervision policy. Usually these goals include *market stability* (continuity of insurance supply and a certain trust level for the insurance companies), its *safety* (avoidance of bankruptcy shock through certain activities and creation of market security networks), *transparency* (open communication with the market and supervisory institutions) and legality also known as integrity (legality of transactions, both in content and form as well as legality of used financial resources).

7 Basic areas of insurance regulation

Insurance regulations create rules, regulations, norms and standards that cover many problem areas. Key problem areas are the following:

- start up of insurance activities,
- performance of activities including:
  - restructuring activities,
  - mergers of enterprises,
  - transfer of portfolio,
  - termination of activities, declaration of bankruptcy,
- finance management,
- broker activities,
- insurance contracts,
- market supervision.

In case of public regulations they can be collected in a single act of law (e.g. code) or dispersed in few places (what is the most common solution). These regulations can be collected both in the regulations of insurance as well as civic and trade law. For example in Poland we can find it in: civil code, maritime code, trade code, insurance activities act, obligatory insurance act, UFG and PBUK, insurance broker act and insurance and pension supervision act.

7.1 Licensing

Insurance companies are treated as part of the financial services market due to the trust nature of its activities. Therefore performance of insurance activities is subjected to licensing (receiving permission). Its aim is to assure that the insurance protection is fit and proper and it favors the stability and credibility of the whole insurance system. Firstly, regulations on performance of the insurance activities include the definition of insurance activity and the insurer.

For example Polish law defines *insurance activities as performance of activities connected with offering protection and protecting in case of occurrence of risk of random events. However, insurer is defined as a subject leading such kind of activity, who recieved permission in this scope from proper authorities***.**

It is necessary to emphasize that proper definition of insurance activities has a major practical relevance.

It allows determining what kind of activities, based on the insurance regulations, need to be performed and what activities can be performed on the basis of general market regulations. In some cases there are situations when various subjects undertake, warily or unwarily, insurance activities without the licensing procedure (for example medical subscriptions offered in Poland). It allows avoiding the loss of time for adjustment to the licensing requirements and performing activity in, so called, regulation "grey area" with the use of arbitration regulatory. The temptation to use such solutions will be greater when the licensing regulations are more strict and the weaker the law is executed in given jurisdiction.

Licensing is based on the researching of the fulfillment criteria suitability of the regulation permission of the applying subject. Currently mostly the suitability of the investors (shareholders) and legitimacy of the financial resources they acquire.

It is also determined whether the applicants have proper financial resources to perform activity of planned profile and in planned scope. Another crucial criterion of the suitability of the applicant is the proper competence and experience level as well as recognition of his key partners (e.g. members of the board, supervisory board, actuaries, internal auditors). Usually the most serious charge for such persons is a court sentence in force. Important factor of the application is a professional action plan for the time horizon of few years, what allows evaluating the credibility and professionalism of the applicant and allows continuous supervision of its economical situation.

Organizational risk management and proper systems and procedures connected with this area become more and more significant criterion of suitability. It is crucial to emphasize that licensing is performed by the same institutions that later are responsible for the supervision of the insurers. Sometimes this responsibility is divided. Such practice was present in Poland until 2002. Licensing was part of the competence of the Ministry of Finance and the supervision was performed by the National Insurance Supervision Department (PUNU).

Licensing procedures are time and labor consuming. They require gathering and checking much information, what can be extremely complex in the age of globalization, and it is usually necessary to gather data that is stored in a different country. According to the provided information an average time of license decision acquiring around the world takes from 3 to 6 months.[11] However, in some cases, it takes much more time.

Most countries in the world grant such permissions sine die and they do not have to be renewed, although in specific cases such permission can be cancelled. Sometimes permissions are given for a specific period of time (e.g. in Ukraine).

Majority of countries do not grant permissions for composite insurers, who provide insurance packages for both life and property. This is justified by the possible temptation of using assets from life insurance for the purposes of property insurance.

Granted permissions, by authority of law, can include all groups from given insurance group or relate to each group separately. Current international practice is divided equally in this matter. Polish regulations are compliant with the second solution.

Applying subject, in majority of countries, cannot perform other professional activities than insurance activities. This rule protects the insurance activities from risks that could have been transferred from other areas of activity. However, in some cases there are exceptions from this rule. For example in Poland the insurance companies are allowed to seek, apart from insurance activities, customers for their open pension funds and distribute banking products.

Revoking a license takes place when the insurance company is no longer compliant with the requirements for such activities (e.g. limited capital, unqualified staff, illegal activities etc.) or due to a request of an individual subject, which decided to stop the activity as insurer.

7.2 Performance of insurance activities

*Modern insurance regulations claim that considerable owners, members of the board and supervisory board, actuaries and auditors need to fulfill the criteria of regulatory suitability***.** It usually means that they are honest, competent, experienced and qualified.

Putting so much attention to the responsibility of people has its justification in the history of the insurance sector.

Research proves that the basic source of problems in the functioning of the insurers and the main cause

[11] Report on laws, regulations and practices in IAIS member jurisdictions, IAIS, December 2007, p. 13.

of their bankruptcy are the incompetent or dishonest owners and/or key workers.

Ownership structure can be changed in the insurance company during its activities. Regulations in most countries require receiving an approval for purchasing the majority of shares or concluding a contract, which indicate that given subject can directly or indirectly take control over the insurer. The control is usually understood as an ownership of particular number of shares or other instrument over the minimal necessary level stated in the regulation, right to vote in this matter and the possibility to change the management of the insurance company.

Performance of insurance activities might require transferring part or whole insurance portfolio (insurance contracts in force) to other subject, which takes over the rights and obligations from concluded contracts. This activity is usually subjected to particular regulation that protects the interests of the insured. The main focus is put on the conditions of the contract that should not be worse than in previous insurer. Most modern economies require an acceptance of supervisory institution for the insurance portfolio transfer, both in the silent form (no objections) or through issuing of permission.

We speak of similar situation in case of a fusion of two or more insurance companies. This fusion leads to a creation of a new subject that becomes a legal successor of merged companies. Such operation is subjected to the permission acquiring from proper competent authorities, which usually include insurance supervision departments and institutions responsible for the protection of the competition.

Insurance company can disturb the obliging rules, what can lead to the implementation of a reparation program towards it. Currently worldwide such programs are undertaken in case of risk of threat to financial stability of the insurer and especially the risk of insolvency. Such situation can be defined as a threat of risk that already happened (e.g. lowering the capital level below the solvency margin), what is currently a dominating standard, or as a threat that can happen in the future, what is based on the use of scenario analysis methods and stress-tests – an important regulatory innovation. At the same time the rule of supervisory intervention ladder is obeyed - reparation regulations allow to escalate undertake activities according to the threat level.

For example, Polish law anticipates three-step reparation ladder, starting from elaboration and presentation of the reparation plan to the supervisory authorities, which needs to include i.e. insurance company financial stability threat elimination activity program. These can result from improper level of own capital, guarantee capital or technical and insurance allowance. Moreover, in serious cases, receiver can be introduced in the company, who should supervise the implementation of the reparation plan. Finally it can be necessary to establish receivership (trust management), which overtakes the authority of the board of directors, supervisory board and the shareholders annual meeting.

The last level of reparation interference is the censure vote for the statute authorities of the insurer and is a sign of lack of trust that these authorities are able to solve issues on their own.

Currently one of the developing subjects of the regulatory penetration is the activity of insurance groups and financial conglomerates. Such regulations are currently applied in half of the countries in the World.[12]

Regulations on insurance groups were firstly introduced in European Union in 1998 through acceptance of the directive about additional supervision over insurance groups (Directive 98/78/EC z 27 October 1998). In most countries these regulation do not require the mother-company to be a licensed financial institution. Nevertheless the suitability requirements need to be fulfilled by this company, it has to own proper internal control system and it needs to provide financial reports on regular basis. Also the possibility of direct control over mother-company and gaining all necessary supervisory information is possible in most cases.

Used regulatory requirements usually deal with the concentration of risk in the group, ownership of internal control system, forbidding of multilevel capital gearing, ownership of sufficient own capital at the group level and the necessity to reveal the internal group transactions.

Organizational and management standards are becoming one of the most important factors of modern insurance companies' activities. This results from a fact that operational risk is recognized as one of the crucial risk factor that threatens the insurance companies.[13]

[12] Report on insurance laws, regulations and practices in IAIS member jurisdictions IAIS, September 2008, pp. 11 – 15.

[13] In the most general manner the operational risk is understood as the risk of loss due to faulty control systems, human error or improper - see Kendall R – Zarządzanie ryzykiem dla menadżerów, Liber, Warszawa 2000, p. 163.

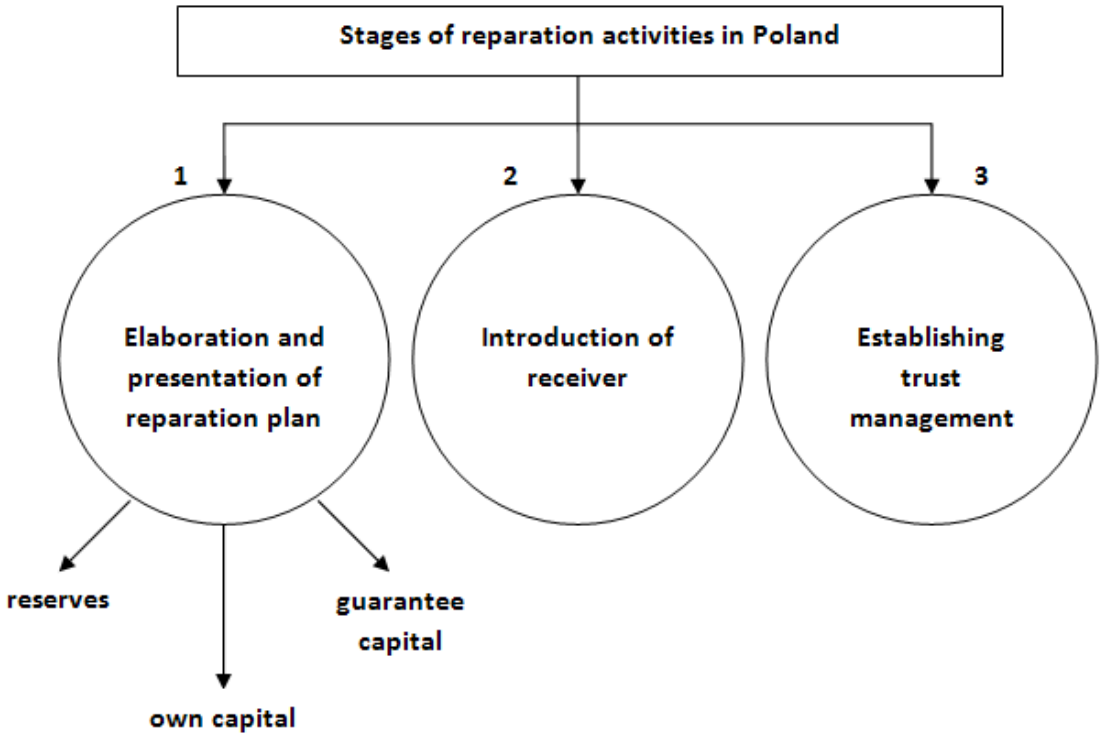

Figure 3. Reparation activity in insurance company
(source: self elaboration)

This fact is reflected in the new EU directive on Solvency II, where the operational risk is present as a separate factor of the insurance company risk portfolio alongside insurance, market and loan risk.

Other issues that are in the scope of special interest of regulatory activities is functioning corporate governance in the insurance company with detailed determination of the competences of particular authorities and organizational units as well as properly organized informational and decision-making procedures.

Operational risk management system, which includes insurance (e.g. obligation to perform actuarial audits), financial (market), loan and operational risks, more commonly becomes a distinguished area in the insurance regulations.[14] One of the significant components of the corporate governance and the risk management system is the internal control. In number of jurisdictions the insurance regulations directly oblige the insurance companies to develop the control functions and organize control authorities. Usually the basic standards of such control, like cross-checking, double asset control or double signature, are determined. One of the components of the internal control system is the internal and external audit. Rules of functioning and application are usually subjected to regulation. For example, the regulation obliging the insurers to use the external audit for the evaluation of the financial reports, periodical rotation of external auditors or the independence rule of the internal auditors is commonly used.

Modern insurance regulations also include general norms of insurance broker activity, what is connected with the fact that major part of sold insurances is not performed directly by the insurers but with the help of insurance brokers.[15]

Usually such regulations introduce the division of brokers into two categories: agents (subjects that operate in the name of the insurer and independent brokers. Usually the criterion for the latter is lack of contract obligation, lack of constant salary and dispersion of their business portfolio among many different insurers. In most countries the number of agents is much higher than the number of independent brokers. Insurance broker regulations usually deal with qualification requirements (education, professional experience,

[14] Report on insurance laws, regulations and practices in IAIS member jurisdictions, IAIS, September 2007, pp. 7-10.

[15] Insurance laws regulations and practices in IAIS member jurisdictions, IAIS, December 2007, p. 48.

minimal age, sterling reputation etc.) and the rules of performance of their work.

7.3 Termination of business activities

Termination of business activities by an insurance company is currently the standard subject of insurance regulation. Their superior goal is to assure orderly withdrawal of the insurer form the insurance market – without negative influence on the interests of the insured. Surcease of activity in the formal and legal aspect is connected with the liquidation of the insurer, either voluntary (by the interested party) or compulsory (due to an administrative decision). In both cases insurance regulations award such competences to the supervisory authorities.

Voluntary liquidation is a result of a business decision of the insurer. Compulsory liquidation is a result of a permanent loss of the insurer of the ability to perform insurance activities as well as insolvency and threat of bankruptcy, connected with it.

It is important to emphasize that the issues of the insurer bankruptcy are, in most countries in the world, subject to separate legal regulations. It is connected with the separation of the nature of insurance business activities and its insurance business model from other types of business activities.

Bankruptcy regulations generally relate to three main issues: premises to start the bankruptcy procedure, subjects authorized to initiate bankruptcy procedure and participation in the procedure and protection of the interest of the insured.

Modern regulation causes of the bankruptcy procedures are connected with the lack of sufficient assets to cover the debit side (liabilities are greater than the assets), insolvency (when debtor is not able to regulate his current liabilities) or the need to protect public interest. Sometimes these are cumulative ant sometimes alternative criteria.[16]

In current regulatory reality the authority to initiate bankruptcy procedure is usually granted to supervisory authorities, even though in many jurisdictions such possibility is granted to the boards of insurance companies and their creditors.[17]

If it comes to the protection of the interest of the insured, insurance regulations relate to the issues by:

- granting high priority to insurance liabilities in the total list of liabilities, especially with relation to the assets that cover the insurance reserves,
- introduction of guaranteed compensation system for the customers of insurers that have bankrupted,
- including the insured representative to the supervision and modeling of the bankruptcy process.

7.4 Financial regulations for the insurers

The key area of insurance regulations is the finance economy of the insurance companies, especially in the scope of assurance of solvency during the period of its functioning (see chapter 6 for details). These regulations relate both to assets and liabilities.

The subjects of modern regulations at the side of assets are usually:

- rules to determine the value of assets for the regulatory needs (present value, historical, allowable components etc.),
- determination of allowable investment instruments, including the concentration limits (e.g. in one instrument or one subject),
- determination of used investment rules (e.g. the prudent man rule).

The subjects of modern regulations at the side of liabilities are usually:

- ways to determine the value of insurance liabilities,
- rules to create reserves for liabilities,
- rules to determine the risk margin for liability value,
- rules to determine the level of own capital for regulatory needs,
- determination of allowable forms of own capital

In most insurance jurisdictions there are detailed requirements towards the level of solvency margin, calculated according to established formulas, usually with relation to the value of the insurance contribution, type of undertaken activities (structure of insurance portfolio), company assets, company liabilities and type of reinsurance agreements.

Insurer risk exposition and quality of his management systems becomes more and more significant among used solvency models. It is a main point in a recently acclaimed UE solvency directive (Solvency II).

[16] Report on insurance laws, regulations and practices in IAIS member jurisdictions, IAIS, October 2005, p. 49.

[17] Ibid p. 49.

8 Basic regulatory choices

Insurance regulations used in particular jurisdictions can differ from one to another in many aspects. Particularly the differences can involve the level of detail, scope, role granted to given market discipline and finally the position and type of supervision.

In case of the level of detail, modern regulation systems can be divided into ones based on detailed rules and ones on accepted regulations. In first case we speak of determined standards that precisely describe current requirements (e.g. financial, organizational, legal etc.). In the second case norms are of general character and focus on the desired outcomes and not on the detailed way of gaining them. For example, instead of providing detailed information about the product character for customers, they can include a norm stating that the customer needs to be informed by the insurer in a manner that allows him or her to make reasonable choice of the product. Such regulations are more difficult to use because of the possible differences in the evaluation of its perception. That is why they are developed in mature markets with proper law culture. Their main advantage is the possibility to regulate the subject to select the best realization for the obliging requirements.

Modern regulatory systems focus on the insurance authorities in case of the regulation subjects. They assume that the quality of these authorities decides about proper functioning of insurance markets.

The key issue, in this aspect, is the question of understanding these institutions. Is it going to based on the formal and legal logic, which indicates that rge regulation subjects should be legal subjects – registered insurance companies, or the economical logic, which perceives the subject of regulation as economical subjects, enterprise groups, leading coordinated insurance activities (the insurance groups).

There is a possibility to use different perspective on this issue and focus of the regulatory scope on offered products (e.g. rules of creation and construction, rates, risk division etc.) and / or the functioning of the market (e.g. product distribution, outsourcing rules, creation and construction of insurance databases, market concentration rules, market accessibility rules etc.).

Role of granting market discipline, groups of institutions and market influence instruments that impact the behavior of insurance authorities, is becoming one of the most important problems of modern regulatory systems. It includes opinions and decisions undertaken by investors (shareholders), creditors, including customers, external auditors, evaluation institutions (e.g. rating agencies) etc.

Its use allows strengthening the administrative and legal influence and decreasing the necessary supervisory effort. Many different customer organizations and professional societies, which influence the behavior of the insurer, should be counted into this group. This discipline functions better at mature and competitive markets.

Market discipline can considerably support the functioning of insurance supervision.

9 Modern regulatory challenges

Insurance regulations have to follow the changes that take place in the character and style of performance of the insurance activities as well as in institutional conditionings of the national regulatory freedom.

From this perspective the key issues are globalization, increasing dependence of insurances from other segments of the financial market and sampling of turnover. In present conditions globalization should be deliberated in terms of threats (e.g. climate changes, pandemics, global financial shocks), markets (increasing importance of transboundary operations), customers (increasing importance of international insurance programs), operators (increasing value of international insurance companies) and the increasing globalization of regulatory standards (Fig.4).

Modern insurance regulatory standards are more commonly created in global institutions at transnational level. Special role in this scope is played by International Association of Insurance Supervisors (IAIS).

It was created in 1994 and currently it combines 140 insurance jurisdictions, being the general law-making institution in the World. These norms are referential to national or regional regulatory systems. Apart form IAIS the activities of Basel Committee (determining reference norms for banking) International Organization of Securities Commissions (determining the regulatory order for the capital market) and International Organization of Pension Supervisors (regulations on employee pension funds) become more and more significant.

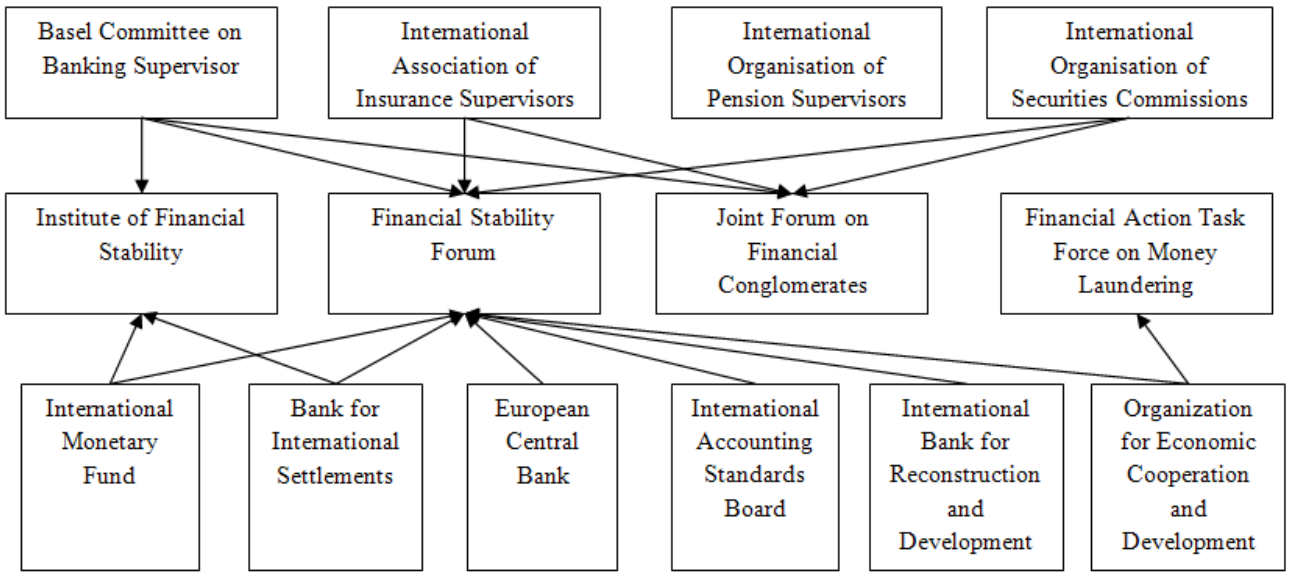

Figure 4. International regulatory structure of financial markets
(source: self elaboration)

It is connected with the trans-sector connections of insurance with other areas of financial markets. All of these law-making institutions are in the scope of influence of other institutions, which are engaged in the coordination of their activities on global scale (e.g. Financial Stability Forum or Joint Forum) or implementation strengthening of their recommendations (e.g. IMF, ECB, BIS or the World Bank).

Modern insurances become more strongly connected with the capital market, a.o. through securitization mechanisms and banking (see chapter 13), becoming part of the regulatory fields of other sectors of financial institutions. Finally, modern regulations must cope with challenges coming from progressing addiction of insurance companies from digitization ov economic turnover.

10 Cost of regulation

Regulations do not have a price but they generate cost. It occurs in a number of different places, thus it is difficult even to estimate them. In most general manner these costs can be divided into three basic categories[18]:

- cost of public regulatory system,
- direct compliance cost of insurance companies,
- indirect cost of insurance companies.

The most visible and easiest to determine position are the costs of the public regulatory system.

It includes the cost of supervisory institution maintenance over the activities of insurance subjects together with the cost of fees and taxes. Costs calculated in such manner represented in the USA in 1997 1,3% of insurance premium of the insurers.[19]

Direct charging of the insurance premium with the cost of supervisory institution maintenance was 0,08 % in the same year so it was a little more than 7 % of fees and taxes paid by insurers to the public sector at that time. At the same time the fees for insurers for that purpose in USA were infavorable in comparison with similar fees for other subjects of the financial sector (see table 3).

This indicates that their competitive position could have deteriorated due to higher cost of supervision.

Second cost position is the spending of insurance companies for the internal adjustment to the regulatory requirements e.g. preparation of proper informational systems for the needs of the supervision, cost of external auditors research, implementation of suitable procedures, responding to inquiries form the supervisory authorities etc.

[18] Grace M.F., Klein R.W – Efficiency implications of alternative regulatory structures for insurance, Centre for Risk Management and Insurance Research, Georgia State University, June 10, 1999, pp. 23 – 26.

[19] Grace M.F., Klein R.W – op. cit p. 25.

Table 3. Cost of supervisory institution maintenance in USA, 1997
Source: Grace M.F, Klein R.W-Efficiency implications of alternative structures in insurance regulation, Georgia State University, June 10,1999,p.43

Supervisory institution	No of super-vised subjects	Budget (in mil. USD)	Assets (in bil. USD)	% Assets	Per 1 subject
State Insurance Supervision and NAIC	7 872	785,4	3,433	0,023	99,76
Federal Reserve System	8 007	517,0	4,791	0,011	64,56
Financial Supervisor Office	2 597	350,0	2,894	0,012	134,77
FDIC	10 922	605,0	5,607	0,011	55,39
Loan Supervision Office	1 215	151,0	777,000	0,019	124,28
National Credit Union Admin-istration	11 238	46,3	351,000	0,013	4,120

These are much more difficult to calculate and analyze. It usually contributes to the majority of cost. For example, there are estimations that show cost of state supervisory system is costing the American insurers approximately 6 billion USD per year - six times grater than the direct cost of maintenance of public supervision.[20]

According to research performed by the University of Zurich, 4,5% of bank cost in this country is connected with its adjustment to regulatory requirements. What is more, this cost is increasing.

The same research indicates that the number of people employed in the banking institutions regulatory authorities in Switzerland has trilled in recent years.[21]

Finally the third and most important regulation cost position is the indirect cost of insurance companies due to adjustment to regulation requirements e.g. regulatory adjustment of used business models, obliging investment limits or product regulations.

It is important to emphasize that direct and indirect costs of regulation of insurance companies are greater when the changes of used solutions are more frequent. Therefore, the stability of agreed solutions is of crucial importance.

[20] Coudrou C.M – The Reed for U.S. insurance regulatory reform: A life insurance perspective, Progres Newsletter, No. 48.
[21] Integrated supervision. Lessing or curse? Credit Swiss Worldwide, 17.11.2006, p 1.

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EVENTS AND EVENT PROCESSES

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Abstract: Presented article describes the issues known from the logical structures characterization theory [2] used in this case to describe the events designed for the needs of proper functioning of organizational structures. Necessary formalization is used strictly for the maintenance of the concept discipline. Event theory [5] is used in the designing of complex structures of organizational systems for which the basic necessity is its compliance with the set functional description. Final organization's characteristics are determined by many factors, such as: a) completeness and non-contradiction of the functional specification b) theoretical correctness of the functional transformation of the organization into the design of its organizational structure c) correctness of the technical project realization.

Key words: object, object configuration, events on the object channels, symbolism and operations on events, regular expression of events, event loops, process as a sequence of events, event net, relations and conflicts in event nets, graph figures in event nets, net correctness.

1 Introduction

Event theory includes a wide research scope that formulates assumptions, hypothesis and proof describing the essence and relations of events. This paper is limited to the research area, in which a single event is defined as the change of the state of the distinguished element, which is called a channel, with the assumption of the finite number of identifiable channels and finite scope of identifiable states of every channel and in conditions where in given time the channel is in one and only one of its states, listed in the scope of states for this particular channel, and also where the time necessary to switch channels is negligible.

Event theory, through its assumptions and inference rules, can be used to define and execute two tasks:

- assurance of the completeness and non-contradiction of the functional specification of designed organizational structure,
- assurance of theoretical correctness of the functional transformation of the organization into the theoretically correct design of its organizational structure construction.

Basic concepts of this theory are: objects, object channels, channel states and events in channels, sequences of series, alternative, synchronous and cyclical events, event nets and areas, forbidden and obligatory event graph figures, regular event network, event network canonical correctness.

In event theory channels are considered as relations between objects that communicate with each other (see Fig. 1 and Fig. 2), with an assumption that every outgoing channel of the object is its belonging channel (on these channel procedures for given object determine the states, which become accessible for the procedures of object's environment).

Every channel that belongs to a given object, represents, in particular time, one of the distinguished states of this object as its own state. Many channels can belong to a single object. Object procedures perform the state forcing operation on these channels.

Let us assume that two objects 0_i, 0_j with unknown internal structure (see Fig. 2) communicate through the K channel set. Any $K_p \in K$ channel can be in one of its $S_v \in S$ admissible states in any time. The communication of objects is based on the fact that the equivalent K_i, K_j channel subsets, where $K_i \cap K_j = \varnothing$, determine (marked: !) the S_v states according to their internal functioning procedures and simultaneously in "suitable" time they "observe" (marked: ?) the channels of their neighbor. This observing usually means the control of O_i object (adequately O_j) over selected K_j (adequately K_i) channels.

Such type of object communication is called loose (autonomic) – contrary to the enforced communication, present in logical control systems. The following part of the deliberations in the article considers the autonomic communication between the O_i, O_j objects.

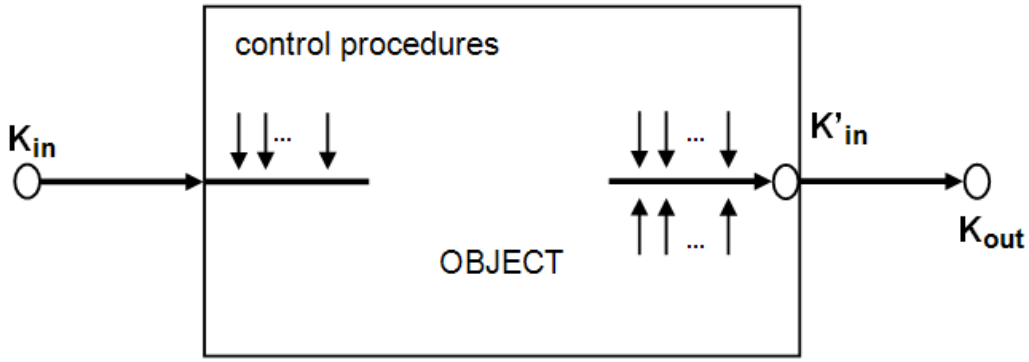

Figure 1. Outgouing K_{out} and incoming K_{in} belonging channels

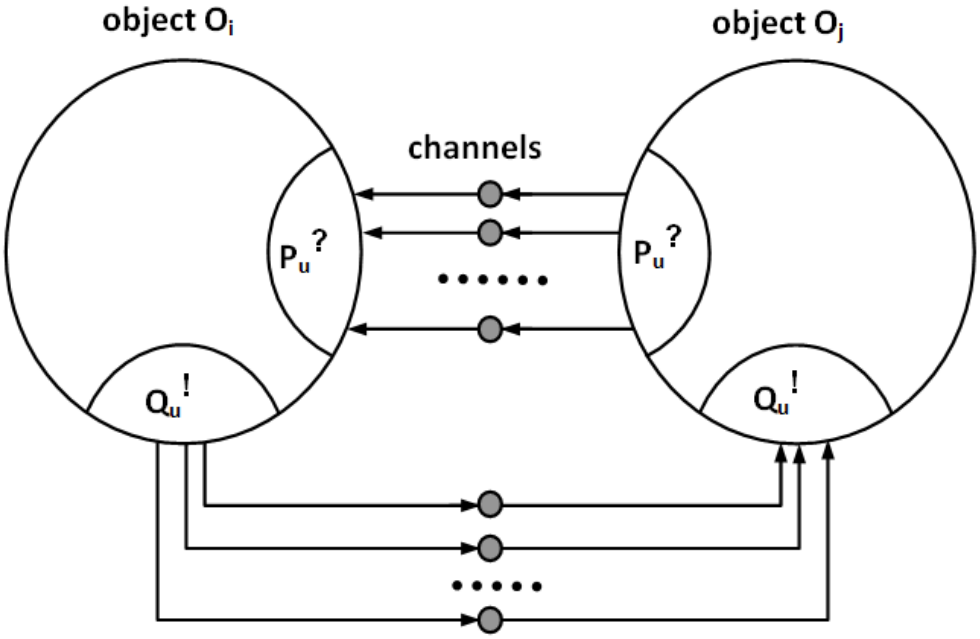

Figure 2. Relations between communicating objects.
Belonging outgoing channels and incoming channels of O_i, O_j objects

Series of channel state change events are realized during the communication of O_i, O_j objects on the K_i, K_j channels (see Fig. 2). Channel state changes create the process observed by the O_i, O_j objects.

Fig. 3 presents the configuration of objects that create a superior object. This is an object whose incoming and outgoing channels (channels $K_{1,0}$, $K_{1,5}$) are the channels connecting internal objects (objects: O_2, O_4) with the environment. The proper outgoing channel of an object can be an incoming channel of one or several objects' that belong to a configuration or an outgoing channel of this configuration.

Object interpretation (modeling) of the organizational system's reality can be performed in a way that the whole internal memory of the organization will be described with the configuration of internal objects and incoming and outgoing channels of these objects. In general case object configuration can have a multilevel structure, where objects with the same or different configuration communicate through channels.

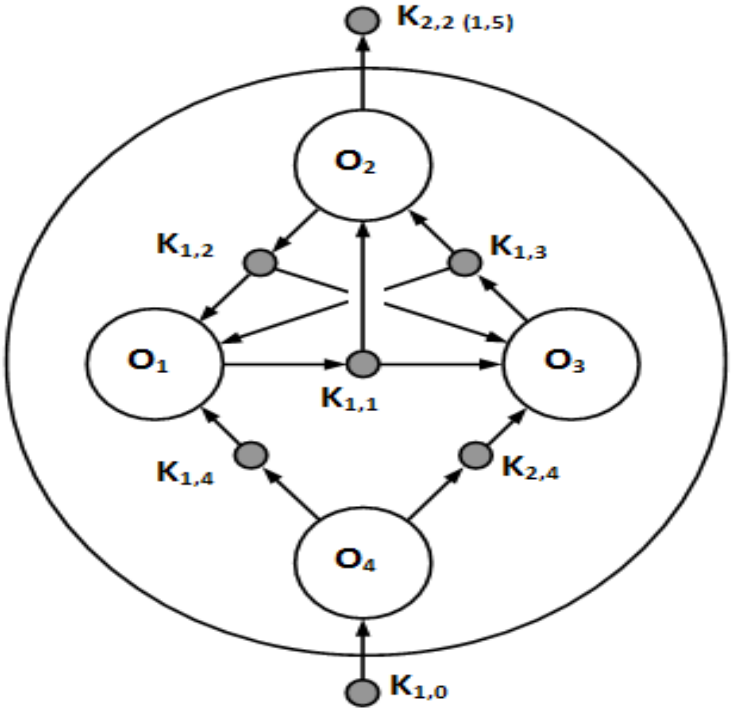

Figure 3. Multiplexing channels of communicating objects. Superior object as a configuration of internal objects.

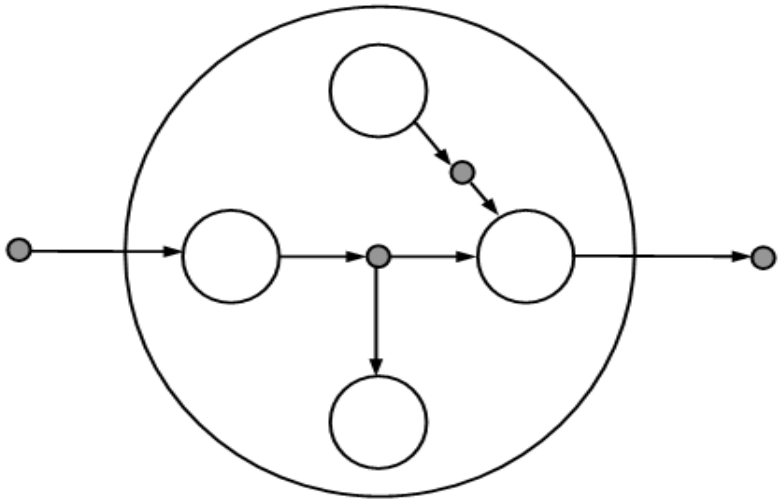

Figure 4. Example of object configuration

Objects create object configuration in the form of a superior object when every incoming and outgoing channel of this object is at the same time a incoming or outgoing channel of a single internal object of this configuration.

At least one incoming and one outgoing channel presence must be assumed for the existence of an object. At least one incoming and one outgoing channel as well as the presence of two internal objects of this configuration must be assumed for the existence of the object configuration in the form of a superior object. Example of object configuration is presented in the Fig. 4.

Objects and channels are connected in any configuration adequately through objects and channels. Fig. 4 presents example of two objects connected in a configuration with one channel (outgoing and incoming).

2 Event and channel concepts

In real life events are usually connected with the consequences of a fact, which can be observed and measured. The causes of events are not always obvious. For the deliberations on event in real life it is necessary to determine their objective area.

Deterministic events, for which the cause and effect chain is known in particular area, and random (probabilistic) events, which causes are beyond the objective area, can occur in a synonymously determined objective area.

Examples of deterministic events are: change of traffic lights in communication, loading a fork-lift transporter in a marked space near a machine, freeing financial resources due to liquidation of endangered bank loan portfolio. Examples of random events are: initiation of fire protection alarm, chemical reactor cooling system breakdown, slump at stock market.

Event is modeled as a change of the state of particular distinguished channel of an object. Object and its channels represent, in the objective area, expected fragments of reality. Every occurrence mechanisms can be either simple (e.g. the change of traffic lights) or extremely complex (e.g. slump at stock market).

In the presented approach object is represented with a collection of belonging channels (also known as outgoing channels), with the assumption that each belonging channel can be described with finite scope of its states. If in deliberations one would assume that a database file will be treated as a channel and its records as the allowable states of this channel, therefore the database file needs to be represented not by a record but rather by one of the finite number of classes that can include this record. The record cannot be interpreted as a channel state because one cannot effectively operate with all of its executions.

Including the record into one of the possible classes should always guarantee a synonymous answer (classes should be disjointed in the set of all possible executions of records and their number should be redefined).

Example of a single event is the change of the outgoing state in the object's channel (see Fig. 5) caused by the forcing operation performed by an object, to which the given channel belongs. Single event is always connected with the emerging of a new state from a particular scope of states for given channel. New channel state is started at the moment of the succession of the event.

Single event will be marked with the Z_i symbol and the event set as Z. Events form the Z set that happen successively create the event sequence.

At given moment of time the channel is able to remember only one state that belongs to the scope of allowable states of this channel.

Event marked with a single symbol Z_i is called an elementary event. Event marked with at least two symbols of elementary events, connected with an operation symbol indicating a connection between these events, is called a composed event.

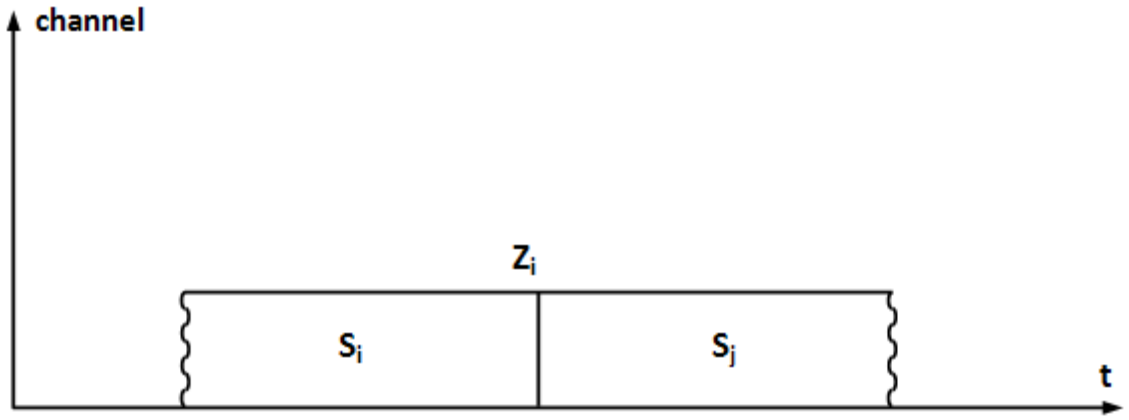

Figure 5. Event $\mathbf{Z_i}$ and $\mathbf{S_i}$, $\mathbf{S_j}$ states in the channel

In order to simplify the deliberations and recording the event symbols will also be interpreted as the symbols of the channel forced states. This assumption is based on the fact that with every event the channel creates a new state corresponding with this event. With this assumption the scope of channel states mutually synonymously responds to the scope of allowable events on given channel.

Two elementary events Z_i, Z_j will be called the alternative (disjunctive) events in case when one of the events excludes the happening of the second event. Alternative events will be connected with the disjunction operation symbol "$\vee$"in the form of the following expression:

$$Z_i \vee Z_j$$

or in the form of expression:

$$Z_1 \vee Z_2 \vee ... \vee Z_m$$

in case of m alternative events.

We assume that due to the assurance of the event operation correctness, the alternative events of given sequence of alternative events will always precede one event realized on channel other than the event belonging to the alternative events sequence.

Elementary events Z_i, Z_j will be called the synchronous events in case, when they happen in given time interval independent of each other so that none of the events is not an effect of another event. Synchronous events will be connected with the "#" synchronism operation symbol and recorded in the form of the following expression:

$$Z_1 \# Z_2$$

or in the form of expression:

$$Z_1 \# Z_2 \# ... \# Z_m$$

in case of m alternative events.

We assume that due to the assurance of the event operation correctness, the synchronous events of given sequence of events will always relate to the change of states taking place at different channels.

Sequences of synchronous events, similarly to the sequences of alternative events, always precede one event realized on channel other than the channels of alternative events sequences.

Synchronous events are also called as parallel or conjunctive.

Elementary events Z_i, Z_j will be called the series events in case, when the direct and necessary condition of Z_j event happening is the happening of the Z_i event. Event series will be connected with the "$\wedge$" synchronism operation symbol and recorded in the form of the following expression:

$$Z_i \wedge Z_j$$

or in the form of expression:

$$Z_1 \wedge Z_2 \wedge ... \wedge Z_m$$

in case of m alternative events.

We assume that due to the assurance of the event operation correctness, the event series of given sequence of events will always relate to the change of states taking place at different channels for any pair of the events form this sequence.

Elementary event Z_i will be called a cyclical (iterative) event in case, when it does not happen or happens creating a sequence of event series.

Cyclical events will be marked with the "*" cycle operation symbol and recorded in the following form:

$$Z_i^*$$

According to the definition of the cyclical event it is expressed as:

$$Z_i^* = Z_\phi \wedge Z_i \wedge Z_i \wedge ...$$

or in more detailed form

$$Z_i^* = Z_\phi \vee [\, Z_i \wedge Z_i^* \,]$$

where: Z_ϕ - empty (fictional) event.

According to the definition the cyclical event relates to the same channel.

Events created as a result of connection of events with elementary operations $\vee$, #, $\wedge$ and * are called regular events.

Brackets determine the sequence of the $\vee$, #, $\wedge$, * operation interpretation in composed events.

Operations $\vee$, #, $\wedge$, * on the Z event set determine the alternative ($\vee$), synchronous (#), series ($\wedge$) cyclical (*) event relations.

3 Examples of event sequences

Examples of compound events with short interpretation comment are presented below.

Example: $Z_1 \# [\, Z_2^* \wedge Z_3^* \,]$

Synchronous with Z_1 event two cyclical events are realized Z_2* and next (after finishing of Z_2*) event Z_3*.

Event graphs are the graphical interpretation of events and regular expressions. Fig. 6 presents the graph of events in a regular expression with the following form

Example:

$$[Z_1 \wedge [\,[\,[Z_2 \,\#\, [Z_3 \wedge Z_4]\,]\,] \vee [Z_5^* \,\#\, Z_6]\,]\,] \wedge Z_7] \vee Z_8^*$$

Arcs of the graph, with assigned synchronous events, are connected with the marking of an angle.

In order to assure the synonymous nature of the event graph interpretation in the Fig. 6 fictional (empty) events were introduced $Z_{\phi 1}$ - $Z_{\phi 4}$ in relation to the outgoing regular expression. Assurance of the synonymy of the symbolic recording interpretation with relation to the graph form is a necessary condition for the proper construction of process models.

It is important to mention that Z_2 and Z_4 events are not synchronous, similarly to Z_6 and $Z_{\phi 4}$ events. The following couples of events can be the $< Z_2, Z_3 >$ and $< Z_6, Z_{\phi 3} >$ couples.

Event graph vertexes shown in the Fig.6 connect the events not indicating the relations between them. In most cases these relations can be correctly interpreted with the analysis of the event graph, although this type of activity does not guarantee the synonymy in case of an attempt of defining the correctness of the event graph. For this purpose event dispersion and concentration constraints, for alternative and synchronous events, are laid upon the graph vertexes. As a result the graph vertexes are changed with dispersing and concentrating knots of alternative and synchronous events.

Series and cyclical events do not have to be distinguished in order to assure the synonymy of the event sequence interpretation. During the transformation of vertexes into knots, vertexes that connect more than one preceding event with following event are changed with two knots – first knot is concentrating and the second one is dispersing. One of the particular events of vertex transformation, connecting series events with cyclical events, into concentrating and alternative knots is presented in the Fig. 7.

Introduction of concentrating knot $V^{>}$ and dispersing $V^{<}$ led to the necessity of introduction of a fictional (empty) event Z_{ϕ}'. In this new situation the cyclical event Z_5* will be replaced with complex event $Z_{\phi}' \wedge (Z_5 \wedge Z_{\phi}')$*. It is easy to spot that both expressions are equivalent in relation to produced events:

Z_5* produces empty | Z_5 | $Z_5\, Z_5$ | $Z_5\, Z_5\, Z_5$ | $Z_5\, Z_5\, Z_5$ …

$Z_{\phi}' \wedge (Z_5 \wedge Z_{\phi}')$* produces empty | Z_5 | $Z_5\, Z_5$ | $Z_5\, Z_5\, Z_5$ | $Z_5\, Z_5\, Z_5$ …

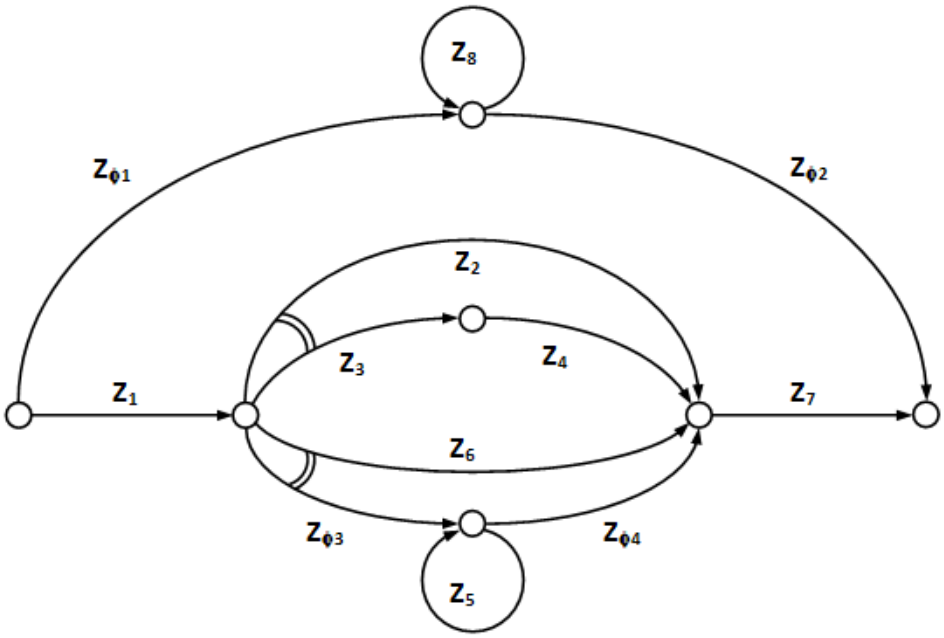

Figure 6. Event graph for regular expression

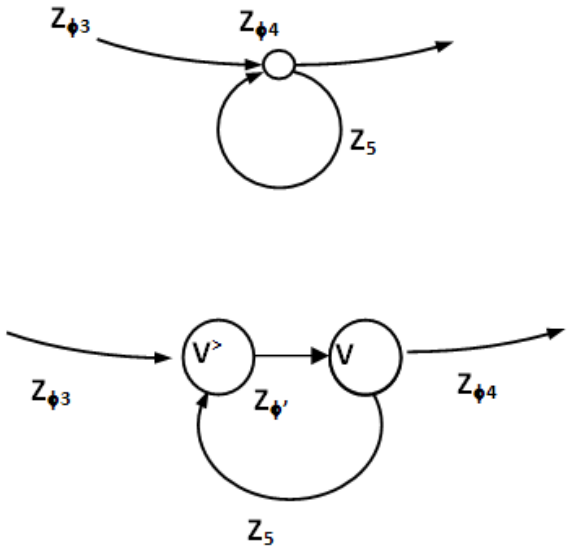

Figure 7. Transformation of vertex in to a concentrating knot

4 Event knots

Alternative dispersive event knot connects one and only one event preceding event with one of many other following alternative events (see Fig. 8). If only one event takes place one speaks of a pair of series events – in such case the symbol V is not used.

The condition of proper $V^{<}$, $V^{>}$ knot functioning is the assurance of alternative activities for both dispersion and concentration of events. In the second case the condition of Z_j event occurrence is the presence of one and only one event from the $Z_1, Z_2, \ldots, Z_m$ event set.

It is important to mention that only the $Z_1, Z_2, \ldots, Z_m$ events originating directly from the $V^{<}$ alternative connection are the alternative events.

Synchronous knot of dispersing events connects one and only one preceding event with many other synchronous events (see Fig. 9). If only one event takes place one speaks of a pair of series events – in such case the # symbol is not used.

Synchronous knot of concentrating events connects many synchronous events with one and only one following event. If the preceding event consists of only one event one speaks of a pair of series events – in such case the # symbol is not used.

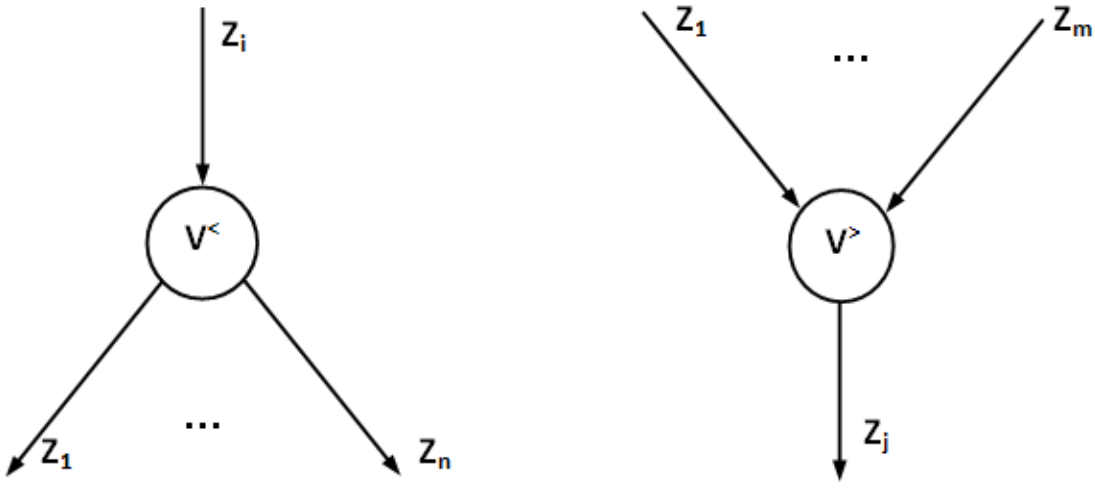

Figure 8. Dispersing and concentrating alternative event knots

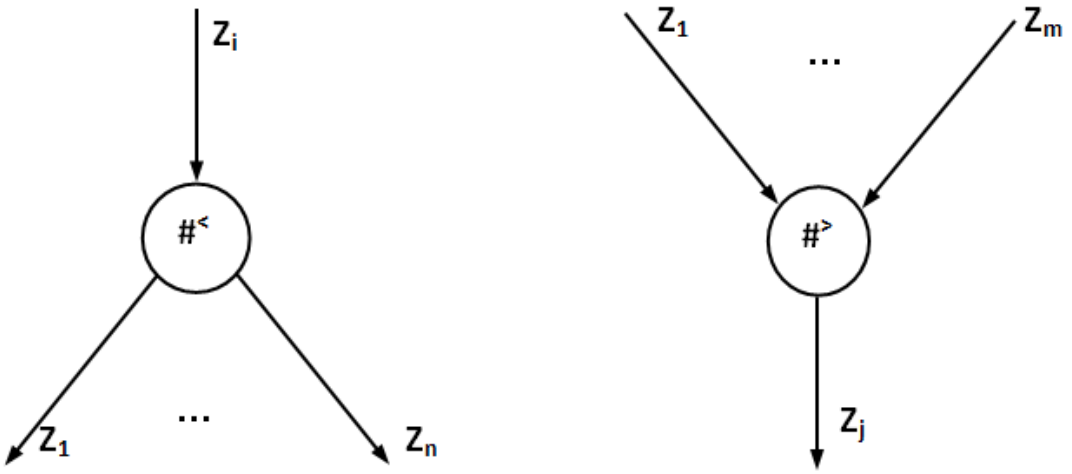

Figure 9. Synchronous knots of concentrating and dispersing events

The condition of proper $\#^{<}$, $\#^{>}$ knot functioning is the assurance of synchrony of activities for both dispersion and concentration of events. In the second case the condition of Z_j event occurrence is the presence of one and only one event from the $Z_1, Z_2, \ldots, Z_m$ event set.

It is important to mention that only the $Z_1, Z_2, \ldots, Z_m$ events originating directly from the $\#^{<}$ synchronous connection are the synchronous events.

5 Event sequences

Series event sequence takes place in a situation when the occurrence of following event is conditioned with the occurrence of preceding event. Fig. 10 presents a sequence of four events Z_a, Z_b, Z_c and Z_d that can be presented as symbols as follows:

$$Z_a \wedge Z_b \wedge Z_c \wedge Z_d$$

Z_d event happens only if it is preceded by the following Z_a, Z_b and Z_c events.

Alternative series event sequence takes place in a situation when after alternative event dispersing knot $V^{<}$ at least two sequences of series events occur.

Example of two alternative series event sequences can be recorded in the following way:

$$[\, Z_a \wedge Z_b \wedge Z_c \wedge Z_d \,] \vee [\, Z_e \wedge Z_f \wedge Z_g \wedge Z_h \,]$$

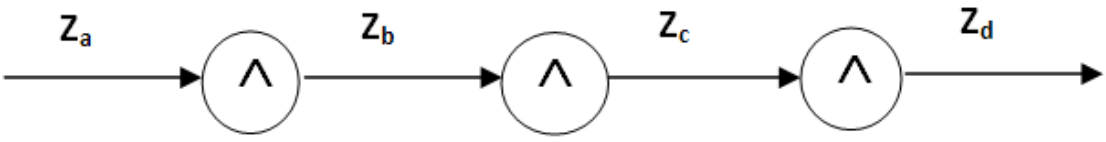

Figure 10. Example of series event sequence

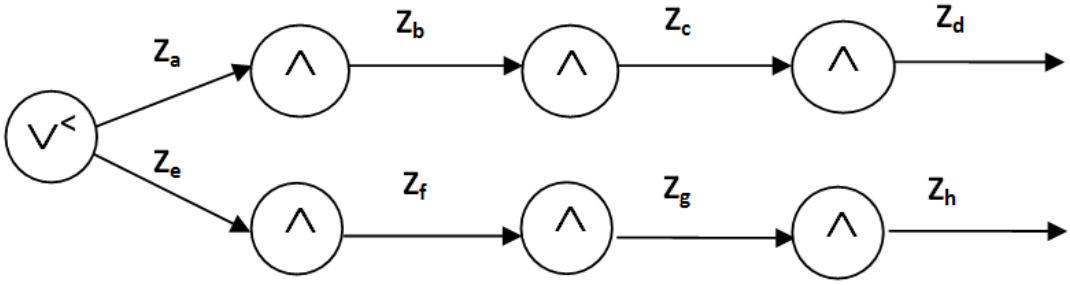

Figure 11. Example of alternative series event sequences

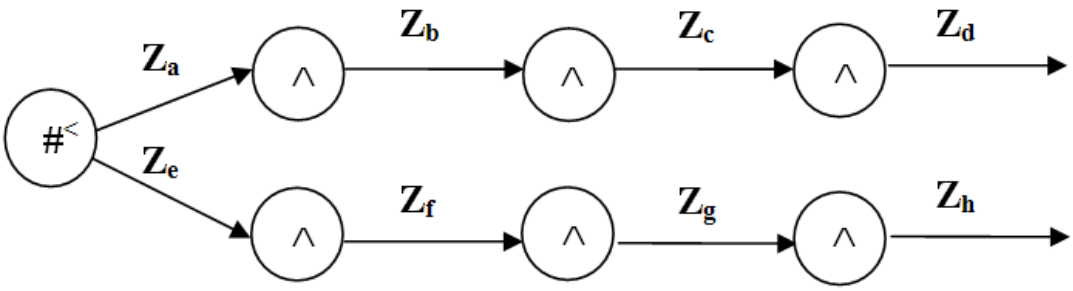

Figure12. Example of synchronous series event sequences

From both series sequences events from only one of them occur (see Fig. 11).

The condition of proper alternative series event sequences functioning is the assurance of alternativeness of activities for both dispersion and concentration of events. In the second case all alternative series event sequences should be ended with $V^{>}$ concentrating knot of alternative events.

Synchronous series event sequence takes place in a situation when after synchronous event dispersing knot $\#^{<}$ at least two sequences of series events occur. Example of two synchronous series event sequences can be recorded in the following way:

$$[\ Z_a \wedge Z_b \wedge Z_c \wedge Z_d\ ]\ \#\ [\ Z_e \wedge Z_f \wedge Z_g \wedge Z_h\ ]$$

From both series sequences events from both of them occur (see Fig. 12).

The condition of proper synchronous series event sequences functioning is the assurance of synchrony of activities for both dispersion and concentration of events. In the second case all synchronous series event sequences should be ended with $\#^{>}$ concentrating knot of synchronous events.

Cyclical event sequence takes place in a situation when performances of given series sequence, closed in (…)* brackets, are compliant with the definition of cyclical event presented above.

after alternative event dispersing knot $V^{<}$ at least two sequences of series events occur.

Figure 13 presents the example of cyclical event sequence recorded in the following way:

$$(\ Z_a \wedge Z_b \wedge Z_c\ )^*$$

possible executions of this sequence are:

Z_ϕ - empty event (lack of event)

$$Z_a \wedge Z_b \wedge Z_c$$

$$Z_a \wedge Z_b \wedge Z_c \wedge Z_a \wedge Z_b \wedge Z_c$$

$$Z_a \wedge Z_b \wedge Z_c \wedge Z_a \wedge Z_b \wedge Z_c \wedge Z_a \wedge Z_b \wedge Z_c$$

Similarly to the cyclical series events, alternative cyclical events are also possible:

$$(\ Z_1 \vee Z_2 \vee \ldots \vee Z_m\ )^*$$

and cyclical synchronous

$$(\ Z_1 \# Z_2 \# \ldots \# Z_m\ )^*$$

Their analysis and transformations are omitted in further deliberations. Detailed description of event operation properties is a part of event algebra.

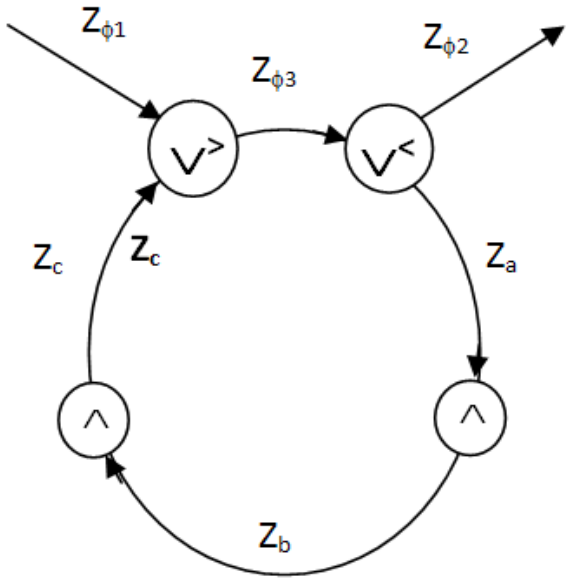

Figure 13. Example of cyclical event sequence

6 Event nets

Event net is constructed from:

- series event sequences,
- alternative series event sequences,
- synchronous series event sequences,
- cyclical event sequences.

Event net is a model of event processes. Its structure determines the execution of the processes, although the set of different process executions in case of cyclical events presence is theoretically a set of infinite size. All executions (processes) of the event net can be successfully presented if cyclical event sequences do not occur in the event net.

Event net is a model of event processes, which allows describing the processes that are correct from the point of view of their realization. Definition and the correctness conditions of event processes in each case should be specified in the categories that guarantee the verification (validation) of the correctness of their performance.

Figure 14 presents an example of event net with cyclical events sequences, alternative series event sequences and synchronous series event sequences, constructed on the basis of the regular expression event graph, presented in the Figure 6.

Processes in properly constructed event net (or in other words the executions in event net) should flow in a way that assures:

- possibility to perform every event and every event sequence in the net at least once,
- event net have one and only one distinguished starting event Z_A preceding the execution of all other events and one and only one finishing event Z_B that takes place after execution of all events that could be executed,
- starting event Z_A can be performed only in case when none of the other events in the net is not and cannot be executed in the net,
- finishing event Z_B in event net can only be executed as the last event process of this net.

Conclusions presented above indicate that event net can be deliberated in two following situations:

- net is not active – none of the events from the event net processes is executed and the net is waiting for the execution of the Z_A starting event,
- net is active - events from the event net processes are executed and the net is waiting for the execution of the Z_B finishing.

Event process is executed in the net through some of the cyclical event sequences and alternative series event sequences and within them through all areas of synchronous series event sequences.

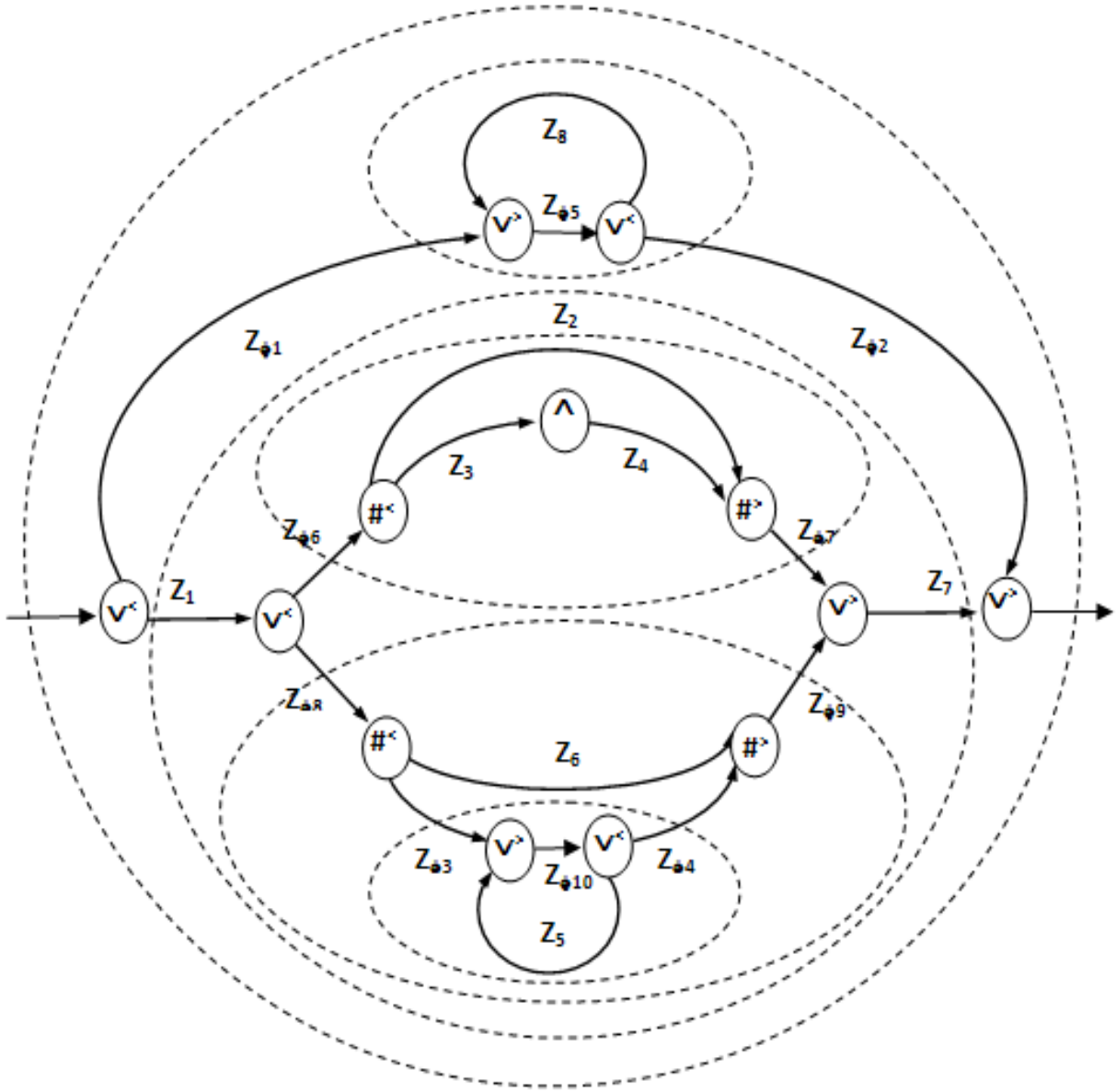

Figure 14. Example of event net

Event net area with one and only one distinguished starting event and one and only one distinguished finishing event will be called the event subnet.

The illustration of event subnet of the event net presented in the Fig. 14 is the fragments marked with the dotted line (all of six possible event subnets are presented in the figure).

Main feature of such defined event subnet is the fact that it represents one event that consists of many internal events of this subnet.

Correct event net is a structure in which other subnets can be presented in the form of a single event representing the whole outgoing net. This informal expression requires a more detailed description and comments on the possible net transformations.

Presented statement leads to the structural method of activity leading to the achievement of correct network.

Structural method of proper event net also assumes that:

- every process has one distinguished start and end,
- processes can cluster in self for any depth,

- processes in the same depth connect with knots (dispersing and concentrating) connecting their starts and ends in a way that indicates the character of the relations between processes.

7 Time lapse, conflicts and relations on event nets

Time lapse is an essential characteristic of all physical processes. Logical connections of the processes and secondly the time conditionings are present in many deliberations on process modeling.

It is necessary to determine the coordinates and time lapse units in order to observe the process flow in time (time clocks of the modeled system).

Time counting needs to consider the relations between time clocks in particular subnets in case of net decomposition into event subnet areas.

Time in event nets flows „in waiting" for the happening of next events. The assumption is that the time of the event, understood as the change of state, is negligible. Event net is a scheme according to which new events occur after given time.

Occurrence of events must synonymously relate to the net structure. Therefore the event net presented in Fig. 14 generates, for example, the following allowable event productions (sequences):

empty | Z_8 | Z_8 Z_8 | … | Z_1 [Z_3 Z_4] # [Z_2] Z_7 | …

Sequences of alternative series events should start and finish with dispersing and concentrating alternative knots. Proper structural rules need to be complied in order to assure these conditions during the construction of the net.

Rules result from relations, which can occur between any two events in the event net structure. Analysis of possible event relations indicates that if some of them occur in certain configurations with other relations, they can become the cause of erroneous event processes.

Alternative events, according to the definition (symbolic recording or event net), should not appear synchronously (e.g. at the same time) in alternative concentrating knots.

Synchronous conflict if alternative events should be prevented during the event net designing phase. Elimination of conflicts through tests can be extremely time-consuming and difficult, when the net has already been constructed.

Synchronous series event sequences should start and end with dispersing and concentrating synchronous knots.

According to the definition (symbolic or event net) synchronous events should not occur alternatively in synchronous concentrating knots.

Alternative conflict of synchronous events should be prevented during the event net designing phase. Elimination of conflicts through tests, similarly to previous case, can be extremely time-consuming and difficult, when the net has already been constructed.

Tolerating alternative conflicts of synchronous events leads to the "pursuit of events" what equals to the loss of consistency between net structure and its functioning (event net stops being the process model).

Connections consisting of events between any pair of events Z_k, Z_l in the net are called the event paths and marked as $Z_k \rightarrow Z_l$ or in a shorter form as $Z_k \rightarrow_l$, if a series of events leads from Z_k event to Z_l event.

If the path $Z_{k\rightarrow l}$ leads from event Z_k to event Z_l and the $Z_{l\rightarrow k}$ path leads form Z_l event to Z_k event than these paths create a cyclical path marked as $Z_{k\leftrightarrow l}$ for any Z_x, Z_y event pair on this path.

Two events Z_i, Z_j with a common starting or finishing knot in an event net with single distinguished starting event Z_A and single distinguished finishing event Z_B, where the events Z_i, $Z_j \neq Z_A$, Z_B, can create four special cases, of concentrating > and dispersing < knots and events related with them, in this net (see Fig. 15).

Presented examples of dispersing and concentrating knots are the starts and finishes of event paths leading to and from these events.

Any of two events in event net with single distinguished starting event Z_A and single distinguished finishing event Z_B, where the events Z_k, $Z_l \neq Z_A$, Z_B, create the upper U and lower L alternative D and synchronous C event relation classes.

These classes are marked as following:

- upper alternative UD,
- upper synchronous UC,
- lower alternative LD,
- lower synchronous LC.

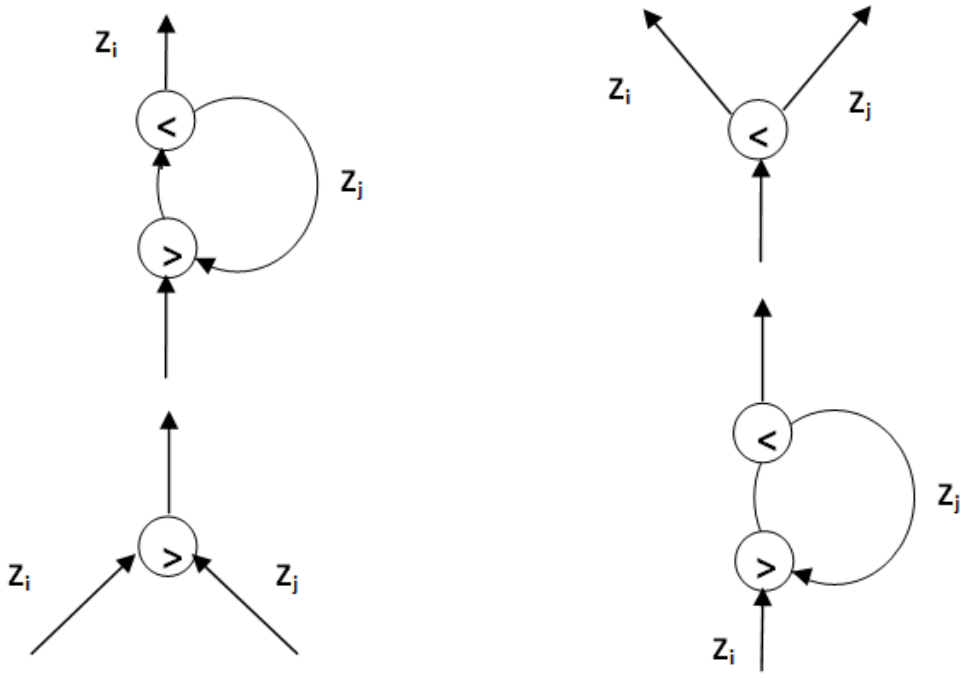

Figure 15. Four special cases, of concentrating > and dispersing < knots and events related with them

Two events Z_k, Z_l of event net, which do not belong to the same series event sequence, belong to the upper alternative UD if paths from at least one dispersing alternative knot lead to them.

Two events Z_k, Z_l of event net, which do not belong to the same series event sequence, belong to the upper synchronous UC if paths from at least one dispersing synchronous knot lead to them.

Two events Z_k, Z_l of event net, which do not belong to the same series event sequence, belong to the lower alternative LD if paths from at least one concentrating alternative knot lead to them.

Two events Z_k, Z_l of event net, which do not belong to the same series event sequence, belong to the lower synchronous LC if paths from at least one concentrating synchronous knot lead to them.

8 Forbidden and obligatory graph figures – structural conditions of event net correctness

Condition of event net structural correctness is the situation when any pair of events Z_k, Z_l of this net belongs at the same time to the upper alternative UD and lower alternative LD class or only to upper synchronous UC and lower synchronous LC.

Forbidden graph figures in the event net are the violation of structural correctness conditions of the event net.

Figure 16 presents two forbidden graph figures (non-allowable) for the correctly constructed event net, which includes alternative and synchronous events.

Obligatory graph figures of event nets are the realization of structural correctness conditions of the event net.

Fig. 17 presents two obligatory graph figures (necessary) for the correctly constructed event net, which includes alternative and synchronous events.

Presented analysis indicate that the correctness conditions of event nets can be formulated in many ways, although the determination of topological properties of the net and its possible subnets is always a starting point. These properties can be used as modeling and controlling tools of discrete processes.

In some cases (see 9) the forbidden graph figures, as illustrated in Fig. 18, can be highly severe limitation for the net.

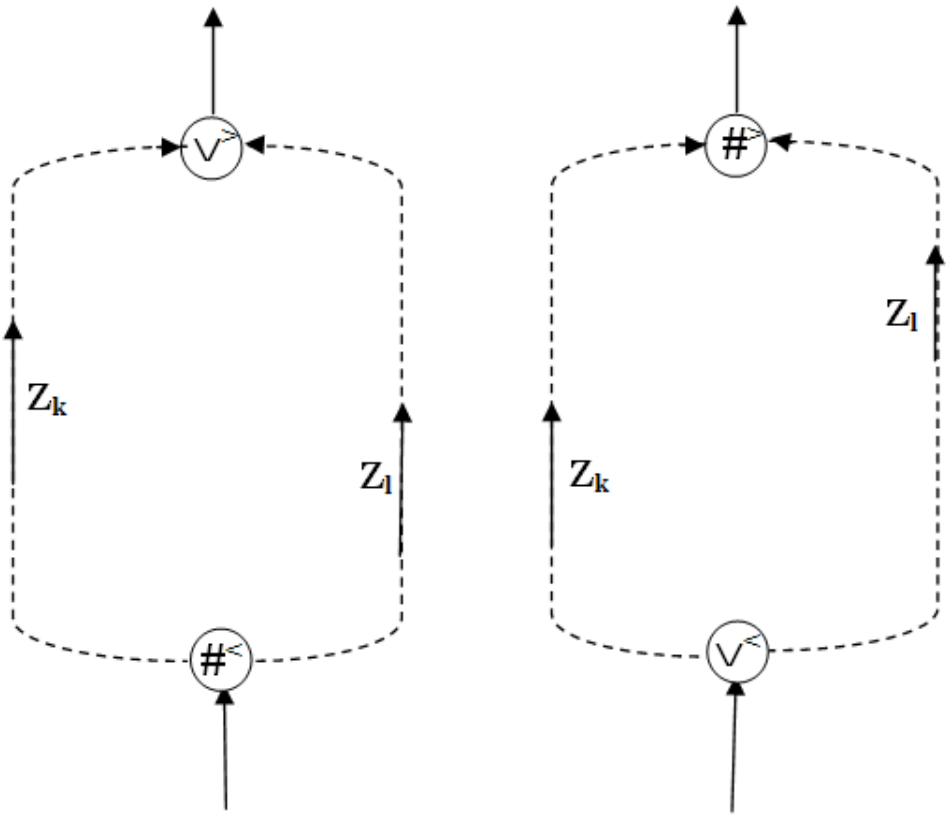

Figure 16. Forbidden graph figures in event net

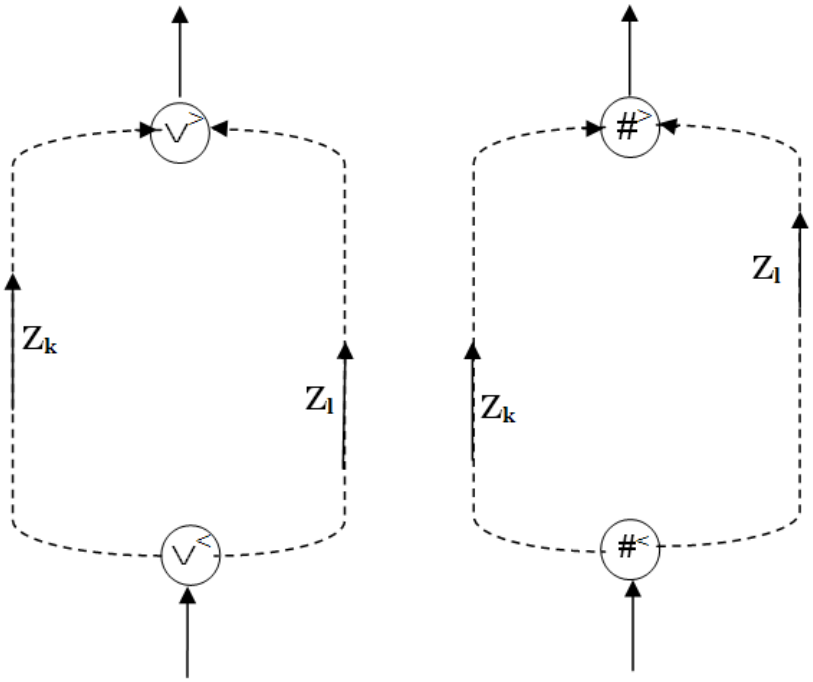

Figure 17. Obligatory graph figures in event net

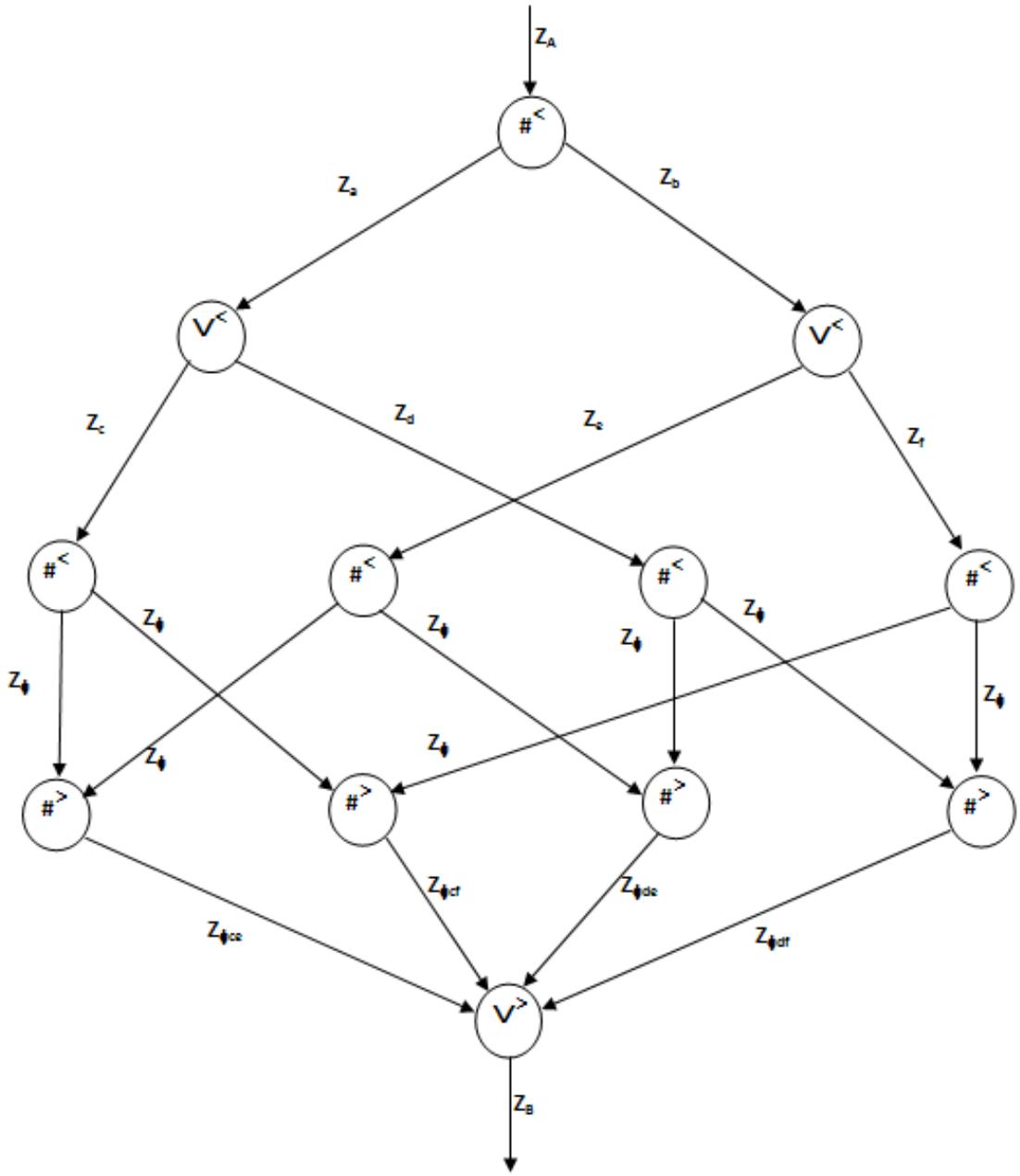

Figure 18. Example of event net that does not fulfill the correctness conditions expressed in the obligatory and forbidden graph figures

9 Continuations

It is easy to deduct that the net presented in Fig. 18 contains both obligatory and forbidden graph figures and according to p. 8 it does not fulfill the structural conditions of net correctness. Simultaneously detailed analysis of any of the four event pairs

$$< Z_c, Z_e >, \ < Z_c, Z_f >, < Z_d, Z_e >, < Z_d, Z_f >$$

indicates that it is manageable and therefore the Z_B finishing event is manageable. In this case we speak of four event pairs from which only one can be realized as a result of preceding synchronous execution of the two Z_a, Z_b events.

However, if the analyzed event net (see Fig. 18) does not structurally guarantee the execution of at least one of the listed event pairs, than the Z_B finishing event also would not be executed, what means the violation of net correctness conditions mentioned in point 8.

Presented abalysis indicates that the event net correctness conditions can be formulated in many ways, although the determination of topological properties of the net and its possible subnets is always a starting point. These properties can be used as modeling and tools of correct designing of organizational structure.

Research on discrete event nets have their obvious implications and modeling languages, such as Perti nets, transforming nets, event algebra and many more.

The key is to apply such local functional limitations, which fulfilled by the net would assure its global functioning correctness – independent of process flow conditions. In other words, event net is a program (space) of its work and the event flow process is the execution of this program – if one uses an IT metaphor. The main success condition is the theoretical event net correctness that does not have to be proven or validated through tests. In research on this phenomenon the technical feasibility of the event is not crucial for the deliberations.

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A CONCEPTUAL FRAMEWORK FOR FORMALIZATION OF NATIONAL INNOVATION SYSTEMS

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***Abstract*:** The concept of National Innovation System (NIS) is explored from the perspective of its propensity for formalization. It is observed that there are problems with formalization (measurement) of NIS and consequently, deficiency in assessment of efficiency of pro-innovative ventures. Based on an overview of the literature, subsystems of NIS are identified and the leading topics within these subsystems are presented. Results of this study are believed to create the platform for formalization of NIS.

***Key Words*:** National Innovation System, formalization, measurement, efficiency

1 Introduction

An increase in the level of innovativeness and enhancement of benefits from this activity are important ingredients in fostering economic activity and boosting competitive advantage. Innovation augments productivity, and thus contributes to the increase of GDP and wealth of the citizens (e.g. [28, 56]). The ability of governments, businesses and individuals to identify, respond to, and especially to introduce progressive change is the bedrock of competitive ability (e.g. [32, 9, 38, 52, 54, 16]). The more practitioners' perspective, taken at a micro-economic level, underlines continuous improvement in technology and business processes as vital to economic prosperity, thereby providing a strong incentive to invest in innovation [13, pp.133-140].

It should be noted though that innovation can be interpreted in different ways (e.g., [19, 50, 39, 41, 42, 44]). Further difficulties lie awaiting the researchers when they try to isolate means to stimulate creativity, as well as enhance innovativeness and entrepreneurship, along with attempting to improve economic performance of firms. And as if this is not enough, differences regarding interpretations are further amplified when micro and macro-economic perspectives are taken into account [45].

Innovativeness is not a new concept, yet issues of innovativeness are gaining more and more recognition. At the macro-economic level, innovation related efforts can be conceptualized within the concept of National Innovation Systems (NIS). There is no single definition of NIS [47][1]. Yet, NIS can be defined as "a network of agents and set policies and institutions that affect the introduction of technology that is new to economy" [11, p. 541].

Lundval [29] identifies two schools of thoughts in the literature about NIS. The first, prevalent mostly in the USA, tends to define innovation in a narrow sense by focusing on science and technology policy, and mostly analyzes the systemic relationships between R&D-efforts in firms and organizations. The other school of thought looks at innovation in a broader sense and defines innovation as a continuous cumulative process involving not only radical and incremental innovation, but also the diffusion, absorption and use of innovation, besides science.

Since its emergence as a topic in management literature in the late 1980s, the concept of NIS has undergone significant changes, and has been "further elabo-

[1] .. the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies. Freeman [20] claims: .... the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state. For Lundvall [29];... a set of institutions whose interactions determine the innovative performance ... of national firms. For Nelson [46]; .... the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country [51]; ... . that set of distinct institutions which jointly and individualy contribute to the development and diffusion of new technolgies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies [33].

rated and theoretically underpinned in the early 1990s" [8, p. 5]. At the outset NIS served to define the key players related to innovation process and the scope of their activities. Works by Nelson [46], Lundval [30], Dosi, et al. [12] and Freeman [21] have not used a standardized structure of presentation of NIS, and have dealt with many countries independently, without an attempt to make cross-country comparisons. Key characteristic features of innovation processes and items that impact upon these characteristics have been determined. One of the lines of thinking about NIS has been directed towards the exploration of efficiency of NIS using parametric concepts. It is quite probable that if there are more Inputs there will be more Outputs, and therefore those who invest heavily may be considered more innovative. However, not only is the level of investment the key to success: efficiency of turning Inputs into Outputs also count. Several studies on the efficiency of organizations use the "best practice frontier" concept: the distance from such a frontier represents inefficiency -- the inability to produce maximum output from given inputs. Parametric approaches (e.g., regression methods) are used to estimate parameters of technical efficiency. However, many elements, such as multicollinearity, measurement error, and omitted variables, can weaken the precision of these parameter estimates [10]. Consequently, it may be more appropriate to depart from a cursory examination of a ratio of Inputs to Outputs (e.g., [15, 55]), and examine "best practice frontiers" using the non-parametric DEA. This means that the measure of technical efficiency (the Farrell Input Saving Measure of Technical Efficiency) is examined as the greatest proportion of inputs which can be reduced and still produce the same output [17], [18]. Several papers have reported results related to the use of this approach (e.g., [35, 43, 36, 38, 23]). According to Balazat and Hanusch [7, pp. 202-203] this approach can be regarded a new line of investigation of NIS that originated with works of Nasierowski and Arcelus a decade ago.

NIS can also be regarded as a subsystem of the national economy where a variety of agencies cooperate, and impact one upon another when carrying innovative projects. Whereas descriptions of NIS are easily available, there is no uniformly accepted idea of how to isolate its subsystems. The questions of formalization of NIS and its subsystems, and interrelationships among these subsystems remains unanswered. These elements cannot be formalized and quantitatively examined. The same is true when the impact of the context of the operation upon the design of NIS is analyzed. The elements in thematic areas overlap, making reports on NIS, at times, redundant in terms of information content. Conclusions from such studies are difficult to quantify, as it is difficult to identify which solutions are correct, efficient and effective. All in all, the concept of NIS, albeit intellectually stimulating, remains as an abstract one and difficult to be interpreted from the perspective of daily operational activities. Thus, the objectives of this study is to explore the ability to 'formalize[2]' the selected aspects of NIS.

In this paper (i) an overview of the concepts with regard to formalizing NIS will be presented, followed by (ii) a specification of NIS subsystems and their key discussion topics, and (iii) a suggested agenda for further studies.

2 Formalization of NIS: Current stock of experience

A model for investigation of NIS, in a more formalized manner, has been introduced by OECD [47], [48][3], and thereafter by Arundel and Hollanders [3, pp. 10-25[4]], Lalkaka [25[5]), Liu and White [27[6]). Some leading policy themes have been identified, which can

[2] Identification of subsystems of NIS, leading topics (motives) within these subsystems, and interrelations among these topics, are an entry point to formalization (and measurement) of NIS.

[3] A new role of governments, building an innovation culture, enhancing technology diffusion, promoting networking and clustering, leveraging research and development, responding to globalization, learning from best practices (pp.63-68); and/or specialization in NIS, institutional profiles, linkages within and between NIS components (pp.21-48).

[4] This model includes: promotion of Intellectual property Rights (IPR), commercialization of public research, R&D and innovation, collaboration, finance, Human Resources (HR), targeted technologies, general policy.

[5] This model includes: S&T Policy, innovation strategy, technical human resources, technical support services, mobilizing financial resources, international cooperation (pp.2-3), as well as setting priorities and allocating resources, develop strategies for scientific research and technology development in public, university and corporate laboratories, build the technical HR for a knowledge society, strengthen the technical support systems for quality, information flaws and the common concerns of alleviating poverty, preserving the environment and defending the nation, a look outwards towards attracting investment and alliances.

[6] This model includes: research, production, end-use (customers of the product or process outputs), linkage, education.

be regarded as a starting point to identify subsystems of NIS, and consequently as an entry point in its formalization. Some ideas regarding NIS subsystems, or leading discussion topics in examination of NIC can also be derived from comprehensive reports e.g., EIS [15 – years 2002-2009[7]], trend Charts on innovation, OECD [48. pp. 10[8]], as well as the Global Competitiveness Index [22[9]].

Based on an overview of the above sources the following subsystems in NIS can be proposed:

- governance of NIS (GNIS),
- commercialization of research results (CRR),
- human capital development (HCD),
- support to innovativeness (SIN).

These topics are consistent with the Lisbon Strategy [26] that is endorsed as a guide to scientific development of the European Union. These topics can be further explored within the subsystems and discussion topics presented in the next section.

3 National Innovation Systems: Subsystems and discussion topics

3.1 Governance of NIS (GNIS)

Productivity increases, largely resulting from innovations, which contribute to improved competitiveness and enhanced distinctive competencies of enterprises, are the key driving forces in boosting economic progress and standard of living. Consequently, governments structure systems that foster innovativeness. The key themes (motives) within governance of NIS include:

- assumptions regarding innovation underpinnings; these items evolve around key strategic objectives, such as improvement of productivity and educational levels, improvement of competitiveness, defining areas of specialization and their coordination with the macro-economic agenda,
- institutions/agencies involved in innovations, their structure, relationships, and responsibilities: this set of topics discusses institutional arrangements behind pro-innovation activities; thus, governments set up institutions to deal with this issue, e.g., in the format of the Ministry of Economic Affairs, the Ministry of Education, Culture and Science, university systems, agencies, etc.; "Innovation performance depends not only on how specific actors perform, but on how they interact with one another as elements of an innovation system, at local, national, and international levels" [48, pp. 10],
- control mechanisms regarding efficiency of innovation systems, its agencies and policies that may improve innovativeness levels,
- promotion of innovation friendly environment, that deals with the atmosphere within which innovations evolve; this atmosphere can be impacted by governments through free flow of information, easy access to ICT, efficient protection of intellectual property rights (IPR) (patents, trade-marks, copy-rights, etc.), simplifications in conditions of running business, and anti-monopolistic regulations.

3.2 Commercialization of research results (CRR)

The commercialization of research results means taking innovations from paper to realty. Whether for improvement of economy, monetary, social, or environment benefits, commercialization involves putting innovations into actual use. Research into innovative products, services and ideas is abundant, but without their application and effective use, these ideas account for nothing. Karlsson [24, pp. 83-85] claims that the following are of key importance: availability of private capital, ownership of research results, entrepreneurial skills, small business involvement, governmental programs, and commercialization drive at universities.

The commercialization of research is paramount to the idea of NIS, and essential to any economy's ability to compete globally.

[7] In EIS 2009 the following indicators have been used: human resources, finance and support, firm investments, linkages and entrepreneurship, throughputs, innovators, economic effects.

[8] This report has emphasized: stable macroeconomic environment, a supportive tax and regulatory environment, appropriate infrastructure and education and training policies, removal of barriers to innovation in the business sector and increase in synergies between public and private investment in innovation.

[9] The key groups of indicators used are: institutions and policies, human capacity, infrastructure, technological sophistication, business markets and capital, knowledge, competitiveness, and wealth.

The following key topics can be discussed within this subsystem:

- Collaboration (networking) between governmental institutions, research institutes and laboratories, universities and business (private sector and entrepreneurs), including issues of public vs private research. There are many players in a NIS, and unless they cooperate, no one wins. All the participants bring different assets to the table: governments - have capital; research institutions and universities - have knowledge; research - findings and people ready to work towards innovation; while businesses and entrepreneurs - have the ideas. Without the interaction and cooperation of all the involved parties, innovative ideas go nowhere. Whereas R&D mainly means inventions, business R&D means the ability to develop business practices that allow innovation to be more easily commercialized. Thus, the link between public and business types of involvement, and collaborative links between such institutions that deal with the flow of money should be explored.
- Encouraging technology and knowledge transfer to firms, and the development of innovation clusters. In order to see innovations become successful, businesses and entrepreneurs need access to information, technology, legal services, etc. As well, there is normally the need for the private capital to support innovative ventures, and the clarification of ownership rights (e.g., Baye-Doyle Act). Involvement of SME and development of entrepreneurial skills are desirable (e.g., [24, pp. 83-85]. This is critical for innovations to reach the application stage.
- Support to targeted technologies and specialization patterns: this sub-topic emphasizes the need to focus strengths on what a country does best, or what it believes will bring successes. Similarly, some claim that investment in lagging areas is likely to be more efficient [53]. Innovation should be efficient and effective, and for a country with an existing competitive edge, applying innovations in areas that are weak vs. strong could mean the difference between a lagging economy and a real competitive advantage.

3.3 Human capital development (HCD)

Human Resources within the NIS context may be defined as individuals and their groups, mainly in the work-force, who have direct or indirect impact upon innovativeness. These individuals are not limited to scientists, engineers, and technologists, but also include, administrators and support staff, who facilitate innovation process. Issues of HR within NIS context also include regulations and policies that impact upon attitudes, knowledge and skills of people, and their availability for economic activities:

- investment in the quality of human resources for innovation: this sub-topic is crucial because without quality human resources it is not possible to move forward with innovations; to this end it is important to identify means used to enhance capabilities of people,
- efforts to increase the number of people in science, engineering and technology (SET) areas: SET is pivotal to innovations, and there is an anticipated shortage of people entering these fields; within this sub-section aspects related to the number of graduates entering SET careers, expenditures on education, education standards (as measured by achievements in mathematics, for example) can be explored from the viewpoint of NIS policies and activities,
- job creation, retention, and reducing unemployment: this topic explores actions taken by governments and companies that allow efficient use of available human capital,
- means to improve labor productivity issues that deal with the activities which may contribute to the increase of labor productivity, which is normally positively correlated with improvement of quality of outputs, and enhancement of innovativeness.

3.4 Support to Innovativeness (SIN)

Financing innovation is about putting in place programs, funds, and tools that allow the stimulation of innovation. This is done in many ways: direct financing, support of governmental research institutes, grants, access to research infrastructure, and institutionalizing policies that allow innovation to flourish. The following topics are here frequently discussed:

- direct support to innovativeness, such as: grants, loans, direct support to finance R&D and no-R&D innovations, tax reductions for pro-innovative projects, subsidies for buildings/infrastructure for innovation activities, subsidies for acquiring machinery, equipment, software, funding R&D, tax

reductions for innovation expenditures other than R&D [3, 4, pp. 27],

- indirect support to innovativeness in the form of: trade fairs, trade missions, information on market needs, training, seminars, legislative arrangements, support to the development of research infrastructure (including ICT), innovation and science parks, technology incubators, information and research infrastructure, creating motivation and incentives for businesses, supply of PhDs in SET, support to new-technology-based-firms, regulations regarding ownership of proprietary rights, simplification of access to private (venture) capital, etc.; these items are crucial, because without ideas, money and innovations the economy cannot become competitive,
- accounting and legal practices that stimulate/hamper innovativeness; to be noted beyond an inflow of funds that support innovative activities, such activities can be stimulated (or confined) by non-financial arrangements; this deal for example with accounting rules that may classify an activity as R&D.

4 Concluding remarks and suggestions for future

Defining NIS

As discussed in this paper, there seems to be no consensus among experts as to what exactly NIS means. Researchers should attempt to arrive at an acceptable definition of NIS that would allow the measurement of NIS related variables. Results of literature analysis related to innovations persistently suggest that even though discussion is about similar phenomena, there is a gap between assessment of innovativeness from the viewpoint of macro-economic indicators (as expressed, for example, by the European Innovation Scoreboard) [55], with perceptions of entrepreneurs that resort themselves to a micro-economic perspective [13]. Concerns related to the differences may be summarized as in Table 1.

Composite indexes of innovativeness and NIS subsystems

Once semantic dilemmas associated with innovations are resolved, questions of measurement of NIS can be explored more in detail. Questions in this area deal with the identification of indicators that indeed are oriented on innovativeness (not necessarily inventiveness), determinants of innovativeness, and thus can serve as a policy setting aid. There is a need to identify composite indexes that reflect the level of innovativeness, and as well can be used to control the level of achievement of objectives related to technological progress. Such an index should be user friendly, universal, rooted in easily available (and quantifiable) data series, prone to be used as policy making guidance and comprehensive composite indexes of the level of innovativeness. A validation of such an index can be done through comparison of its rankings of countries to those produced by other composite indexes.

To be noted, there is a host of indexes that pretend to 'measure' selected aspects of NIS, as well as a variety of composite indexes that measure/rank countries with respect to innovativeness levels (or can be considered as a proxy of innovativeness) [42, 1, 2, 34].

Table 1. Differences between 'macro' and 'micro' perspectives to innovativeness
(source: [41, 44, 45])

MACRO PERSPECTIVE	MICRO PERSPECTIVE
inventions (exploration)	innovations (exploitation) [31]
composite indexes	fragmented questionnaire studies with little chance to find an unifying pattern
government, theory efficiency	SME, practice, effectiveness
correctness (political, legal)	profit, risk reduction, competitive position
laboratories, research centers	technology incubators, daily practice
grants, formal contracts	loans
formal training programs	informal business meetings
setting rules and standards	adopting to conditions
WHAT DO COMPANIES WANT?	WHAT CAN GOVERNMENTS OFFER?

To be noted, however, definitions do not bring clarity, formalization, and later on measurement of aspects of these constructs is hard to accomplish, and concurrently, it is unpractical to the independent, isolated researcher to propose his own interpretations. It may be suggested to draw from the stock of existing knowledge, select one set of solutions, and then follow them consistently through the study.

Efficiency

Once means to quantify aspects of NIS are determined, concerns of the evaluation of efficiency can be addressed. Identification of efficiency of innovation policies used in different countries (here: efficiency of turning inputs into outputs) can be achieved, for example, using "Farrell Input-Saving Measure of Technical Efficiency" and the DEA method. Based on an assessment of efficiency, the key points for policies oriented on enhancing innovativeness can be established. These key points, along with the results of analysis of detailed innovation policies, may lead to the identification of "best practice frontier innovations" (BPFI) applicable to the specific context.

Longitudinal studies

Once the means to quantify aspects of NIS are determined, some stability while measuring innovativeness can be achieved. Then, longitudinal studies may be undertaken to cross-validate the assessment of accuracy of procedures and policies. It is important to remember, however, that some leading indexes of innovativeness change their selection of indicators. Thus, the research problem will also rest with the identification of results produced by adopted policies, irrespective of indicators used in the index. Certainly the problem of isolating results of these approaches from market forces, for example, will remain complex to be resolved. As well, it will be interesting to explain whether countries and companies are innovative because they are rich, or is it vice-versa, and countries and companies with wealth are, as a proverbial consequence, innovative?

Agenda for future research

The advancement in finding clarity in the above specified areas will have several managerial and scholarly implications. Despite growing integration through the European Union (EU), considerable differences do exist between European countries with respect innovation 'philosophy' and the role of governments in fostering a supportive environment.

The way R&D is allocated in different countries also sheds light on priorities of governments and may require different managerial approaches (note: the EIS, for example, takes an implicit assumption regarding uniformity of NIS policies). Future researchers of the topic should also look at emerging economic superpowers such as China and India - the concentration on diffusion of knowledge, instead of for knowledge creation, may be an idea to consider. Issues of NIS formalization (as presented in this paper) may serve as an outline for further studies, fragmented to distinct sub-systems and topics. However, exploration of these topics cumulatively may contribute to the clarification of issues if innovation principles, and the key role of NIS.

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