

Research on Intelligence of Medium Sized Enterprises

Stefan Trzcielinski

Poznan University of Technology, Poznan, Poland

Abstract--At the end of the nineties of the 20th century the concept of intelligent organization was introduced to the theory of management as a result of the development of the concept of a learning organization. Numerous studies confirm that improving the intelligence organizations can be achieved when an organization has the ability to learn quickly and accurately. The ability to learn is necessary condition of intelligence of organization.

The company that accumulates knowledge is a learning organization. If, however, it is able to use the resource, which knowledge is, for its own benefit and intentionally develop it to suit the ongoing and anticipated changes in the environment, then it is an intelligent organization.

In this paper the result of investigation on the relationship between Knowledge Based Economy (KBE) and changes of enterprises' intelligence is presented. To identify the relationship the Knowledge Based Methodology (KAM) was used to assess the changes occurring in the environment. They were treated as independent variables. Next, using a questioner, the changes of intelligence of enterprises were identified. The changes were interpreted as dependent variables. The correlation between independent and dependent variables has shown that Polish medium sized enterprises improved their intelligence however the improvement was disproportional to the development of KBE. In this paper the drivers and barriers of the development of intelligence are presented.

I. INTRODUCTION

Learning, intelligence and knowledge are the words around which such concepts of management like learning organization, intelligent organization and knowledge management have been developed. Historically, the earliest one that was introduced to management theory was the concept of a learning organization. It happened mainly due to Peter Senge, who popularized this problem in 1990.

The competence of the organization comes from its participants so their learning and the pursuit of excellence

(personal mastery) is a prerequisite for organizational learning. In the process of individual learning an important role is played by the mental models that are assumptions about the reality. They are shaped by the reality but on the other hand influence the way of perception of the reality. They have an active character what means that polarize the action of human being. Because people are guided by different mental models, their action in the same situation is also different. If the mental models adequately reproduce reality, their action is correct. If, however, are not adequate, then their awareness becomes critical because mental models that are not realized cannot be changed and remain constant, which in turn leads to an increase in inadequacy in relation to the changing reality (Fig. 1).

The factor that directs the effort and the development of the members of the organization on its learning is a shared vision. The vision of the organization must consist of the visions of its participants, because only they motivate people to action. The inspiration for its construction may have come from senior management of the company, who must convince to own vision the members of the organization. In this regard, it is necessary openness to the views of others, listening to other people's arguments and refrain from own assessments. On the other hand, however, discussion and presentation of own views are needed with the intention to create a basis to take the necessary decisions. The process of discussion and exchange of views leads to learning of teams, and thus the entire organization. At the same time it is important to think with "big wholes" that is system thinking, focusing on processes rather than on individual events and expressing functioning of the organization in terms of the relationships between its members and teams and so in terms of shared responsibility for the problems it faces and which need to be resolved [10].

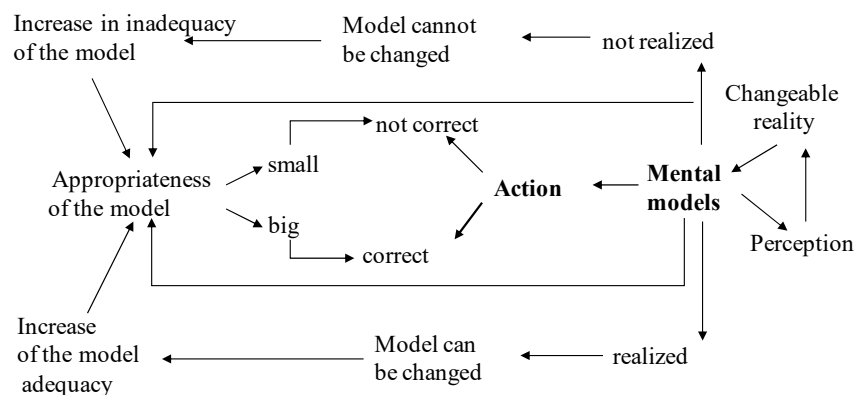


Figure 1. Mental model and appropriateness of human being action
Source: own work

At the end of the nineties of the 20th century the concept of intelligent organization was introduced to the theory of management as a result of the development of the concept of a learning organization. As stated by March [6] numerous studies confirm that improving the intelligence organizations can be achieved when an organization has the capabilities to learn quickly and precisely. Organizations depend on people for sustaining their knowledge level. Since knowledge systems increase the professional performance of individuals, the individuals become prepared to create and embed knowledge in the organization. Individuals must participate actively in several learning processes in order to require the requisite knowledge to perform tasks [2]. There are also another views on what create organizational intelligence. E.g. Dove [4] states that enterprise intelligence is a result of the way the enterprise is built and operated. It is wired into the fundamental structure and fabric of the enterprise. It is neither the result of a management team's annual strategic whimsy, nor the collective talent of a group of employees, but rather a phenomenon that emerges by design. There is little human choice in the matter. A higher order of systemic design reigns.

In our research both views have been implemented to investigate the enterprises' intelligence.

The ability to learn is necessary condition of intelligence of organization. Learning by the organization depends on the memory of the participants as well as its own memory. This memory consists of operating rules, procedures, technologies, beliefs and organizational culture in which the experience of the organization is preserved [6]. The information which in the learning process are retained in the beliefs and attitudes of the people Nonaka and Takeuchi [8] call knowledge. They distinguish between tacit and explicit knowledge. Tacit knowledge is personal, context-specific, and therefore hard to formalize and communicate. In contrast, explicit knowledge is codified and is transmittable in formal, systematic language, expressed in words, numbers, scientific formulas, procedures and rules. Both categories can be a source of knowledge creation within each of them. The creation and transfer of knowledge within the category of tacit knowledge takes place in the social process of sharing experiences (socialization). In contrast, the conversion of tacit knowledge into explicit occurs in the process of externalization in which the tacit knowledge takes the shapes of metaphors, analogies, concepts, hypotheses or models. Creating knowledge within the category of explicit knowledge happens as a result of combination understood as reconfiguration, sorting, adding, combining, categorizing and connecting existing information, with use of means such as documents, meetings, telephone calls and computer networks. In contrast, the conversion of explicit knowledge in tacit (internalization) occurs through sharing of common mental models, which is supported by documentation or verbalization of knowledge [8].

The enterprise that accumulates knowledge is a learning organization. If, however, it is able to use the resource, which knowledge is, for its own benefit and intentionally develop it

to suit the ongoing and anticipated changes in the environment, then it is an intelligent organization. The ability of the enterprise to understand the situation and give proper response to them, it is mobilize adequate resources, as well as to develop these resources, whether in order to eliminate or weaken the negative impact of these situations (threads), whether to use the opportunities, is called his intelligence. For this purpose, an intelligent enterprise can use physical, financial, human and knowledge resources.

There are many reasons why people want to be more intelligent, but their synthesis can be come down to the fact that a higher level of intelligence allows you to be more effective in new situations. The same effect concerns the intelligence of enterprise. Such enterprise is capable of achieving success, because it decides how to use abilities and possesses the capacity to adapt to new conditions, create and implement bold solutions, ongoing analysis of the internal and external situation, and correct errors and shortcomings.

The key components of a knowledge economy include a greater reliance on intellectual capabilities than on physical inputs or natural resources, combined with efforts to integrate improvements in every stage of the production process, from the R&D lab to the factory floor to the interface with customers [9]. Improvement of conditions for enforcing intellectual property of enterprises is one of goals of development of economy based on knowledge and innovation that is a part of Europe 2020 strategy [5].

To check if the goal is being achieved the research was undertaken if intelligence of enterprises follows the development of Knowledge Based Economy. The emphasis was shift on organizational drivers and barriers of the process. That was because introducing a novel technology without appropriate organizational changes can lead to significant productivity losses, as any benefits of the new technology are offset by negative interactions with existing organizational practices [9].

There are a little studies how changing knowledge environment is used by enterprises to improve their intelligence and therefore the creativity and innovativeness. They rather concern: what skill sets would be most valuable in terms of competitive advantage in the year 2020, importance of knowledge management to the knowledge economy and to productivity growth [1], identification and analysis of factors motivating and constraining knowledge creation and sharing in organizational [3].

This paper presents original findings concerning adaptation of intelligence of Polish medium sized enterprises to the changes of Knowledge-Based Economy in the period from 2007 to 2011. The concern is only about medium sized enterprises. Some aggregated data through small, medium and big sized enterprises concerning their:

- flexibility are available in Trzcielinski [11],
- agility are presented in Trzcielinski [12], Wlodarkiewicz-Klimek [15],
- intelligence can be found in Trzcielinski [13].

II. METHODOLOGY OF RESEARCH ON ADJUSTMENT OF ENTERPRISES TO THE KNOWLEDGE BASED ECONOMY

A. General approach to the research

The methodology of the research includes three main steps (Fig. 2):

- 1) identification and measuring the Knowledge-Based Economy factors that refer to the intelligence of the enterprises,
- 2) identification and measuring the factors that describe the intelligence of the enterprises,
- 3) correlation between KBE and enterprise factors that concern its intelligence.

B. Methods of research on changes in the business environment

The study of changes in the business environment was conducted with use of KAM methodology (Knowledge Assessment Methodology) that was elaborated to assess changes in individual economies (countries), in the process of transition to a Knowledge-Based Economy (KBE). The KAM methodology uses 148 indicators which are ultimately aggregated in four KBE pillars [7]:

- Economic Incentive and Institutional Regime,
- Education and Training,
- Information and Communications Technologies (ICT) Infrastructure,

• Innovation and Technological Adoption

These four pillars of the knowledge-based economy led to the formulation of their counterparts in enterprises. These equivalents are defined as: strategy of business agility, human capital of enterprise, information and communications technologies, changes of organizational structures (as a result of organizational innovation) and have become the research areas of changes taking place in enterprises. As a result of qualitative analysis carried out from the view point of relations with the research areas of changes taking place in enterprises, from a list of 148 KAM indicators 53 indicators have been selected, which are treated as independent variables of the first level of complexity (IV-1) (Table 1). The values of these indicators for Polish economy came from the official statistics, among others: the World Bank, OECD, UNDP Human Development Report, IMF, UNCTAD and UNESCO.

For the purpose of examining the relationship of the specific area of changes taking place in the enterprise, selected IV-1 have been aggregated into second level independent variables (IV-2). Aggregation was done by clustering the variables with use of Manhattan Distance Metric method offered in frame of the Statistica software. Aggregation was conducted to determine on the higher level of synthesis the relationships between independent variables and changes in the enterprises, treated as dependent variables [13].

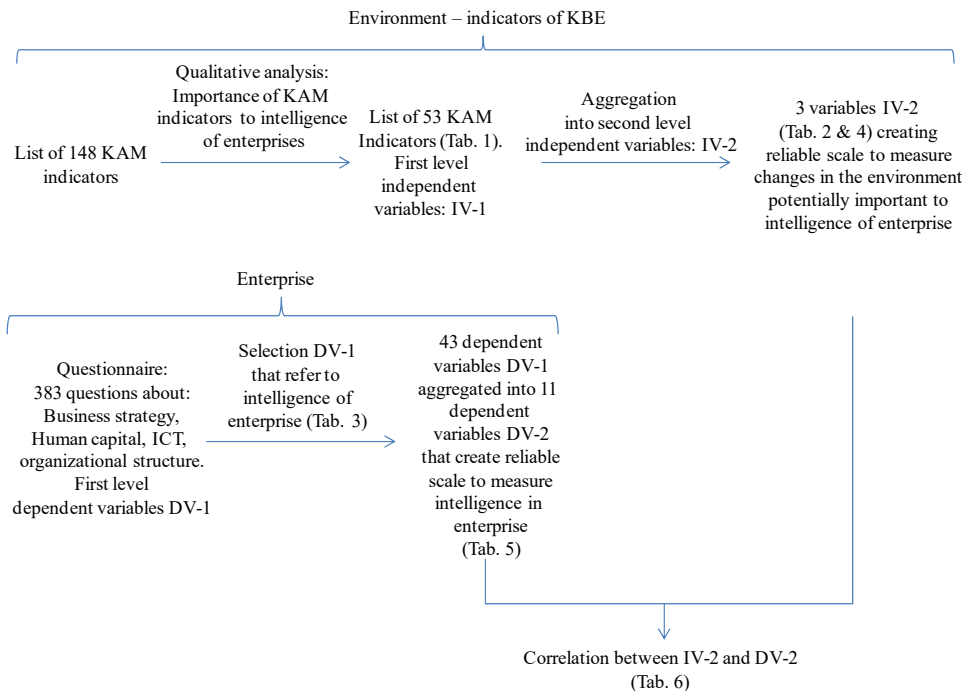


Figure 2. General scheme of the research
Source: own work

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

TABLE 1. KAM VARIABLES SELECTED ACCORDING TO THEIR INFLUENCE ON FEATURES OF ENTERPRISE AGILITY

Knowledge Assessment Methodology (KAM)				Knowledge Assessment Methodology (KAM)			
KAM areas	No. In KAM	Independent Variables	Feature of Agility B,F,I,S	KAM areas	No. In KAM	Independent Variables	Feature of Agility B,F,I,S
1	2	3	4	5	6	7	8
Overall Performance of the Economy	1	Average Annual Gross Domestic Product (GDP) Growth	E	The Innovation System	48	Private Sector Spending on R&D (1-7)	B, I
	2	Gross Domestic Product (GDP) Per Capita	E		49	Firm-Level Technology Absorption (1-7)	F, S
	4	Human Development Index (HDI)	I		50	Value Chain Breadth (1-7)	B
The Economic Regime	9	Gross Capital Formation as % of GDP (Average)	E	51	Capital Goods Gross Imports (% of GDP)	B	
	10	Trade as % of GDP (DDP)	B	52	Capital Goods Gross Exports (% of GDP)	S	
	13	Exports of Goods and Services as % of GDP, (DDP)	B	55	Intellectual Property Protection (1-7)	I	
	15	Intensity of Local Competition (1-7)	S	56	Adult Literacy Rate (% age 15 and above)	I	
	17	Cost to Register a Business (% of GNI per capita)	B	59	Secondary Enrollment (% gross)	I	
The Innovation System	18	Days Required to Start a Business	B	Education	60	Tertiary Enrollment (% gross)	I
	27	FDI Outflows as % of GDP, (average)	B		61	Life Expectancy at Birth (DDP)	F
	28	FDI Inflows as % of GDP, (average)	B		62	Internet Access in Schools (1-7)	B, I
	29	Royalty and License Fees Payments, (US\$ millions), (DDP)	B		63	Public Spending on Education as % of GDP, (DDP)	I
	30	Royalty and License Fees Payments (US\$ millions) Per Million Population, (DDP)	B		Labor	80	Unemployment Rate (% of total labor force)
	31	Royalty and License Fees Receipts (US\$ millions), (DDP)	B	86		Extent of Staff Training (1-7)	I
	32	Royalty and License Fees Receipts (US\$ millions) Per Million Population, (DDP)	B	88		Cooperation in labor-employer relations (1-7)	S
	33	Royalty and License Fees Payments and Receipts (US\$ millions)	B	90		Pay and productivity (1-7)	F, S
	34	Royalty and License Fees Payments and Receipts (US\$ millions) Per Million Population	B	91	Reliance on professional management (1-7)	I	
	37	Researchers in R&D	B, I	92	Local availability of specialized research and training services (1-7)	I	
	38	Researchers in R&D Per Million Population	B, I	Information and Communication Technology	137	Telephones Per 1,000 People	B, I
	39	Total Expenditure for R&D as % of GDP	B		138	Telephone Mainlines Per 1,000 People	B, I
	41	University-Company Research Collaboration (1-7)	B		139	Mobile Phones Per 1,000 People	B, I
	42	Scientific and Technical Journal Articles, (DDP)	I		143	International Internet Bandwidth (bits per person)	B, I
	43	Scientific and Technical Journal Articles Per Million Population, (DDP)	I		144	Internet Users Per 1,000 people	B, I
	44	Availability of Venture Capital (1-7)	F, S		145	Fixed broadband internet access tariff (US\$ per month)	B
	45	Patent Applications Granted by the USPTO	I	147	Government Online Service Index	B, I	
46	Patent Applications Granted by the USPTO Per Million People	I	148	ICT Expenditure as % of GDP	I		
47	High-Tech Exports as % of Manufactured Exports, 2009 (DDP)	B, I					

Symbols in column 4 and 8 refer to features of enterprise agility that are B – Brightness, F – flexibility, I – Intelligence, S – Shrewdness.

Source: Own work

C. Methods of research on changes in the enterprises

In order to identify changes that have occurred in enterprises, a standardized interview questionnaire has been developed containing 383 questions, ordered in four research areas, namely: strategy of business agility, human capital of enterprise, information and communications technologies, changes of organizational structures. The study was conducted in 2012 in 150 enterprises throughout Poland, including 45 large, 60 medium and 45 small enterprises. The period of observation of the changes has covered years from 2007 to 2011. The adoption of the five-year period was dictated by the desire to obtain reliable data from respondents, who were the chief executives or business owners. It was assumed that the five-year period enables reliable data reconstruction. The questions in the questioner have been treated as first level dependent variables (DV-1). These variables were aggregated into second and third level dependent variables (DV-2, DV-3). Grouping has been done by clustering the variables with use of Manhattan Distance Metric method offered in frame of the Statistica software. The aggregation was carried out to enable the identification

of relations between the independent and dependent variables on higher level of synthesis [13].

D. Methods of research on agility of enterprises in KBE

Agile enterprise is one that is able to identify and use of market opportunities arising in the changing environment. Agility of enterprise consists of the following attributes [14]:

- Brightness - the ability to identify market opportunities,
- Flexibility - the feature of resources, which allows the enterprise to use a wider repertoire of opportunities, thus offering a wider range of products, services or projects,
- Intelligence - the ability to learn and self-improvement,
- Shrewdness - the ability to adapt to changes in the environment, impact on the environment or change the business environment.

In order to analyze the relationships that exist between the changes that have occurred in the environment and in enterprises in the period from 2007 to 2011 the following was done [13]:

- Standardization of 53 independent variables (IV). Because their values were not comparable, they have been

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

converted into sten scale (scale at which the average in the population is 5.5 and the standard deviation is 2.0).

- From the 53 KAM variables some subsets of variables describing the situations significant to brightness, flexibility, intelligence and shrewdness of the company have been separated. In case of the intelligence the subset comprises 25 variables. Due to large number of variables they have been clustered with use of Manhattan Distance Metric method. The following criteria for clustering were implemented: education and training, designates of potential of creativity, ICT supporting knowledge management.

From the clusters three second level independent variables (IV-2) have been separated. Each of them consists of four first level variables (IV-1). Such number of IV-1 variables is determined by the minimal condition of estimating if IV-2 meets the requirement of reliable scale (reliability has been checked using Cronbach's alpha test) and the ability to analyze the correlation with the second level dependent variables (minimum requirement is three variables) (Table 2).

- The first level dependent variables (DV-1) have been transposed on a scale from (-5,0) to (5,0), since the value of individual DV-1 were not comparable. As a general rule of transposition it was assumed that if all the surveyed companies assess a given DV-1 positively, its value would be (+5,0); if all companies assess it negatively, its value would be (-5,0); the balance of negative and positive assessments gives an assessment (0,0).
- The first level dependent variables (DV-1) have been aggregated in a second and third level dependent variables (DV-2 and DV-3), whereby as the aggregation criteria it

was used their relationship with brightness, flexibility, intelligence and shrewdness of the company. The criteria of selection of dependent variables DV-1 into a set referring to intelligence of enterprise are shown in table 3.

The starting point for the aggregation DV-1 into the DV-2 was creation of clusters of dependent variables. Keeping the order in which the variables DV-1 were included in the clusters, they have been selected and grouped into four-elements DV-2. Such number of aggregated DV-1 meets the minimal requirements of analysis if the variables DV-2 can be considered as components of reliable measurement scales. The analysis depended on grouping the variables DV-2 in such variables DV-3 that's reliability was confirmed by Cronbach's alpha test.

- The analysis of the correlation between independent and dependent variables has been done. Only population of medium sized enterprises was considered. From the point of view of the essence of the correlation, the term independent and dependent variable is not appropriate because the correlation coefficient cannot be a base to conclude about the cause and effect relation. However, interpreting the correlation it was assumed that changes in the macro-environment of companies (independent variables), and this environment is the subject of analysis of Knowledge Based Economy, are primal cause of changes in enterprises (dependent variables). Such relation is also accepted in strategic management and is the logical consequence of assumption that the economic policy of countries and economic groups should cause such acting of enterprises that is desired for achievement of social and economic objectives.

TABLE 2. INDEPENDENT VARIABLES POTENTIALLY SIGNIFICANT TO THE INTELLIGENCE OF ENTERPRISE

Second level independent variables		Reliability		First level independent variables IV-1	
Symbol	Name	alfa Crobnach	assessment	No.	Name
I1	Situations potentially significant to the intelligence of enterprise - creative economy (absolute values)	0,725	good	37	Researchers in R&D
				42	Scientific and Technical Journal Articles
				45	Patent Applications Granted by the USPTO
				47	High-Technology Exports as % of Manufactured Exports
I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	0,657	acceptable	38	Researchers in R&D Per Million Population
				43	Scientific and Technical Journal Articles Per Million Population
				46	Patent Applications Granted by the USPTO Per Million People
				55	Intellectual Property Protection
I3	Situations potentially significant to the intelligence of enterprise - staff development potential	0,885	good	60	Tertiary Enrollment (% gross)
				62	Internet Access in Schools
				63	Public Spending on Education as % of GDP
				144	Internet Users Per 1,000 people

Source: [13]

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

TABLE 3. CRITERIA OF SELECTION OF THE DEPENDENT VARIABLES FOR A SET OF ENTERPRISE'S INTELLIGENCE

No.	Criteria
1	Learning / staff training
2	Vision of enterprise / strategic management
3	Organizational memory: procedures, technologies, organizational culture
4	Reaction on changes occurring in the environment
5	Staffing policy: employment, staff development
6	Team Based Working
7	Contemporary methods of management
8	Innovativeness, creativity
9	Information and computing systems

Source: Trzcielinski [13]

- I2 (situations potentially essential for the intelligence of enterprises - creative economy, the relative values) - positive changes include changes up to 40% of possible,
- I3 (situations potentially essential to the intelligence of the enterprise - the development potential of human resources) - positive changes include changes up to 42% of possible.

In the period between 2007 and 2011 there has been improvement of the conditions in the environment of enterprises significant to the development of both the creative economy and education and knowledge of the society.

III. DISCUSSION OF RESULTS

A. Changes in the business environment

The changes in the business environment are calculated as the difference between values of the independent variables in 2011 and 2007. These values have been standardized and are expressed on a sten scale, ranging from 1 to 10. Therefore the maximal absolute value of the change for a single first level variable (IV-1) can be 9 and for the second level variable (IV-2) that groups four IV-1 may be 36. The maximal change has been treated as a reference point to assess the scale of the changes of the independent variables [13].

The values of the independent variables and their changes are presented in table 4. The changes that have occurred in the environment can be assessed positively.

The positive change of the environment, described by 12 variables that refer to intelligence of enterprise, covers 41% of the maximal possible changes. The change range analyzed in cross-section of second level independent variables IV-2 (each of them aggregates four IV-1) is as follows:

- I1 (situations potentially essential for the intelligence of enterprises - creative economy, the absolute values) - positive changes include changes up to 44% of possible,

B. Changes in companies

Table 5 presents dependent variables DV-1 aggregated into dependent variables DV-2 and the value of their change in the period 2007-2011. Among 43 DV-1 only 6 got worse value change. Others were changed positively however the values of change are small and in 27 cases are no bigger than 1 that is no more than 20% of maximal possible change. The only exception is variable 38 that expresses the number of changes of employment about 5% or more. Its standardized value in the scale from 0 to 5 is 4. It can be interpreted that medium sized enterprises were agile in terms of adjusting the employment to the changes in the environment.

Analyzing the second level dependent variables DV-2 describing changes which occurred between 2007 and 2011, it was found that among the eleven DV-2, there were no such that aggregate all or most of the DV-1 with negative value (Table 5). This confirms the positive trend of changes in intelligence of enterprises. The maximal possible absolute value of the change of DV-2 aggregating four DV-1 is 20 (each DV-1 can reach a maximal absolute value of 5). The range of value change was calculated as the DV-2 value change share in the maximal absolute value of change.

TABLE 4. STANDARDIZED VALUES OF THE INDEPENDENT VARIABLES POTENTIALLY ESSENTIAL FOR ENTERPRISE'S INTELLIGENCE

Second level independent variables IV-2		First level independent variables IV-1		Standardized values							Value of second level independent variables			Change value of Intelligence		
Symbol	Name	No.	Name	2007	2008	2009	2010	2011	Zm	Formula	2007	2011	Change	2007	2011	Change
I1	Situations potentially significant to the intelligence of enterprise - creative economy (absolute values)	37	Researchers in R&D	4,00	4,00	3,00	6,00	8,00	4,00	+	12,00	28,00	16,00			
		42	Scientific and Technical Journal Articles	3,00	7,00	5,00	3,00	7,00	4,00	+						
		45	Patent Applications Granted by the USPTO	3,00	7,00	4,00	4,00	7,00	4,00	+						
		47	High-Technology Exports as % of Manufactured Exports	2,00	4,00	6,00	7,00	6,00	4,00	+						
I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	38	Researchers in R&D Per Million Population	4,00	4,00	3,00	7,00	7,00	3,00	+	12,00	26,50	14,50	33,00	77,50	44,50
		43	Scientific and Technical Journal Articles Per Million Population	3,00	7,00	5,00	3,00	7,00	4,00	+						
		46	Patent Applications Granted by the USPTO Per Million People	3,00	7,00	4,00	4,00	7,00	4,00	+						
		55	Intellectual Property Protection	2,00	5,50	7,00	7,00	5,50	3,50	+						
I3	Situations potentially significant to the intelligence of enterprise - staff development potential	60	Tertiary Enrollment (% gross)	2,00	4,00	5,00	7,00	7,00	5,00	+	9,00	23,00	14,00			
		62	Internet Access in Schools	2,00	4,00	6,00	7,00	6,00	4,00	+						
		63	Public Spending on Education as % of GDP	3,00	6,00	6,00	7,00	3,00	0,00	+						
		144	Internet Users Per 1,000 people	2,00	4,00	5,00	6,00	7,00	5,00	+						

Source: [13]

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

TABLE 5. CHANGE OF DEPENDENT VARIABLES EXPRESSING INTELLIGENCE OF MEDIUM SIZED ENTERPRISES

Dependent variables DV-2					Dependent variables DV-1		
No.	Symbol	Name	Value change	Range of change	No.	Name	Value change
1	DV 11-VC-1	Change of both personal policy & budget for training	0,08	0,40%	1	Employing people with Basic competencies and training them	-0,42
					2	Employing highly competent people and a little training	0,83
					3	Change of budget for training	-0,17
					4	Change of budget for training [%]	-0,17
2	DV 11-VC-2	Flexibility of organizational structures	4,42	22,10%	5	Change of structure for marketing functions	1,00
					6	Change of structure for sale functions	1,33
					7	Change of structure for purchasing functions	0,83
					8	Change of structure for production/operations management	1,25
3	DV 12-VC-1	Importance of competencies, percentage highly qualified Staff and variety of work at operational level	4,42	22,10%	9	Change of foreign languages skills	1,08
					10	Change of highly qualified employees	0,83
					11	Change of highly qualified employees [%]	0,83
					12	Change of variety of tasks performer at operational level	1,67
4	DV 12-VC-2	Importance of top management initiatives concerning strategy, structure & HR management and flexibility organizational	1,75	11,67%	13	Change of top management initiatives concerning organizational strategy and structure	0,67
					14	Change of importance of HR management	0,67
					15	Change of flexibility of structure for R&D functions	0,42
5	DV 13-VC-1	Variety of tasks performer by administrative staff and way of recruitment	2,58	12,90%	16	Change of variety of tasks performer by administrative staff	1,75
					17	Change of recruitment by Assessment Centre	0,08
					18	Change of recruitment by HR department	0,50
					19	Change of recruitment directly by top management	0,25
6	DV 13-VC-2	Importance of ICT, use of process documentation and owners of processes	3,33	16,65%	20	Change of importance of ICT	1,50
					21	Change of use of process maps	0,58
					22	Change of use of processes inspection documentation	0,58
					23	Existence of owners and leaders of processes	0,67
7	DV 14-VC-1	Employees with flexible working time, percentage of functions performer according to strict procedures and use of organizational documentation	3,08	15,40%	24	Change of percentage of employees with flexible working time	0,92
					25	Change of percentage of functions/processes performer according to strict procedures	1,00
					26	Change of use of organizational charts	0,92
					27	Change of use of classification of business processes	0,25
8	DV 14-VC-2	Bargaining power	2,00	10,00%	28	Change of bargaining power against suppliers	0,83
					29	Change of bargaining power against customers	0,92
					30	Change of bargaining power against local government	0,25
					31	Change of the bargaining power against tax offices	0,00
9	DV 15-VC-1	Change of tools to manager competencies and importance of candidates knowledge	2,92	14,60%	32	Change of use of external institutions to manage the competencies	0,58
					33	Change of investigation of employees' expectations	0,33
					34	Change of importance of candidates' specialist knowledge	1,42
					35	Change of importance of candidates' general knowledge	0,58
10	DV 15-VC-2	Employment and top managers knowledge about designing organizational structures	5,33	26,65%	36	Change of employment	-0,08
					37	Change of employment [%]	-0,17
					38	Number of changes of employment about 5% or more	4,00
					39	Change of top managers knowledge about designing organizational structures	1,58
11	DV 15-VC-3	Use of organizational documentation, importance of the issue on organizational structure and scope of competition	0,08	0,40%	40	Change of systematic process inspections	0,17
					41	Change of use of classification of business processes	0,00
					42	Change of importance of the issues on organizational structures	1,50
					43	Change of scope of competition	-1,58

Source: own work. Symbols of dependent variables mean: DV-dependent variable; I - intelligence, together with the number of variable DV-3 (the dependent variables DV-2 are aggregated in DV-3 in such a way that DV-3 is reliable measurement scale); VC - value change (between 2007 and 2011) together with number of DV-2

All dependent variables DV-2 (Table 5) got positive change of value but the change is relatively small and covers from 0,4% to 26,65% of maximal possible value change. The increase of intelligence of enterprises is mostly the result of implementing: employment policy aimed at hiring highly qualified staff and workers who are skilled in variety of tasks, flexible time of work, modern and flexible organizational

structures e.g. process oriented structures and computer-aided management systems.

C. The relation between changes of environment and intelligence of enterprises

Table 6 presents the dependent variables concerning the intelligence of enterprises which are in statistically significant relationship with the independent variables.

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

TAB. 6. CORRELATION BETWEEN CHANGES OF ENVIRONMENT AND INTELLIGENCE OF ENTERPRISE

Independent variable IV-2		Value change IV-2	Correlation	Dependent variable DV-2		Value change DV-2	Influence on DV-2 when IV-2 increases
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	-1,000	DV-I2-VC-1	Importance of competencies, percentage highly qualified Staff and variety of work at operational level	4,42	Negative
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	0,655				Positive
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	-0,500	DV-I2-VC-2	Importance of top management initiatives concerning strategy, structure & HR management and flexibility organizational structures	1,75	Negative
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	0,982				Positive
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	-1,000	DV-I3-VC-2	Importance of ICT, use of process documentation and owners of processes	3,33	Negative
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	0,655				Positive
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	0,655	DV-I1-VC-1	Change of both personal policy & budget for training	0,08	Positive
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	-0,971	DV-I3-VC-1	Variety of tasks performer by administrative staff and way of recruitment	2,58	Negative
IV-I2	Situations potentially significant to the intelligence of enterprise - creative economy (relative values)	14,50	0,500	DV-I4-VC-1	Employees with flexible working time, percentage of functions performer according to strict procedures and use of organizational documentation	3,08	Positive
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	0,619	DV-I1-VC-2	Flexibility of organizational structures	4,42	Positive
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	0,954	DV-I4-VC-2	Bargaining power	2,00	Positive
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	-0,916	DV-I5-VC-1	Use of organizational documentation, importance of the issue on organizational structure and scope of competition	2,92	Negative
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	-0,979	DV-I5-VC-2	Employment and top managers knowledge about designing organizational structures	5,33	Negative
IV-I3	Situations potentially significant to the intelligence of enterprise - staff development potential	14,00	-0,958	DV-I5-VC-3	Use of organizational documentation, importance of the issue on organizational structure and scope of competition	0,08	Negative

Source: own work. Symbols meaning: IV-Ix - independent variable concerning intelligence with its number; DV-dependent variable; I - intelligence, together with the number of variable DV-3 (the dependent variables DV-2 are aggregated in DV-3 in such a way that DV-3 is reliable measurement scale); VC - value change (between 2007 and 2011) together with number of DV-2

It can be noticed that improvement of IV-I2 (situations potentially significant to the intelligence of enterprise – creative economy; relative values) affects negatively four dependent variables (DV-I2-VC-1, DV-I2-VC-2, DV-I3-VC-2, DV-I3-VC-1). At the same time the first three are positively affected by improvement of IV-I3 (situations potentially significant to the intelligence of enterprise – staff development potential). The contradictory influence of both independent variables can be explained that with better condition to obtain staff with required competences (IV-I3) the top management turns less his attention to use the opportunities of creative economy (IV-I2). Another words, the highly competent staff compensates the less engagement of top management. It is partly confirmed by negative correlation of IN-I3 with three dependent variables (DV-I5-

VC-1, DV-I5-VC-2, DV-I5-VC-2) which refer to top management active involvement in improvement organization of the enterprise.

IV. CONCLUSIONS

- For the years 2007-2011, the conditions in the business environment potentially important to the intelligence of enterprise (independent variables) were improved. These include:
 - factors influencing the creativity of the economy, such as the number of employees of R&D, the number of scientific and technical publications, number of patents granted, export hi-tech products and the degree of intellectual property protection,

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

- factors affecting the development potential of staff, such as the rate of enrollment in higher education, internet access, public expenditure on education and the number of Internet users per 1,000 inhabitants.

The scale of this improvement is 41% of the possible changes.

2. In the same period the internal factors influencing the intelligence of enterprise (the first level dependent variables DV-1) were improved. After have been grouped, these factors create the following second level dependent variables:

- Change of both personal policy & budget for training,
- Flexibility of organizational structures,
- Importance of competencies, percentage highly qualified staff and variety of work at operational level,
- Importance of top management initiatives concerning strategy, structure & HR management and flexibility organizational structures,
- Variety of tasks performer by administrative staff and way of recruitment,
- Importance of ICT, use of process documentation and owners of processes,
- Employees with flexible working time, percentage of functions performer according to strict procedures and use of organizational documentation,
- Bargaining power,
- Use of organizational documentation, importance of the issue on organizational structure and scope of competition,
- Employment and top managers knowledge about designing organizational structures,
- Use of organizational documentation, importance of the issue on organizational structure and scope of competition.

The scale of improvement in factors describing the intelligence of enterprises was 14,0% of maximal possible changes.

3. The changes in enterprises occurred on a smaller scale than in the environment, that allows to put the judgment, that the adaptability of enterprises is limited. Medium sized enterprises do not fully exploit the favorable conditions that have occurred in their environment.

4. The changes in the environment, which improve both the creativity of the economy and development potential of human resources, are important activators of growth of intelligence of enterprise. However managers do not utilize them fully. This is confirmed by bigger rate of positive changes in the environment that in the enterprises.
5. The internal barrier of growth of medium sized enterprises intelligence is relatively small engagement of managers into improvement of organization of enterprise.

REFERENCES

- [1] Brinkley, I.; *Defining the knowledge economy*. London, The Work Foundation, 2006.
- [2] Carneiro, A. "The Role of Intelligent Resources in Knowledge Management", *Journal of Knowledge Management*, vol. 5, 4, pp. 358-367, 2001.
- [3] Correia, A.M., Paulos, A., Mesquita, A.; "Virtual communities of practice: Investigating motivations and constraints in the processes of knowledge creation and transfer", unpublished.
- [4] Dove, R.; "A System Framework for Intelligent Enterprise", *Paradigm Shift International*. Essay #063, January 2002.
- [5] *Europe 2020: Communication from the Commission. Europe 2020: A strategy for smart, sustainable and inclusive growth*. European Commission, Brussels, 3rd March 2010.
- [6] March, J.G.; *The pursuit of organizational learning*, Malden, Blackwell Publishers, 1999.
- [7] *Measuring knowledge in the world's economies. Knowledge Assessment Methodology and Knowledge Economy Index*. World Bank Institute, 2008.
- [8] Nonaka, I., Takeuchi, H.; *The knowledge-creating company*, New York, Oxford University Press, 1995.
- [9] Powell, W., Snellman, K.; "The Knowledge Economy", *Annual Review of Sociology*, 2004, vol. 30, pp. 199-220.
- [10] Senge, P.; *The Fifth Discipline: The Art & Practice of The Learning Organization*, Doubleday, New York, 1990.
- [11] Trzcielinski, S.; "Agile Enterprise - Research on Flexibility", Robot Motion and Control (RoMoCo), IEEE Conference Publications, <http://ieeexplore.ieee.org>.
- [12] Trzcielinski, S.; "The influence of Knowledge Based Economy on agility of Enterprise", *Procedia Manufacturing* 3 (2015) pp. 464 - 471.
- [13] Trzcielinski, S.; "The intelligence of Polish enterprises during the period 2007-2011", in: *Management Science during Destabilization. Local Insight*, J. Teczke, K. Djakeli, P. Buła, Eds, International Management Foundation. Cracow University of Economics, 2015.
- [14] Trzcieliński, S., Trzcielińska, J.; "Some elements of theory of opportunities", *Human Factors and Ergonomics in Manufacturing and Service Industries*, 2011, 21 (2), pp. 124-131.
- [15] Włodarkiewicz-Klimek, H.; "The influence of human capital on shaping agility of a knowledge-based organization", in: *Management Science during Destabilization Global Perspective*, T. Chachibaia, H. Łyszczarz, A. Żak, eds, International Management Foundation. Cracow University of Economics, 2015.