INFORMATION TECHNOLOGY IN VIRTUAL ENTERPRISE

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Abstract: There is a common belief expressed in the subject literature that information technology (IT) is critical contingency factor for virtual organization. Therefore our interest was to investigate the relation between the intensity level of IT use and the level of the organization virtuality. In that purpose we elaborated a tree of features describing virtuality and categorized IT tools into two groups taking into considerations the functions which they play or can play in virtual organization and the range of their influence to cope with cooperation of distributed partners. The research sample included 45 firms, mostly small and medium, belonging to six branches. The firms had been chosen according to pre-selection criteria, confirming that they construct a network to run their operations. Some indicators were elaborated to measure the level of virtuality and intensity of use of IT. Next correlation was checked between these two levels. In this paper we present what we have found about the relation.

1 INTRODUCTION

Virtual organization is being associated with the information and telecommunication technologies (IT technologies). The association appears in various context. For instance, the following statements can be found in the literature referring to the domain: IT is a tool for coordination in the virtual organization (Appel and Behr, 1998), IT technologies affected directly the opportunity to develop the virtual teams (Ishaya and Macaulay, 1999), IT connects the partners into an virtual organization perceived as a temporary partner's network (Byrne, 1993, Jägers et al., 1998), IT is the feature that constitutes the virtual organization (Byrne, 1993, Gristock, 1997). As the virtual organization is so widely perceived in association with IT, and there is no systematic research on such an association, the authors decided to look at the problem more deeply.

2 THE RESEARCH PROBLEM

The problem that became the research subject can be articulated in the following question:

Is there any correlation between the company's virtuality level (Trzcielinski, & Wojtkowski, 2007) and the degree of the IT implementation by the creator initiating the virtual organization?

To answer the question, we have operationalized the notion of virtual organization and we have prepared the IT's typology.

2.1 Features of Virtual Organization

Referring to the studies on the domain's literature, fifteen features of the virtual organization have been distinguished and then aggregated into four meta-features defining the company's virtuality (Trzcielinski, 2007).

1. Openness. The feature associated mainly with a special susceptibility of virtual organization to construct the cooperative connections with other entities. The proximate cause to arrange such connections is a need for providing the adequate competences necessary to make profit of the market chance observed. This feature includes:

- Skill to choose and effectiveness to exploit the key competences,
- Confidence and equal status of partners and readiness to get the same/common goal,
- Tendency to give the firm's resources to carry out the tasks to be accomplished in the network, to increase the resources and to widen the access to the resources,
- Openness and honesty in sharing profits, costs and risk by all partners,
- Skills to develop the one common customer relationship management system, supervision

and fulfilling the customer needs, appropriate customer segmentation.

2. Temporariness of Partnership. It is due to the exploitation of the partners' key competences for a determined time period, i.e. the different time period of participation in the virtual organization as well as a different role in the organization (Christie, & Levary, 1998). This feature includes:

- Temporariness of virtual organization related to its short lifetime,
- Reconfigurability of the partners' network meant as a readiness to enter and to retire from the virtual organization after having completed the task,
- Institutional independence of the partners,
- Heterarchy expressed by the degree of formalization, organizational structure's flattening, management decentralization and variability of the decision center.

3. Orientation to Market Opportunities. The success or failure of the venture depends, among others, on the ability to identify and to immediately reply to the market opportunities. The feature includes:

- Organization's flexibility to respond and adapt its activities to the variable market conditions.
- Integrity of organization, i.e. the virtual organization is perceived by outsiders as an entity

4. Organizational Distance between Partners. There are three basic component features of it: territorial and time distance, social distance and information distance among partners of virtual organization. This feature includes:

- Territorial distance considered as a geographical dispersion of partners; it could refer to the dispersion within local, country, European or worldwide market.
- Time distance related to the different time zones the particular partners of virtual organization are running their activities in. The time distance can generate troubles due to delayed flow of and access to information, time-shifted response to the changing market conditions, difficulties to create the virtual organization and to coordinate its activities
- Social distance appearing mainly as a lack of the *face-to-face* contact between partners and informal horizontal communication.
- Information distance manifested by the response time to the risks and disturbances affecting the fulfilling of the company's functions.

The above four features has been decomposed into detailed ones. The detailed features have been, in turn, decomposed into the symptoms of the virtual organization's presence; referring to the last ones, the questionnaire for interviewing the management body of the companies under test has been developed.

2.2 IT Tools

IT tools are meant here as a set of tele-computing technologies, without splitting into software, hardware or IT infrastructure. The IT tools are their specific designation resulting from their special properties. Therefore, different groups of the IT tools can be defined referring to these features. In this paper, the function-based and the range of influence-based classifications have been assumed (Trzcielinski, 2007). Referring to the functions, the following types of IT tools are depicted.

1. Communication Supporting Tools. The notion denotes the IT tools used to achieve the fast and precise information exchange between partners, customers and even competitors. The process of planning and coordinating the tasks run by distributed partners of virtual organization is more difficult. The physical distance between partners significantly increases the information distance measured with the time of reaction to the noticed market chances and to the risks and disturbances arising when the virtual company is accomplishing its tasks. The information flow is just necessary not only to create the virtual organization but also to complete successfully the tasks the virtual organization has been brought into existence. The classic communication - supporting tools are fixed telephony and facsimile. A sharp technological development caused the thorough integration of solutions of information technology and telecommunications. A new quality of the IT tools has appeared enabling the efficient communication between the business process players. At present, the use of electronic mail, internet portals, mobile telephony, internet communicators and VOIP as well as transmission of information using mobile telephony as well as opportunity to talk via internet is often more convenient and efficient than electronic mail. Thanks to variety of the IT-based communication tools, the integration of partners within a virtual organization becomes simple and flexible.

2. Information-decision Process Supporting Tools. This kind of tools supports the information-decision making processes in virtual company. Among others, the tools make use of the distributed data bases located in both the data centers belonging

to the virtual organization's partners and the common data bases accessible by internet. Information in data bases can refer to material and non-material resources, expertise of particular partners, customer relation management, scenarios of previous projects, competences of the virtual company's partners and the company environment features. The IT tools of that kind are used to perform among others the following:

- Financial, statistical, demographical analyses etc.,
- Selection and sorting information,
- The physical and decision-making processes coordination within the supply chain,
- Stock management,
- Scheduling the delivery,
- Cost calculation,
- Capacity planning and the use of resources,
- Process control,
- Demand forecasting,
- Document exchange (e.g. orders and invoices),
- Finance management.

3. Design Supporting Tools. In virtual organization, the design functions (designing of product, for example) can be accomplished by the physically distributed designing team. Therefore, the communication functions among partners and function of the access to the shared resources in the form of accessible files (data exchange), information on the progress of the project have to be integrated in these tools and to make possible the aligned realization of anticipated tasks. The designing tools used in the virtual organization depend on the branch in which the perceived market opportunity is located. For instance in case of production companies, the IT tools and systems involve CAD, CAM, CAPP, and others. However, the same group encompass also the tools for WWW service design (MS FrontPage), graphical project's preparation (Corel, Adobe), multimedia presentations (MS PowerPoint), information flow modeling using the UML standard (MS Visio).

The recent IT, regardless the classification criterion, cannot be unambiguously assigned to their function. Therefore, it should be assumed that the types as mentioned above overlap each other.

Regarding the range of the influence, four classes of the IT tools have been identified.

1. Desktop Tools. The group involves the tools related directly to the workplace, and the usefulness of these tools to develop the virtual organization is very low. Such a limited usefulness results from the fact the tools themselves do not form the IT network

connections to other players of the business processes.

2. Local Network Tools. The class encounters all IT tools ensuring efficient communication, fast access to data as well as the information exchange within the local IT infrastructure of the company. It refers mainly to the internal aspect of the virtual firm. The examples are LAN, intranet, local post office and the local database servers.

3. Distributed Network Tools. In the class, the integrated local network tools and wide IT infrastructure going beyond the physical framework of the company (MAN and WAN, Internet, Extranet) are placed. The integration of the IT tools seems to be significant to the virtualization of company and business. With this class of tools, suppliers and customers can communicate and cooperate with no limits resulting from their territorial dispersion.

4. Mobile Tools. The tools of this class present all features of classes mentioned above and an additional ability of remote connection to LAN, WAN and to individual desktop tools. To establish the communication, not but the mobile Access Points are required and the physical IT infrastructure is not needed.

3 RESEARCH SAMPLE AND MEASUREMENT METHOD

The surveys has been carried out in 2003-2006 in companies which were creating and are still developing the virtual organization. The creator is meant as a firm which notice a market opportunity in its environment, enters into contract with customer and realizes the contract in the networking.

3.1 Research Sample

The network partners ware chosen regarding their key competencies required to accomplish the actual contract. Thus, the choice of the sample has been targeted, and the criterions were:

1. The creator develops a network with the virtual organization features. The features being at least as follows: temporary inter-partner relations, territorial dispersion of partners, low degree of formalization of the structures being developed to carry out the business project.

2. Operational activity of particular companies is placed in various branches.

3. In the company, at least one type and one class

of the IT tools is used.

The test sample involved 45 firms from the production and service sectors, located in the Wielkopolska voivodeship in Poland. The branch structure of the companies under consideration is as follows: IT services – 10 firms, real estate related services - 11 firms, turnkey fair stands services – 10 firms, constructions and building maintaining services – 5 firms, printing services – 4 firms, manufacturing – 5 firms.

3.2 Measurement Method and Results

To measure the level of the company's virtual organization and its IT tools implementation level, an interview questionnaire has been elaborated to enumerate the following: symptoms of presence of the virtual organization assigned to particular meta-features of the company's virtuality, and use of the IT tools.

Intensity of presence of the particular symptoms and IT tools have been assessed according to the Likert order scale ranging from 1 to 5. Referring to the answers given by the companies, the company's virtuality level has been measured regarding the actual meta-feature. Then, a synthetic virtuality level has been found (Table 1).

$$\mathbf{C} = \left(\frac{spktT}{iTw * 5} \right) * 5 \qquad (1)$$

where:
C – virtuality level coefficient regarding actual meta-feature,
spktT – sum of points obtained for total meta-feature,
iTw – amount of virtual organization symptoms assigned to an actual meta-feature.

$$\mathbf{V} = \left(\frac{spktTV}{iTwV * 5} \right) * 5 \qquad (2)$$

where:
V – virtuality level coefficient for the company under test,
spktTV – sum of points obtained for entire company,
iTwV – total number of the total organization symptoms shown in the questionnaire.

The intensity level of IT use has been measured using two below coefficients.

$$\mathbf{V_{IT}} = \left(\frac{spktT_{it}}{iTw_{it} * 5} \right) * 5 \qquad (3)$$

where:

V_{IT} – IT application intensity coefficient,
$SpktT_{it}$ – a sum of points obtained by the firm which creates the virtual organization, regarding the intensity of use of IT,
ITw_{it} – number of the questionnaire statements referring to the IT technologies applications.

$$\mathbf{V_{ITK}} = \left(\frac{spktT_{itk}}{iTw_{itk} * 5} \right) * 5 \qquad (4)$$

where:
V_{ITK} – communication technologies application intensity coefficient,
$SpktT_{itk}$ – a sum of points obtained by the firm which creates the virtual organization, regarding the intensity of use of communication technologies,
ITw_{itk} – number of the questionnaire statements referring to the communication technologies applications.

The results of the measurements are presented in Table 2.

Statistical analysis of the obtained data shown in table 2 has been preceded by the test to answer the question: if obtained results for variables: V (synthetic virtuality level)), $\mathbf{V_{IT}}$ (IT technologies implementation level), $\mathbf{V_{ITK}}$ (communication technologies implementation level) agree with the normal distribution.

Table 1: Average level of the firms' virtuality regarding actual meta-feature and the whole branch.

Branch	Virtuality degree with regard to the meta-features				[V]
1	2	3	4	5	6
Constructions and maintaining	3,89	4,29	4,22	3,40	3,95
IT services	3,74	4,37	3,77	3,46	3,84
Real estate services	3,81	4,55	3,48	3,55	3,88
Printing	3,70	4,27	4,17	3,30	3,83
Turnkey fair stands	3,96	4,39	4,19	3,62	4,04
Manufacturing	3,92	3,29	3,36	2,94	3,52
Average of all groups	3,84	4,28	3,83	3,44	3,87

Columns: (2) Openness, (3) Relationship temporality
(4) Orientation for market opportunities
(5) Organizational distance
(6) Synthetic degree of virtuality [V]

Table 2: Average level of the firms' virtuality regarding actual meta-feature and the whole branch.

Branch	Synthetic degree of virtuality [V]	Intensity level of IT use	
		all IT tools [V_{IT}]	only communi-cation tools [V_{IT}]
1	2	3	4
Constructions and maintaining	3,95	2,16	3,96
IT services	3,84	2,29	3,80
Real estate service	3,88	2,11	4,13
Printing	3,83	2,57	3,75
Turnkey fair stands	4,04	2,52	4,28
Manufacturing	3,52	3,12	3,12
Average of all groups	3,87	2,46	3,94

As the test sample size is lower than 2 thousand cases, the Shapiro-Wilk test has been used to estimate the normality of distribution of the observations. For each of the variables mentioned above, the test results permitted to state that the distribution differs from the normal distribution. Because the distribution of results obtained cannot be considered as a normal distribution and the correlation has been examined for two variables (V and V_{IT}, V and V_{ITK}, respectively) measured on the Likert scale, therefore, the Spearman-Rang correlation coefficient has been applied to compute their correlation. The found correlation results are presented in Table 3.

In face of the low correlation coefficient V and V_{IT} a thesis can be advanced that the level of the company's virtual organization does not depend on the IT tools implementation degree by the creator. Moreover, the negative correlation coefficient implies that an increase in the IT tools implementation degree results in the decrease in the company's virtuality level. Such conclusions undermine the opinion widely presented in the literature which states that there exists a strong relationship between the IT implementation and the virtual organization.

The correlation between V and V_{ITK} is different than that mentioned above. The correlation coefficient value allows to assess this correlation as placed between the average and high one. Thus, the conclusion can be drawn that the group of the IT

tools used especially for communication purposes (communication tools) by the virtual organization's creator makes a crucial impact on the company's virtuality level.

Table 3: Matrix of correlation between the synthetic virtuality level and the intensity level of IT tools use.

Spearman Rang-order correlation Bold values of correlations are significant for p<0,05			
Features	Synthetic virtuality level [V]	Features (IT tools application degree)	
		all IT tools [V_{IT}]	only communi-cation tools [V_{IT}]
1	2	3	4
Synthetic virtuality level	1,000		
IT tools application degree — all IT tools [V_{IT}]	**-0,245**	1,000	
IT tools application degree — only commu-nicatio n tools [V_{IT}]	**0,474**	-0,146	1,000

4 DISCUSSION OF THE RESULTS

In research work, a set of 45 firms showing symptoms of creating the virtual organization have been considered. The research has indicated that different IT tools are used by the firms. Among these tools are such once which are used to run the firm's operational regardless the firm's participation in the companies' network organization. Analysis of the correlation coefficients obtained has shown that the commonly shared opinion presented in the literature and indicating the strong relationship between the IT [V_{IT}] and the company's virtuality [V] is, in fact, a one going too far. In our opinion, such a common statement comes from the assumption that IT promote the creation of virtual organization but it is not included into consideration, that some tools can be applied by the company regardless it creates or not the virtual organization. Therefore, it cannot be stated that the virtual organization's creation and running is strongly supported by the IT.

The research work as well as the statistical analysis of results have shown the reality in which the processes related to the creation and running the virtual form of a company z are mostly promoted by the communication technologies. Communication technology tools have been considered within a set of the IT. However, due to its low percentage within the set, such tools did not significantly affect the correlation between the IT [V_{IT}] and the company's virtuality level [V].

In our research, a relatively wide range of the IT tools has been considered, including the tools referred to, in both the literature and the subjective assessment by the authors, as those supporting the creation and running of the networking. Due to research, it could be found that some IT tools have been totally dismissed in the firms creating the virtual company. Thus, the assumed set of IT tools has shown an 'excess'. Evidently, it reduced the correlation factor's value. In addition, the reduction in the correlation coefficient resulted from the fact, that the firms are using the application-oriented specialized IT tools. Therefore, the variety of applied IT increases while the share of the 'commonly used' IT tools relatively decreases; the 'commonly used' IT tools being meant the tools applied regardless the firm's/branch's specialization.

The computed correlation degree between [V_{IT}] and [V] (Table 3, column 2) determines only the force of the relationship. The correlation does not explain the quantitative relationship between [V_{IT}] and [V]. Therefore, to explain the latter, the regression anlysis has been performed. The regression analysis has been carried out for both the relationship between [V_{IT}] and [V] (Fig. 1) and between [V_{ITK}] and [V] (Fig.2).

After having tested different regression models with the *Statistica 6.0* package, the exponential regression model has been chosen. The choice was based on the variance analysis with which the degree of matching the model to the empirical data can be determined.

In Fig.1 one can notice that the company's virtuality level increases slightly when the IT implementation level (in the range 1,8; 2,3) increases. The continued increase in the IT implementation level results in an decrease in the company's virtual organization level [V]. The explanation of the latter is that only some kinds of the IT tools promote the virtual organization. The company's virtuality level does not increase because some technologies do not serve the virtual organization but are used just to run normal operations of the firm.
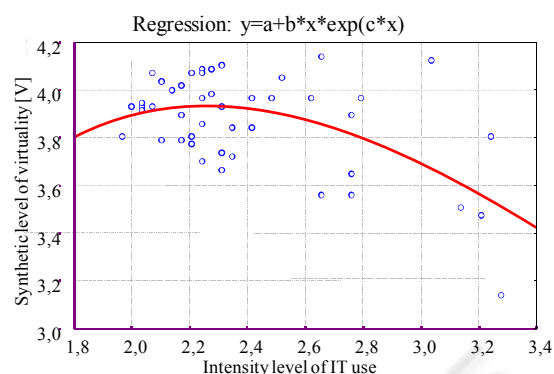

Figure 1: [V] and [V_{IT}] regression analysis.

Referring to the results presented in Table 3 (column 2), the high correlation between the communication tools and the company's virtual organization level can be noticed (correlation coefficient is near to 0.5). From this observation, the thesis can be advanced: Among the IT tools used by the creator to develop the company's virtual organization, the communication technologies are the dominating ones.

High degree of relationship between the communication technologies [V_{ITK}] and the company's virtual organization [V] can be explained in the following way: the fast flow of information is the most important factor for virtual organizations enabling to achieve the competitive advantage in its business environment. As the virtual organization encounters the partners in territorial dispersion, the communication technologies are crucial when developing and running the companies in networking. These technologies are crucial in any network as they ensure the contact between partners, coordination of activities (by the creator), supervision or just accomplishment of tasks by the distributed partners. Therefore, the communication technologies such as fixed and mobile telephony, internet services including electronic mail, communicators and fax are highly exploited by the virtual organizations to realize the emerging market opportunities.

Fig. 2 shows that the company's virtuality level increases sharply for a given range of the communication tools implementation level. The higher limit of the range can be assumed to be of 3.6. The continued increase in the implementation level value does influence the company's virtual organization level very slightly. The explanation is that such tools are substitutes to each other (mobile telephony versus fixed telephony, e-mail versus communicators).
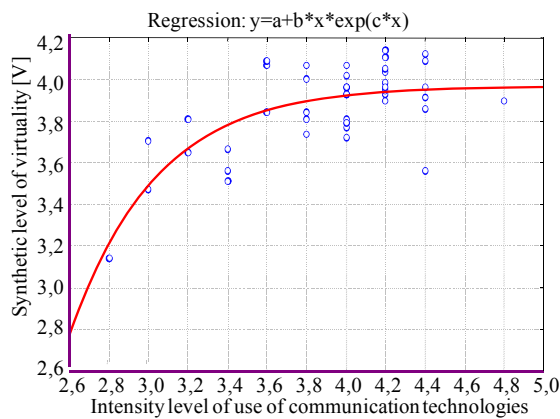
Figure 2: Regression analysis between [V] and [V$_{ITK}$].

5 CONCLUSIONS

In this paper we have focused on the research results that significantly undermine the wide spread opinion, referred in the literature, about the strong relationship between the IT and virtual organization. The studies carried out in this work have shown that the virtual organization level of the company depends on its specialization. Moreover, there is higher level in the small business. The notice seems to be logical as such companies has limited capacities in their disposal. Therefore, especially when facing the complex projects, to have access to necessary capacities, the networking, including virtual organization, is arranged. Thus, the conclusion can be drawn that the a concept of agile enterprise is an appropriate solution mainly for small businesses. Meanwhile, the bigger companies (represented by production entities in our survey) arrange the more stable networks; therefore, a concept of lean management is more suitable for them.

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