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Organizational culture deformations in conditions of intellectual work virtualization

Deformacje kultury organizacyjnej w warunkach wirtualizacji pracy intelektualnej

Abstract

The study examines the effects of intellectual work virtualization on internal uncertainness of organizations using the entropy approach adopted from the information theory. The results are grouped using marginal cases marking limits of entropy value of virtualized organization linked to specific type of organizational culture.

Keywords: *organizational culture; entropy; Ackoff classification; atomic organization; mass individualization; customer involvement; adaptability, controllability*.

Streszczenie

Artykuł bada wpływ wirtualizacji pracy intelektualnej na wewnętrzną niepewność organizacji stosujących podejście entropii przyjęte z teorii informacji. Wyniki zostały pogrupowane przy zastosowaniu marginalnych przypadków okreslających granice wartości entropii wirtualnych organizacji powiązanych ze specyficznym typem kultury organizacyjnej.

Słowa kluczowe: *kultura organizacyjna, entropia, klasyfikacja Ackoffa, organizacja atomistyczna, masowa indywidualizacja, udział klienta, zdolność do adaptacji, zdolność do kontroli*

1. Formulation of the general problem and relationship to the important scientific and practical problems

One of the defining characteristics of modern industrial society is virtualization of labor, including the intellectual work. This process began approximately within the last decade of the 20th century and by 1997 had reached already a significant level when more than 2 million employees were involved in virtual activities in the EU and about 11 million – in the US. Some forecasts for the year 2017 do estimate virtual employment share in the intellectual work as being 36%, so one can expect that very soon more than half employees engaged in the intellectual work will carry out their duties remotely using modern communication technologies. In this context, we need to recall the background of the process of intellectual work virtualization. As the beginning of the process the year of 1976 can be considered, when the term "telecommuting" was introduced which had meant the specific type of remote work under the contract. At the end of the 80's the European Commission put into use the term "telework". The contemporary term "virtual employment" has been use since 90's, when modern information and communication technologies fundamentally changed the relations in business, the very method of business organization. It is clear that virtualization at first had affected the degree of intellectual work which can be done remotely with the minimum involvement of fixed assets.

In Ukraine the first in-depth study of remote (virtual) employment was conducted by GfK Agency and was contracted by Bitrix24, the most popular platform developer for the collaboration and joint remote work organization. The activities of 1035 enterprises were analyzed and detailed (longitudinal) interviews with 221 respondents were held. The results were presented in March 2016 at the national (Ukrainian) site of GfK agency [1]. The data of the study indicate that Ukraine is in line with global trends ruling the virtual employment utilization: national rate of remote employment in March 2016 was 21%, while for Kyiv it was much higher – 33%, i.e. it is consistent with the average international level. Moreover, in the IT sector the utilization of virtual employment even exceeds the world average being about 40%. The average rate of remote employees in Ukraine is about 33% of office workers, and depending on the size of the company this share varies from 37% for micro enterprises (number of employees up to 10) to 11% for large enterprises (number of employees more than 251). The most typical virtual employment is for people aged from 25 to 42 years (this age range is characterized by the highest share of remotely employed). The most common sphere of virtual employment is IT, Finance and Management (Control). It should be noted that for remote employees a higher qualification is more typical (73% versus 58% for stationary ones) and a very high percentage of higher education – more than 83%. Quite interesting is the fact that the vast majority of remote employees (73%) receive the same salary, as stationary ones, and only 5% – bigger.

The main disadvantages of virtual employment that domestic experts noted are the following:

- Increased risks of breaking the information security of the company;
- Complicated control of subordinates' working time utilization by the supervisor (88% of managers do not control the working time usage by remote employees);
- The risk of losing the company's corporate spirit, its culture and shared values;
- Loss of effective communication within the teams (only 44% of managers are using modern telecommunication technologies and software for communication with remote subordinates);
- Employees working remotely can combine work for their company with other activities, including even employment by competitors;
- The progress of employees working remotely is difficult to control, the risk of deadlines violation by remote employees is bigger than by stationary ones;
- The management of remote employees is more time-consuming than of stationary ones;
- Virtual employees tend to render poorer quality than stationary ones.

As the advantages of remote (virtual) employment experts commonly referred to the following:

- Ability to sustain comparatively steady headcount of employees for jobs (positions), the need for which arises sporadically;
- Cost reduction of office rent, equipment, workplace equipment and maintenance (78% of CEOs believe that such a reduction exists and 67% can even indicate specific components of this reduction, primarily a reduction of labor costs by optimizing taxes; geographic expansion of employment, and the savings on rent and equipping the workplaces with office equipment);
- Ability to expand the geography of recruitment, which, as noted above, according to company chief executives can lead to savings on wages;
- The ability to attract highly qualified specialists.

2. Task specification and objectives

It should be noted that for companies, which have a long experience of partial virtual employment, economic considerationswent to the background, trading places for the reasons of business efficiency improvement through flexible work schedule.

After a brief analysis of the virtual employment significance in Ukraine it makes sense to switch to the theoretical issues and identify the main features of this trend primarily from the positions of organizing and managing.

At present, the scientific literature is still in the process of determining the characteristics or features of virtual intellectual employment, but most researchers support the following list:

- Virtual intellectual employment primarily involves creative professionals, intellectual workers and narrow specialists who can work remotely for many companies (organizations) simultaneously;
- Virtualization of intellectual work is implemented via the use of modern communication technologies in private or public networks or in cloud environment;
- Virtual intellectual employment is not limited by both time and space, and in most cases is quite difficult to be directly controlled. It is based on self-organization and self-control;
- Virtual intellectual work normally utilizes the only and most valuable resource – the knowledge, skills and competence of employees. In this sense, one could argue that virtual employment is a unique activity in which employees are responsible for resources directly provided to the company and are expected to offer a wide variety of approaches to the same problems;
- Virtual intellectual employment is a unique activity in which employees are responsible for their own training and development;
- The modification of motivational mechanisms is inherent for virtual intellectual employment – if at the conventional approach to business organization the majority of staff is motivated by the X model of McGregor, the specific requirements of virtual employment can be met exclusively by individuals motivated by the model Y;
- Intellectual work virtualization, propagation of social networks and a significant expansion of the assortment of the modern companies (so called mass individualization) ultimately leads to the very specific transformation of consumers into company staff (due to the possibility to influence the process of design and manufacturing of the product), and vice versa – employees turn into consumers of specific resources which the company can provide– knowledge, information, communications *et al*;
- Virtual intellectual employment in a network or cloud space is more individualized and independent, because of certain tasks (projects) employees are hardly dependent on the employer and are able to use their own approaches to realize the tasks at the same time being collective, because quite often executing complex projects employers use the virtual services of numerous professionals who should be organized in teams;
- Virtual intellectual work is quite complicated and diverse so that individual employees can perform certain projects from the beginning to an end and should master a variety of skills to the high level – in a sense it is a violation of the principle of specialization, which has been one of the main approaches to the production organization since 17th century.

According to the objectives of this study the third, the fifth and the eighth features of virtual intellectual employment are the most important. Indeed, these peculiarities define the crucial role of self-management in the system of modern business relations – self-organization and self-control is a prerequisite for successful activities in the virtual mode, and the possibility to choose their own approaches to carry out any activity is a source of responsibility which leads to intensive self-development. Virtual employee's motivation is defined by the sixth feature – focus on the McGregor's Y model leads to the situation when such a worker reveals a well-defined tendency to take over the creative tasks. Moreover, only the persons directed by McGregor Y model valuesare suited to effective virtual work which is not accompanied either by motive or by the strict control of the supervisor.

It is important to consider the marginal impact of these features of virtual employment on organizational efficiency. Firstly, it is important to define the modern approach to the definition of efficiency, suitable for use related to the organizations oriented to words virtual intellectual work. In this respect, most realistic is to determine what belongs to such guru in the scientific management as P. Drucker, who had noted that "...the efficiency and productivity of corporations should not be expressed in financial terms, otherwise they will senseless for intellectual workers. But the effectiveness of the "non-financial" sense is a consumer value... In the future strategy will be based on new definitions of efficiency and productivity" [2, 3, 4]. Quite remarkable is P. Drucker's interpretation of man's role in speeding up the economic and social development and ensuring good governance of the company – in the same book he is saying: "... in the early 50th last century the essence of the term "supervisor" has changed and got the following meaning – "the man responsible for the efficiency and results of the team". And now this statement again had been altered. The supervisor is perceived as a "person responsible for the knowledge utilization and effectiveness". That is according to the contemporary interpretation the process of information (knowledge) accumulation and elaboration is treated as the main factor that causes a change in the organization's efficiency.

Grounding on this definition, consider an organization that utilizes a virtual intellectual work on the basis of entropic approach that is commonly used in information theory. Such an organization can be interpreted as an open system that "provides" entropy to the environment and absorbs "energy"from the environment improving one's own competence (the amount of information collected). For any economic system it is important that its entropy, taken over a period of time $H(t)$, should seek a minimum $H(t) \rightarrow 0$. This is a condition for the stability of the system against the destabilizing factors that occur in the environment. And vice versa, in the accumulated entropy that is not "thrown" to the environment, uncertainty is increasing inside the organization i.e. the organization uncertainty being a consequence of certain actions. This can lead to very undesirable outcome even including the destruction of the organization.

Thus any economic system (organization) can exist only through the so-called metabolism (substance exchange) with the external environment. According to M. Porter concept [5, 6] the channels of this exchange are consumers, suppliers and competitors. Thus metabolism is regulated by legislation. According to the information theory the relationships that occur during this exchange can be described through entropy of an association [7]. In information theory two types of entropy of an association are distinguished –

- entropy of an association of two or more elements;
- entropy of two or more interdependent elements;
- entropy of two or more independent elements.

In the last two cases, entropy of an association refers to the probability of simultaneous occurrence of two events – being dependent or independent of each other. In the first case the amount of information generated by the occurrence of two events is considered. Accordingly entropy of two events association $H(X;Y)$ will be determined by the following relations (in the sequence corresponding to the list of an options above):

$$H(X;\ Y) = \sum_{i=1}^{n} \sum_{j=1}^{m} p(x_i;\ y_j)\ \ln\ p(x_i;\ y_j) \tag{1}$$

$$H(X;\ Y) = H(X) + H(Y/X) = H(Y) + H(X/Y) \tag{2}$$

$$H(X;\ Y) = H(X) + H(Y) \tag{3}$$

where: $H(X)$, $H(Y)$ – unconditional entropy of X and Y correspondingly;
$\quad\quad H(Y/X)$ – conditional entropy of Y relative to X;
$\quad\quad H(X/Y)$ – conditional entropy of X relative to Y;
$\quad\quad p(x_i;y_j)$ – probability of simultaneous occurrence of two events X and Y.

Prior to the treatment of treat these complicated conditions, it makes sense to analyze theoretically the possible marginal cases that define specific value of the economic system entropy (in our case – the company), to give their interpretation in the framework of the organization theory and the organizational culture, where the perspectives of modern organizational structures' development are treated along with and different classification principles of organizational cultures.

2.1. Atomistic Organization

Let us suppose that organization has *n* employees who know *n* approaches to execute current tasks and the organization does not restrict this choice even refusing to manage the progress of employees closely, focusing only on achieving the final result getting the best of employees' competencies. In terms of

organizational culture such an organization belongs to the "guerrilla squad" type of the Ackoff's classification when there is an unlimited choice of approaches for the implementation of clearly defined objectives. In terms of entropic approach this marginal case is the worst since the entropy of the system, defined by the formula (1) is the largest and equals $\log_2 n$, where n – number of the system. This so-called zero test has the highest entropy as it was proved in the theory of information. Regarding the objectives of this study it can be said that this marginal case corresponds to completely virtual organization, which on the basis of free choice was joined and abandoned by employees possessing fully independent skills and approaches that are necessary to execute specific tasks of the organization. Considering the features of virtual intellectual work which were defined above one can assume that such an organization could even include consumers who are provided by contemporary information and communication technologies with the opportunity to influence the process of developing and manufacturing the product. In this case, the uncertainty (entropy) is even rising through expanding the boundaries of the system.

2.2. "Hospital" (rigid organization)

Let us imagine the opposite marginal case – when there is only one approach to the task execution approved (acknowledged) and the organization is strictly demanding employees to follow this approach. This situation corresponds to "hospital" type of organizational culture introduced by Ackoff. In this case, by definition the entropy of the system equals zero, because there is only one way to execute the tasks, the selection of which is guaranteed (the probability of such a selection equals 1). That is the organization of the "hospital" type has the greatest possible certainty and minimal entropy. This organization rejects the possibility of the use of virtual employment, primarily because it is impossible to control, and, as a consequence of that performance management is quite complicated. Such an organization embodies a process of gradual incremental improvement of the procedures of its own activities while remaining strictly determined concerning the choice of approaches to business processes. However, if the approach adopted in such organizations would be false, or cease to meet the requirements of the environment, the organization ceases to be effective and may even cease to exist due to significant losses.

It is clear that the marginal cases, which were considered, do not occur in reality. Any organization being even the most rigid one must have a set of approaches to cope with the uncertainty of the environment (according to the concept of so-called contingency management). On the contrary, flexible organization that makes extensive use of virtual employment, is interested in limiting the choice of approaches to tasks execution. The possible mechanism of such restrictions and related role of self-management will be discussed below.Currently there is a need to explore it's the theoretical impact of entropy. Using the expressions (1)÷(3) one can

determine the entropy of the association. As it will be shown below it depends on the number of possible approaches to tasks execution and the uniformity of distribution of "popularity" of certain approaches among employees. Consider two intermediate theoretical cases.

2.3.1st "intermediate" theoretical case

Suppose that a set of possible approaches is limited and there are i approaches to execute the specific tasks that are utilized by identical groups of K workers. Simple transformations that can be made with formula (1) for this case (a system of independent elements) allow to determine that the decrease in entropy in relation to the case of the atomistic organization, which, as indicated above, is characterized by the maximum possible entropy $\log_2 K$. That entropy "defect" depends on the size of the group, using the same approach to execute the specific tasks and – automatically for uniform distribution of these approaches "popularity" –on their number. It is obvious that the marginal case of the entropy reduction will be its zero value for $i = 1$ and $K = n$ (this case corresponds to the organization of the "hospital" type by Ackoff). Fewer are different approaches to tasks execution and, accordingly, the larger the group, using separate approaches, the smaller the uncertainty is. We just got a mathematically rigorous proof of this fact. Summarizing the considerations that were made for atomistic organization of the "hospital" type (rigid organization) and analysis of recent theoretical case with uniform popularity of different approaches to tasks execution, we can conclude that the entropy of organizations consisting of independent employees is in the range:

- $0 \leq H(X) \leq \log_2 n$ – for range between "hospital" and the atomistic organization and

- $\log_2 n - \log_2 K \leq H(X) \leq \log_2 n$ – for range between uniform popularity of different approaches to tasks execution and atomistic organization.

3.4.2nd "intermediate" theoretical case

Interesting is also the issue of entropy change for the system of independent employees in the case of ununiformed "popularity" distribution of individual approaches to tasks execution. More specifically, it is interesting to find out whether ununiformed "popularity" of different approaches to tasks execution in the case of independent employees will lead to further reduction of entropy. To resolve this problem one needs to compare the reduction of entropy arising in the two cases: $\frac{1}{n}\Sigma_1^i K \log_2 K$ and $\frac{1}{n}\Sigma_1^i K \log_2 K_i$ given the fact that $K = \overline{K_i}$. After elementary transformations, we can determine the difference between the listed expressions defining the result's sign: $\Sigma_1^i (n - iK_i)$. This difference is positive for all i and K_i ($n = iK_i$ only when $i = 1$ and $K_i = n$, in other cases $n > iK_i$). Thus, it can be concluded that the

ununiformed employee groups that use the same approach to the tasks execution in organizations consisting of independent employees leads to decrease of total entropy, which depends on the distribution of workers between groups that prefer certain approach to the tasks execution.

For the two dependent systems the integral entropy of system *X* related to system *Y* is defined by the sum of absolute entropy and conditional entropy. From information theory whence entropic approach was borrowed it is known that entropy of association is always greater than entropy of a single entity, but smaller than the sum of their entropies:

$$\max[H(X); H(Y)] \le H(X; Y) \le H(X) + H(Y) \qquad (4)$$

Unconditional entropy *H(X)* or *H(Y)* – is a specific amount of information related to each element of the system consisting of subsystems between which there is no relationship. The conditional entropy corresponds to the uncertainty that remains when the distribution of the second random variable is known – it is the uncertainty that remains in the *X* after *Y* system was fully determined.

A given expression to define the range of entropy association can be interpreted as follows – if the states of the system elements are independent of each other or if the state of one system does not depend on the state of another system, the uncertainty that certain element of the system (or certain system) will be in one of the possible states *ij* is fully determined by stochastic characteristics of individual elements of the system or probabilistic characteristics of the systems themselves.

3. Cases of interdependent employees

Marginal values of entropy for these cases are defined by condition (4), but, as well as in the considerations above, it is important to determine the direction of change of entropy under conditions that correspond to different practical situations, including those related to changes in the organizational culture of modern enterprises using virtual employment and identify the role of self-management in such enterprises, which is required by objectives of this study.

Consider the case when the enterprise had involved the consumers (multiplicity *Y*), who can affect the process of development and manufacturing of products through modern communication technologies thus directly affecting *X*– the multiplicityof employees. Within the multiplicities of employees' *X* and consumers *Y* there are no internal dependencies, and they are completely free to choose the desired approach to the task execution or satisfaction of their desires even dreams regarding the product.

The entropy of a complex (associated) system is defined as:

$$H(X; Y) = H(Y) + H(X/Y) = H(X) + H(Y/X) \qquad (5)$$

$$H(Y) \geq H(X/Y) \text{ та } H(X) \geq H(Y/X) \qquad (6)$$

The first component of the expression (5) – the consumer entropy is fully consistent with the marginal estimates which were made above. So unique products made to individual consumers'orders will raise maximal entropy which is quite natural. Forming groups with similar aspirations and demands, a loss of uniformity and consolidation of these groups will lead to a decrease in entropy, which is also quite an expected result. In the real economic situation the groups formation of consumers with similar priorities may be caused by fashion trends, cultural values, property status and other external factors relating to the socio-cultural environment and the general condition of the economy.

Let us define the content of processes that constitute the conditional entropy change being the second component of the equation (5). The conditional entropy $H(X/Y)$ determines the amount of residual entropy (i.e., uncertainty which remains) of the system X after Y system is fully known. Regarding this, the evaluation (6) is quiteinteresting indicating that additional entropy increase is not greater than its "basic value". In terms of our research, this means that the virtual enterprise has a latent period when uncertainty is maximal, i.e.considering expression (4) is the sum of the uncertainty of consumers and employees. These components can be evaluated using speculationsmentioned above. Indeed, on the basis of these speculations, there are several threshold values of entropy of a complex system in question (see Table 1, which summarizes the results of the previous theoretical analysis).

Table 1. Threshold values of entropy of an open system. Self-eleboration.
Tabela 1. Wartości progowe entropii system otwartego. Opracownie własne.

	Isolated	Uniform groups	Different-sized groups (additional reduction of entropy)
Employees	$\log_2 n$	$-\log_2 k$	$\frac{1}{n}\sum_1^i (n - i \cdot k)$
Consumers	$\log_2 N$	$-\log_2 K$	$\frac{1}{N}\sum_1^i (N - j \cdot K)$

1) "Single" (isolated) consumers and employees, so all the consumers have different taste and desires, and the employees striving to meet them use different individual approaches – this case is related to the maximal possible entropy which equals $\log_2 n + \log_2 N$, where N – "power" of consumers' multiplicity (i.e. their number).

2) Customers and employees are united in the equal-sized groups with identical priorities (tastes, needs, desires and approaches to tasks execution) – the entropy decrease relative to the maximum value equals $(\log_2 k + \log_2 K)$, where K – the size of the groups of consumers who have the same priorities.

3) Customers and employees are united in the different-sized groups with the same priorities – value of the entropy decrease relative to the maximum is presented in the last line of table 1.

4) Employees are united in the equal-sized groups while consumers are united in the different-sized groups – the entropy decrease relative to the maximum equals to $\log_2 K$ plus additional component $\frac{1}{N}\Sigma_1^i (N - j \cdot K)$, which corresponds to the ununiformed distribution of priorities among consumers.

5) Consumers are united in the equal-sized groups while employees are united in the different-sized groups – the entropy decrease relative to the maximum equals to $\log_2 k$ plus additional component $\frac{1}{n}\Sigma_1^i (n - i \cdot k)$, which corresponds to the ununiformed distribution of the approaches to the tasks execution among employees.

From these idealized models let us progress to the analysis of the real situation prevailing in virtualized enterprises focusing on effects obtained through self-management.

Mutual help and support within the organization that ultimately leads to a narrowing set of possible approaches to the tasks execution causes mutual dependence between employees of the organization. According to the author's opinion, self-management as a science providing the pivot for the effective management of personal activities can constitute the basis for such dependence arising. That self-management is a mechanism of hidden dependence of virtual employment system elements that regulates the extents to which the employees of virtual intellectual work are really independent in the selection of approaches to tasks execution. The real level of limitations "set" of such an approach depends on a large number of factors, but above all – the degree of prevalence of knowledge of time management and self-control techniques.

At the same time in the environment there are also mechanisms that give launch to the consumers' interdependencies. First of all, these are the common values, fashion, social and cultural characteristics (factors) and others.

One can imagine more complicated combinations of independency and interdependency of employees such as independent virtual staff and interdependent stationary staff affected by customers or other possible cases. All these situations can be modelled using the results put in table 1 but maybe some additional transformations regarding the value of entropy should be needed based on expressions (1)-(3)&(5)-(6). The resulting entropy still be in the threshold defined by expression (4) but at the same time the expected organizational culture of such combinations of virtual and stationary employees cannot be defined on the ground of Ackoff's classification and other more sophisticated approaches

should be utilized. The detection of reliable approaches for these cases and the identification of respective organizational culture is obviously beyond the tasks of current investigation and makes the direction of future research.

4. Conclusions

Thus the concluding analysis of organizational culture deformations in conditions of intellectual work virtualization should note that:

·On the basis of classical definition of entropy the variety of cases of the employment virtualization were analyzed theoretically and the identification of organizational culture for these cases was done using one of the basic classification approaches.

·The marginal case of complete virtualization of intellectual work with fully independent employees will lead to the maximal uncertainty inside the organization and consequently to the biggest possible entropy that is defined entirely by headcount of such an organization. The organizational culture in this case has all the features of "guerilla squad" by Ackoff.

·Organization of virtual employees into the groups leads to diminishing of resulting employees being the most substantial in the case of ununiformed groups of certain approaches to the tasks execution supporters. The organizational culture in these cases are in the move to the "hospital" type by Ackoff.

·The stiffest organizational culture possible corresponding to Ackoff's type "hospital" gives zero entropy for the organization.

·Involvement of customers into the process of product development and manufacturing which corresponds to most advanced the paradigm of business yet cannot be described with mathematical rigorosity but main factors influencing the resulting uncertainty of organization and related organizational culture should be addressed through qualitative approaches.

·The self-management on the one hand and the common values influenced by organizational culture on the other can diminish the resulting instability of an organization facilitating its level of control and not sacrificing additivity.

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