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IMPROVING A COMPANY'S COMPETITIVENESS BASED ON INNOVATIVE TRANSFORMATIONS OF INTRA-ORGANIZATIONAL INTERACTIONS

MELHORAR A COMPETITIVIDADE DE UMA EMPRESA COM BASE EM TRANSFORMAÇÕES INOVADORAS DE INTERAÇÕES INTRAORGANIZACIONAIS

MEJORAR LA COMPETITIVIDAD DE UNA EMPRESA A PARTIR DE TRANSFORMACIONES INNOVADORAS DE LAS INTERACCIONES INTRAORGANIZATIVAS

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ABSTRACT
The paper considers the actual problems of increasing the competitiveness of the organization due to organizational changes in the conditions of restrictions associated with the pandemic. The importance of organizational efficiency as a significant factor in improving competitiveness has been shown. The impact of changes related to work in the conditions of a pandemic for various types of organizations characteristic of transport enterprises has been considered based on multi-agency models. The dependence of the drop in efficiency in the conditions of a decrease in the communication flow for various types of organizations in a changing external environment has been determined. The influence of the individual efficiency of employees on the effectiveness of the organization as a whole has been analyzed. Strategies for compensating for the drop in efficiency under new conditions have been considered and the conditions of their applicability have been determined. A variant of improving organizational efficiency using "communication brokers" has been proposed, the conditions for its most effective use for various types of organizations have been determined.

Keywords: intra-organizational interactions; innovative transformations; organizational efficiency; organization structure; company competitiveness.

RESUMO
O trabalho considera os problemas reais de aumento da competitividade da organização devido a mudanças organizacionais nas condições de restrições associadas à pandemia. A importância da eficiência organizacional como fator significativo na melhoria da competitividade tem sido demonstrada. O impacto das mudanças relacionadas ao trabalho nas condições de pandemia para vários tipos de organizações características das empresas de transporte tem sido considerado com base em modelos multiagências. A dependência da queda na eficiência das condições de diminuição do fluxo de comunicação para vários tipos de organizações em um ambiente externo em mudança foi determinada. Foi analisada a influência da eficiência individual dos funcionários na eficácia da organização como um todo. Estratégias para compensar a queda de eficiência sob novas condições foram consideradas e as condições de sua aplicabilidade foram determinadas. Uma variante de melhoria da eficiência organizacional usando "mediadores de comunicação" foi proposta, as condições para seu uso mais eficaz para vários tipos de organizações foram determinadas.

Palavras-chave: interações intraorganizacionais; transformações inovadoras; eficiência organizacional; Estrutura de organização; competitividade da empresa.

RESUMEN
El artículo considera los problemas actuales de aumento de la competitividad de la organización debido a los cambios organizacionales en las condiciones de restricciones asociadas a la pandemia. Se ha demostrado la importancia de la eficiencia organizativa como factor significativo en la mejora de la competitividad. El impacto de los cambios relacionados con el trabajo en las condiciones de una pandemia para varios tipos de organizaciones características de las empresas de transporte se ha considerado con base en modelos multiagenciales. Se ha determinado la dependencia de la caída en la eficiencia en las condiciones de una disminución en el flujo de comunicación para varios tipos de organizaciones en un entorno externo cambiante. Se ha analizado la influencia de la eficiencia

individual de los empleados sobre la eficacia de la organización en su conjunto. Se han considerado estrategias para compensar la caída de la eficiencia en las nuevas condiciones y se han determinado las condiciones de su aplicabilidad. Se ha propuesto una variante de mejora de la eficiencia organizacional utilizando "intermediarios de comunicación", se han determinado las condiciones para su uso más efectivo para varios tipos de organizaciones.

Palabras clave: interacciones intraorganizacionales; transformaciones innovadoras; eficiencia organizativa; estructura de organización; competitividad de la empresa.

1. INTRODUCTION

Competitiveness is determined in modern market conditions not so much by the availability of resources, budget, established production, as by the efficiency of their use. The competitiveness of the company directly depends on the development and implementation of innovations and modern technologies that affect the production sphere and optimize the entire production process to save money and inventory. However, competitiveness is not limited to the improvement of the technological cycle. The so-called "dynamic abilities" are the most important" (Teece, Pisano, 1994), which allow the company to demonstrate a timely and adequate response to changes in the external environment and ensure the implementation of the necessary innovations due to an easily configurable and transformable system of competencies of the company.

Dynamic abilities are a unique resource of the enterprise. The manifestation of a quick, adequate, high-quality response to the rapidly changing external situation is a competent redistribution of resources, empowerment, the ability to create or transform the necessary departments to solve acute issues. The success and the possibility of conducting these operations are embedded in an effective organizational structure that determines the dynamics of managerial and operational interactions within the organization. In general, it can be said about a promising and deep potential for development, which is proved by numerous studies of recent years considering the organizational redesign as a rich reserve of the company to increase competitive advantages (Besley, Ghatak, 2005; Morris et al., 2010).

The company's dynamic capabilities are particularly relevant in the conditions of a shrinking market when increasing competitiveness becomes one of the priority tasks. In modern realities, with regularly occurring price wars, the need to work at the limit of profitability, the use of intangible reserves comes to the fore, the main source of which is the potential of employees and the formation of the most favorable conditions for its use.

Transformations of the organizational structure require less investment than production, which is also an undeniable advantage in the current economic environment. Unprecedented changes in working conditions associated with the coronavirus epidemic have caused the need to modify the organizational structure of the company to obtain higher economic results due primarily to effective management and corresponding changes in organizational structures (Shevchenko et al., 2020).

The organizational structure as a whole is a set of static characteristics that create formal chains of subordination, and dynamic characteristics of regulated and unregulated interaction of employees forming a communication network (Pismennaya, Vlasyuk, 2016). Therewith, the structure, frequency, and quality of interactions have a decisive influence on the effectiveness of work. All departments of the organization are involved in the communication process – management, commercial, and production units. It is impossible to achieve maximum efficiency of the organization's work without trusting, prompt, transparent communications of people who represent the priority goals of the company and are on the same page.

In connection with all the above, it is of significant interest to improve the interaction algorithm, increase the efficiency of the company due to changes in the organizational structure, both in its static and dynamic aspects. The improvement of the organizational structure is of key importance for planned joint activities and in the conditions of rapid changes in the external environment, which often require the adoption of complex, unpopular decisions from the point of view of employees, especially during the global crisis. From this position, the increase in the company's competitive advantage lies in building an effective communication system, a structure with significant adaptive capabilities, the ability to anticipate, develop and implement innovations.

Summarizing the above, we note that static characteristics, such as the depth of hierarchy levels, the density of the network of interaction between organizational units and entire divisions; as well as dynamic ones that affect the dissemination of information – the speed of dissemination, indicators of the impact of working units on each other, the time of adaptation of the company in response to changes in the external environment, determine organizational efficiency.

The purpose of this work is to consider several typical organizational structures, taking into account the dynamic component of interactions in the conditions of a decrease in the level of interaction characteristic of a pandemic, and to determine the possibilities for compensating for the negative consequences of such a decrease by modifying the organization's communication network. Based on simulation modeling, we will determine the most effective way of organizational changes, depending on the type of organization.

2. METHODS

We consider the influence of the changing external environment on the behavior of the company, while the company is considered as a set of identical interacting agents N_0. Multi-agent models have become widely used as a means of analyzing the dynamics of various socio-economic systems due to both the simplicity and naturalness of the initial assumptions and the ability to analyze in detail the complex dynamics of elaborate systems of various volumes (see, for example, (Davis, 2013; Rovenskaya et al., 2020)).

Considering the behavior of a company in a changing external environment, we believe that the *i*-th agent can be in two states s – the initial one corresponding to the initial state of the organization ($s_i = 0$) and the target one corresponding to the new state of the external environment ($s_i = 1$). The probability *P* of switching the *i*-th agent to the target state at each step of the simulation is determined by a logistic function of the following form

$$P(i) = Ce^{ax_i/x_{oi}}/\left(1 + Ce^{ax_i/x_{oi}}\right)$$

where x_i is the number of agents associated with the *i*-th and in a state other than the base one, x_{0i} is the total number of agents associated with the *i*-th. The parameter a determines the individual effectiveness of an individual agent. With its growth, this agent needs less and less information from other agents to make a decision about switching to the target state. Two characteristics are key to system behavior – the structure of the organization as a whole, and a – the characteristic of the individual effectiveness of each agent.

The structure of an organization is determined by the number of agents $N_i$in a hierarchical unidirectional relationship and the number of hierarchy levels G_i, the number of

agents connected by a bidirectional connection N_p and the number of groups in which bidirectional communication is implemented G_p.

Three types of organizations are considered in this paper – purely hierarchical ($N_i = N_0$, $G_i = 4$, $N_p = 0$, $G_p = 0$), adhocratic with clan elements ($N_i = 3, G_i = 1$, $N_p = N_0 - 3$, $G_p = 3$) (in Kuhn's terminology (Quinn, Rohrbaugh, 1981)) and hybrid ($N_i = N_0/2, G_i = 2$, $N_p = N_0/2$, $G_p = 8$). These types of organizations cover almost the entire spectrum of possible organizational structures, representing both marginal cases and some combination of them. The principal difference between the hierarchical structure and other studied types is in unidirectional communication when the information about the target state available to lower-level agents is entirely determined by the state of agents located at a higher level.

Modeling of the changing external environment was performed by feeding one of the agents standing at the top of the hierarchical structure of the company, at the *k*-th step of modeling a variable external signal of the form

$$I(k) = \begin{cases} 1, if\ mod(k, T_v) = 0 \\ 0 \end{cases},$$

Two variants were considered – an external signal with a fixed period of changes T_v=const and an external signal in which the period of its receipt changed randomly within different limits ($2<T_v<6$). The behavior of the system was considered when changing the parameter *a*, which determines the adaptive capabilities of an individual agent.

To compare the dynamics of various organizational structures, a characteristic was previously proposed, which is the normalized time of switching the organization as a whole to a state corresponding to external influence (Pismennaya, Vlasyuk, 2016). We develop the described model, assuming a change in the external signal. Due to the significant transiency of the task, it seems promising to use not the time of transition to a stationary state as a characteristic of the organization's adaptive capabilities, but the number of agents normalized to the size of the organization that are in a new (target) state after a fixed number of modeling steps T (in our case, T = 100, which significantly exceeds both the duration of the signal propagation along the organization in the stationary case and the period of external influence) $S = N(k|s_i = 1)/N_0$. A larger value of this characteristic will correspond to the

best adaptive capabilities of the organization and its greater competitiveness. The final result was obtained by averaging the results of 100 separate simulations of the system dynamics. An increase in this parameter did not show a significant effect on the results.

To model the behavior of an organization in a pandemic, when communication between employees is difficult, another parameter was introduced – the coefficient of weakening of the communication flow in the organization, which determines the decrease in the information available to an individual agent.

3. RESULTS AND DISCUSSION

In this section, we analyze the dependence of the previously introduced features S – shares of the organization in trust as at the end of the simulation (higher values correspond to better adaptation of the organization to external conditions for the same period) from the values of the parameter a, which determines the probability of the transition of the agent in the target state (higher values correspond to a high probability of transition to the target state at a constant state of other agents) for different organizational structures – hierarchical ($N_i = N_0,\ G_i = 4,\ N_p = 0,\ G_p = 0$), adhocratic-clan – ($N_i = 3,\ G_i = 1,\ N_p = N_0 - 3,\ G_p = 3$) and hybrid ($N_i = N_0/2,\ G_i = 2,\ N_p = N_0/2,\ G_p = 8$) in the context of a changing environment and reduce communication that exists in modern conditions of the pandemic.

A decrease in communications between individual agents belonging to the company is expected to lead to a decrease in the adaptive capabilities of the company as a whole, although the degree of degradation of organizational efficiency and its manifestations at different levels of individual effectiveness of individual agents significantly depends on the type of organization.

Even a small drop in the intensity of communications leads to a significant, almost zero, drop in organizational efficiency for hierarchical organizations, the most typical for the transport industry, with low levels of individual efficiency. At higher levels of individual efficiency (readiness) of the agents that make up the organization, the drop in the level of efficiency of the organization as a whole almost linearly depends on the decrease in the volume of information circulating in the organization. Note the presence of a clearly defined threshold effect – after reaching a certain level of individual efficiency, a hierarchical

organization reaches the maximum possible level of efficiency for itself and further development of personnel does not increase this efficiency.

An increase in the degree of uncertainty of the external environment, as was shown earlier (Pismennaya, 2015), significantly reduces the effectiveness of hierarchical organizations. This effect is enhanced under the conditions of communication restrictions, while organizational efficiency as a whole can reach 10% of the possible maximum even at high levels of individual efficiency.

For adhocratic organizations, the decrease in the effectiveness of the organization as a whole due to communication restrictions with a low degree of uncertainty of the external environment is not as significant as for hierarchical organizations with low levels of individual efficiency. However, at high levels of individual efficiency, a decrease in communication activity reduces the level of efficiency of the organization as a whole several times, practically reducing the effectiveness of this type of organization to zero.

An increase in the degree of uncertainty of the external environment does not lead to a significant change in the profile of the dependence of the organization's effectiveness on the individual effectiveness of individual agents. A decrease in communication activity in such conditions leads to a decrease in the efficiency of the organization, leading it to levels of 10% compared to the efficiency of a hierarchical organization.

For hybrid organizations that combine the hierarchical part and project teams, at low levels of uncertainty of the external environment, the growth of individual efficiency leads to an increase in the efficiency of the organization as a whole, while a decrease in communication activity reduces the efficiency of the organization and the levels of organizational efficiency achieved in these conditions are comparable to the efficiency of a hierarchical organization.

The increase in the uncertainty of the external environment shows the advantages of a hybrid organization that combines hierarchical and project elements in conditions of reduced communication activity. A decrease in this activity leads to a decrease in organizational efficiency, but the levels achieved are significantly (1.5-2 times) higher than the levels achieved in the same conditions by hierarchical organizations.

Further analysis was carried out to determine the impact of possible strategies to compensate for the decrease in communication activity on organizational efficiency to choose

the best direction of organizational changes. The simplest approach to compensate for the decrease in communication activity is to increase the number of connections between individual agents in the organization.

For a hierarchical organization, we considered adding new channels of interaction that connect employees at the same level of the hierarchy. In the case of low variability of the external environment, the organization of such contacts does not fundamentally change the behavior of the system as a whole. In the case of the high variability of the external environment, such organizational changes lead to a significant increase in organizational efficiency, including a decrease in communication activity. By adding additional channels of interaction, the efficiency of the organization can grow by 2-3 times.

For an adhocratic organization, the addition of new channels of interaction linking individual project groups at the execution level leads to a decrease in the level of organizational efficiency with a decrease in communication activity. This effect is observed at both low and high levels of environmental variability.

For a hybrid type of organization that combines hierarchical and project elements, the addition of communication channels between employees located at the management level – in the hierarchical part of the organization – generally leads to a decrease in organizational efficiency.

Another possible way to increase communication activity is to form a communication broker within the organization – an employee who interacts with a large set of employees and is connected, on the one hand, with the management level, and on the other – with the operational level.

Adding such a broker in a hierarchical system can significantly increase organizational efficiency, especially in the case of a high level of uncertainty in the external environment. Such a broker allows increasing the efficiency of the organization by 1.5-2 times in case of a decrease in communication activity.

Adding such a broker to an adhocratic organization also increases its efficiency, especially in the case of relatively high levels of local efficiency. Therewith, the increase in the efficiency of the organization can reach 2-5 times, depending on the level of decrease in communication activity.

The creation of a communication broker in a hybrid organization also leads to an increase in organizational efficiency, especially for the case of the high variability of the

external environment, while the increase in efficiency in the presence of a broker compared to the original organizational structure is higher, the greater the loss of communication activity.

The development of the pandemic led to the fact that employees, being isolated, faced several predictable problems, for example, the need to establish the efficiency of the home office, and non-obvious difficulties related to the lack of a familiar circle of communication or corporate procedures. Moreover, the technical side, which implies debugging equipment, getting access to working files, installing the necessary programs, in most cases turned out to be much easier to solve. Difficulties arose at the moment when there was a decrease in the information flow in the established communication network of both formal and informal interactions. The regulated algorithms of work and execution of absolutely every task were violated. The vast majority of employees felt a lack of information due to a decrease in the level of communication with colleagues and management, difficulties in supporting decision-making, professional advice, and monitoring the performance of duties. The management units also experienced difficulties in monitoring the implementation of the designated functions, development processes, and project management. The main reason for these difficulties was a significant decrease in the communication flow. The usual algorithm for the execution of job descriptions and duties has undergone serious failures, and sometimes the inability to perform in a remote format. The transition to online approvals required significant time costs and an increase in the implementation time of all operations. As the results of multi-agent modeling show, a drop in efficiency occurs in this case, regardless of the type of organization. It is somewhat easier for such deterioration to be tolerated by organizations of a hierarchical type, but only in the conditions of carrying out habitual, unchanging activities. The emergence of abrupt changes in the external environment leads to a significant drop in organizational efficiency.

For hierarchical structures characteristic of the transport industry, in the conditions of a decrease in the communication flow, we found a threshold effect with an increase in personal efficiency – the efficiency of the organization as a whole increases sharply when employees reach a certain level of personal readiness and in the future, the growth of organizational efficiency slows down significantly. The reason is the limited contacts in the hierarchical environment – after reaching a certain level of personal adaptive capabilities, sufficient to make the right decision based on the available data, further development does not increase the

overall efficiency, because the data available to the agent no longer becomes. Based on this, we can recommend the development of employees of hierarchical structures that demonstrate low organizational efficiency, until the first signs of growth in the effectiveness of the organization as a whole appear.

As practice has shown, in conditions of the high variability of the external environment, companies implementing organizational structures with hybrid properties, combining both hierarchical and project structures, coped more easily with the limitations and difficulties associated with the pandemic, compared with companies operating through heavy, unwieldy structures with a large number of hierarchy levels and a high degree of bureaucracy. This was especially evident at the beginning of the introduction of restrictions. The results of our modeling show that such structures achieve significantly (up to 1.5-2 times) higher levels of organizational efficiency in these conditions. The reason for this behavior is a combination of a hierarchical structure of small depth, which ensures rapid communication of information to project teams and bidirectional communication of employees in project teams, which allows maintaining a sufficient number of channels for its receipt in conditions of lack of information.

The self-isolation regime demonstrated the value of informal interaction, which is not fixed by the regulations, taking place "on the go". In this aspect, the organization's communication network contributes to the development of potential employees, the development of intellectual capital, becomes a full-fledged resource of the company, stimulates the growth of collective dynamics, and multiplies corporate value (Nappi-Choulet et al, 2019). The results of the lack of latent communication were failures of cross-functional coordination, and, as a result, a decrease in the efficiency of the company's functioning, which means the threat of holding positions in the market. A sharp decrease in the regularity and productivity of interactions demonstrated communication gaps both in the labor and social sphere. Companies, having hurled all their efforts into solving urgent problems, often dispersed the focus of attention from the social sector, as a result of which employees had a reduced sense of belonging to the company, involvement in common corporate goals, and, consequently, the level of productivity. Moreover, the information pause regarding the way of development of the enterprise in the new realities, the occupied market share, the understanding of current affairs in the company generated the appearance of negative rumors, which further contributed to the fragmentation of the team. Since the company's success in the

market significantly affects the well-being of employees, their need for such information is high. The omission of information, mainly negative, can play a bad role and provoke a crisis. An open dialogue and the dissemination of reliable data increases the degree of trust in the team and is an essential factor in the effectiveness of the organization.

In the conditions of a pandemic with a high degree of uncertainty of the external environment, forced changes in the communication system can act as a way to increase organizational efficiency (Sukoco et al., 2020). At first glance, the simplest way to increase efficiency in the context of a decrease in the communication flow is to add new links between existing organizational units and individual employees. In this way, the organization tries to fill the gaps in obtaining information. The results of our modeling show that such a consolidation of the communication network is successful only for a hierarchical organization and in the case of the high variability of the external environment. Therewith, the increase in efficiency due to additional interactions for this type of organization can be significant. Additional channels of interaction compensate for the lack of up-to-date information while maintaining a high degree of manageability characteristic of hierarchical structures. However, for organizations that are already characterized by a significant information load on an individual agent, the addition of new channels of interaction at the horizontal level does not lead to a significant increase in efficiency.

One of the phenomena of the communication process during the pandemic is the appearance of "communication brokers" – an additional link connecting management and subordinates. This employee is a shadow leader who interacts with a large circle of colleagues, enjoys the respect and trust of the team. Such an employee manifests himself/herself as a confident, competent specialist, in whom the team feels supported as a professional who can solve the most acute problems, shows responsibility at all levels, focuses on the development of the company, and effectively cooperates outside the hierarchy. The contribution of such employees is widely in demand, especially in a remote work situation, when it is much more difficult to get objective information about the mood of the team and maintain a general understanding of the current situation in the company.

The results of our modeling show that adding a communication broker to the organizational scheme can significantly increase organizational efficiency for all types of organizations. A communication broker in a hierarchical organization allows information

from the top level of management to reach the level of execution as quickly as possible, while the breadth of its connections is fundamental. The addition of a single broker made it possible to significantly increase the efficiency of the hierarchical organization in the case of the high variability of the external environment. For hybrid structures, a communication broker is also the best strategy for compensating for a decrease in the communication flow, and its influence increases as the number of control signals circulating in the system decreases.

4. CONCLUSION

The competitiveness of the organization directly depends on the development and implementation of innovations and modern technologies that affect the production sphere and optimize the entire production process to save money and inventory. However, competitiveness is not limited to the improvement of the technological cycle, the "dynamic abilities" are important, which are a unique resource of the enterprise. The manifestation of an adequate response to the rapidly changing external situation is the operational and purposeful management of the enterprise. The success and the possibility of such actions are embedded in an effective organizational structure that determines the dynamics of managerial and operational interactions within the organization.

The development of the pandemic has led to a decrease in the information flow in the established communication network of both formal and informal interactions. The vast majority of employees felt a lack of information. The results of modeling using the multi-agent approach show that for typical types of organizational structures – hierarchical adhocratic and hybrid, such a decrease in organizational efficiency can be successfully compensated by organizational changes based on compensating for the lack of information with new channels of interaction. Therewith, the obvious way to create new channels through horizontal interaction of employees has limited applicability. Such a consolidation of the communication network is successful only for a hierarchical organization and in the case of the high variability of the external environment. Therewith, the increase in efficiency due to additional interactions for this type of organization can be significant. For organizational structures characterized by a high information load on an individual employee, it is more effective to form a "communication broker" in the organization's communication network – an employee characterized, on the one hand, by the breadth of communication links, on the

other hand, considered by other employees as a verified source of information. Such a change in the organizational structure makes it possible to compensate for a significant share of the drop in efficiency associated with a decrease in the level of information circulating in the organization, while for hybrid organizational structures, the effectiveness of such a change is maximum at the lowest levels of information exchange.

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