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Assessment of the Influence of Adaptability Factors on the Effectiveness of Managing Changes in Enterprises by Fuzzy Logic

Andrii Shpakov, Sergii Stetsenko, Hanna Shpakova^{*}, Lesya Sorokina, Roman Akselrod

Kyiv National University of Construction and Architecture
03037, 31 Povitroflotskyi Ave., Kyiv, Ukraine

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Abstract. The article is devoted to solving the urgent issue of identifying factors to stimulate staff that will best provide flexibility and the ability to manage changes in the operating system of the enterprise. The purpose of the study is to identify the correlation between the transformation ability of enterprises and the adaptive capabilities of the main driver of change management – personnel, and to identify internal factors that are the drivers of change. The study was conducted on the example of data from Ukrainian construction companies. The McKinsey “7S” model is used as a conceptual framework to identify such factors. According to the model, all factors are grouped by the following components: strategy, skills, shared values (corporate culture), structure, staff, systems, and style. Since the purpose of the study is to identify the impact that adaptive capabilities of staff have on the flexibility and ability to transform the company, the paper describes a model of the impact of factors of the group “staff” on the flexibility and effectiveness of change. The simulation was performed using tools of fuzzy logic. As a result, it was determined that the effectiveness of transformations is influenced by the following indicators: productivity (output), the administrative burden on wages (the ratio of administrative expenses to wages in operating expenses), the availability of employees with higher education among management staff, the experience of management staff, the ratio of labor costs to wage costs. The proposed evaluation system allowed to identify key factors for the transformational ability of enterprises, which will, if necessary, purposefully influence them, achieving the desired level of flexibility and providing adaptive capabilities of the enterprise system. Prospects for further research should be the creation of models based on fuzzy logic, which take into account the influence of factors in the formation of strategy, skills, corporate culture, structure, systems, and style on the transformation ability of enterprises in construction

Keywords: change management, tools of fuzzy logic, staff, construction company, efficiency



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^{*}Corresponding author

INTRODUCTION

Ukrainian enterprises, during the implementation of operational, financial, and investment activities, are constantly faced with the variability of the environment due to transformational processes that are constantly taking place at the level of the world economy, the Ukrainian financial and economic system, sectoral markets, etc. In the long run, the tendencies of changes for Ukrainian enterprises are [1]: “Ukraine’s accession to the European Economic Space; implementation of projects to harmonise the Ukrainian national standardisation system with the requirements and rules, according to which the systems of national standardisation of the European Union members are functioning; implementation of energy and resource-saving programs as a priority direction of the country economic security development; the digital transformation of the country economic system; transition to the digital basis of many organisational, structural, and financial-economic relations between economic entities; deregulation and institutional changes of the economy; the influence of economic cycles, structural transformations caused by events in the east of the country”. Changes constantly affect all spheres of enterprises activity. They influence all factors of future development, and also have different directions. That is, changes can influence enterprises in a positive aspect (transformation of the institutional environment [2], changing the regulatory framework due to the transition to European product quality requirements [3]), and in a negative aspect (COVID-19 epidemic, etc.). To develop effectively, to use favorable trends, and confront negative challenges, enterprises need to change, transforming the operational system in response to external environment impacts, even ahead of them. That will help to ensure their own survival and sustainable development in the long term. But the uncontrolled changes can threaten the existence of the enterprise even more than external influences, so the actual direction of economic science development today is change management.

For successful implementation of changes in the system of strategic management, business entities need to change the approach to management, involve personnel support, form an effective organisational structure, promote changes in corporate culture, and establish links between all management chains for effective communication. The paper [4] notes: “the implementation of changes is a complex process, which is not always successful due to different reasons. Failures in most change processes can be caused by poor communications and connections, underestimation of the amount of necessary preparation for change, and the main goal of the study is to identify key steps that can improve change management”. It is also important to emphasise the importance of change management not only at the level of individual enterprises but also for the implementation of projects in different sectors of the economy. Thus, in the article [5] it is noted that “change management plays an important

role in improving the success of projects. Flexible project management provides new management opportunities based on the adoption of changes as an inevitable component of the project management process in the construction sector”. One can agree with the authors of the article that change management should be implemented at all levels of management and areas of activity of enterprises.

Change management is a relatively new direction of economic development and enterprise management, which along with the most pressing tasks of the present day, for example: ensuring sustainable development [6; 7], digital transformation of construction [8; 9], resource and energy saving [10], assuring long-term competitiveness [11-13], transition to industry 4.0 and 5.0 [14]. But the scientific studies, which are conducted in this direction, are trying to solve one of the most urgent tasks of economic science – providing opportunities for enterprises to implement adaptation to constant changes and transformations of the external environment. As a result of the change management process, enterprises should gain greater operational efficiency and/or productivity, while creating additional competitive advantages and gaining new perspectives and platforms for further development. The urgency of change management research is indisputable and has great prospects for development, therefore the *purpose of the study* is to build the dependence between the ability to transform enterprises and adaptive capabilities of enterprise personnel – the main driver of change management. In phase two, we have to identify internal factors that form the list of change factors (on the example of construction enterprises).

LITERATURE REVIEW

The issue of change management at enterprises is considered in numerous scientific works, which are focused on solving tasks on revealing changes and their consequences within the framework of construction projects [15], simulation modeling of changes [16], identification of factors of change management success at the level of realisation of construction mega-projects [17] and factors, which lead to changes in construction enterprises [18] the influence of organisational culture on the efficiency of construction enterprises [19-21], leadership [22-24] and support for changes by management staff [25; 26], a clear plan for implementation of changes [4] practical aspects of implementing changes [27], search for solutions that will provide the best flexibility and response to changes [5].

The article [12] analyses and groups the changes and their factors at the construction stage, which are grouped according to the degree of impact, the time of implementation, the person responsible for change management, the reason for changes, the renewable or non-renewable resources, the type of contract, the stakeholders’ interest, as well as shows the impact of changes on key

elements of the project and gives recommendations, which will minimise the consequences of unwanted changes for stakeholders. In the paper [16] it is stated that the processes of change management may fail due to dependence on the human factor, and also proposed the use of automation systems for change management in order to reduce the “human factor” influence. The authors of the work [17] identified eleven factors that ensure the efficiency of change management in construction projects. Namely: accumulation and application of technologies, innovations, application of specific management system, organisational regime and structure, support from management staff, implementing of project culture, social behavior, corporate reputation, and fulfillment of social obligations in five categories (project environment, construction opportunities, organisation, positive culture and behavior, as well as requirements for sustainable development). The study [18] presents a number of factors that lead to changes, among which authors distinguish the following: “increased competition, new laws and regulations, organisational growth, economic crises, support from top management, and clear planning of changes are factors of successful change management”.

The paper [19] examines the impact of organisational culture, learning, and knowledge management systems on the effectiveness of construction, and authors of [22; 25; 26] emphasise the importance of leadership, motivation, and support of transformations at the level of top management. The article [4] highlights critical importance for successful implementation of changes

in the following steps: clear planning of the program of changes, neutralisation of opposition, and formation of new organisational culture. Anthony Mento, Raymond Jones & Walter Dirndorfer [27] in their work consider practical aspects of the implementation of the three most famous change management models in the business, including Kotter’s strategic eight-step model for transforming organisations, Jick’s tactical ten-step model for implementing change, and General Electric (GE)’s seven-step change acceleration process model. In the work [5] it is stated that the most effective decisions of flexibility in change management are: permanent monitoring and improvement of resources, flexible working process, client participation, simplified communication, quick response to requirements, constant learning.

Since most of the analysed papers emphasise the importance of staff in change management, it is proposed to use the widely used McKinsey 7-S model created by the American authors’ team, T. Pithers and R. Waterman as the basis for assessing the company’s ability to transform [28]. This model gained wide popularity in the 1980-ies. The advantage of the model (compared to other models of the company’s microenvironment assessment) is that it emphasises the importance of the human factor in the company’s development and considers the structure of the company not only on the basis of available material values [29].

MATERIALS AND METHODS

The research is carried out in several stages (Fig. 1).

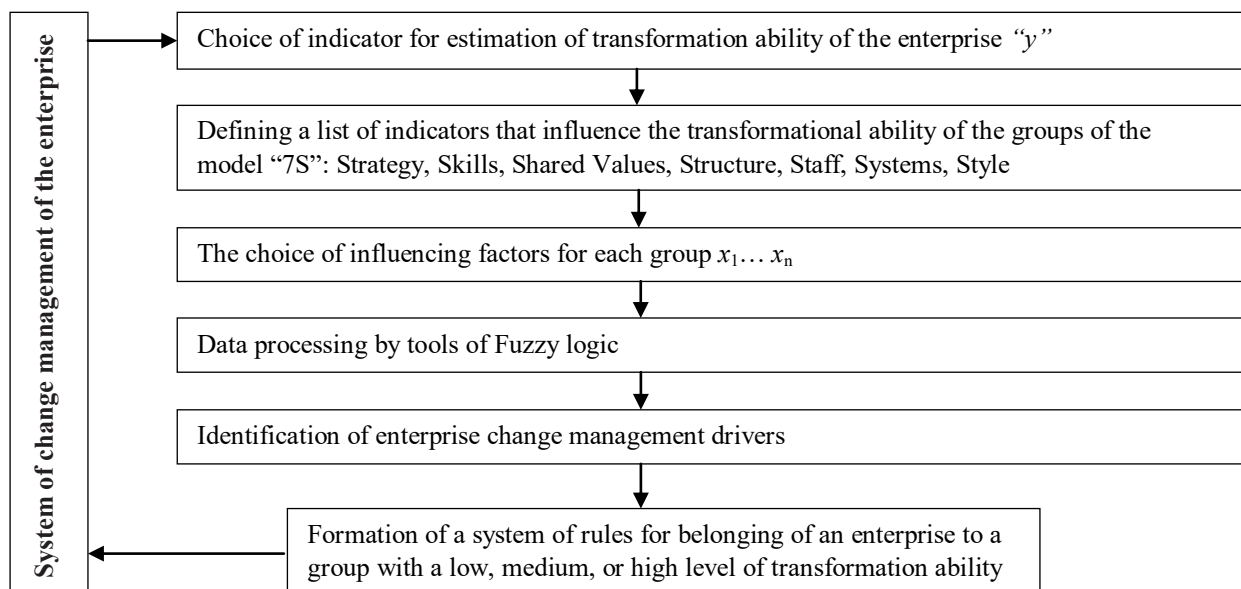


Figure 1. Conceptual model for determining the impact of staff adaptability on enterprise transformation

The first stage of the model is the assessment of the ability of the enterprise to change. Transformative ability is proposed to be defined as the ratio of the efficiency of the operational activities of the construction enterprise in the estimated period to the average efficiency

of the operational activities of the construction sector in the relevant period. This is due to a study hypothesis, which assumes that the higher the ability to change the enterprise is, the higher the effectiveness of its activity compared to other competitors.

The second stage of the research is to determine on the basis of the literature review the list of indicators to be combined in the group according to the model “7S” and to determine their influence on the transformation ability of the enterprise on the basis of Fuzzy logic. The system of fuzzy logical conclusion by means of the Matlab Fuzzy Logic Toolbox application package was created with the help of the system of fuzzy output of the Madami type. In this case, systems like Madami are the result of designing and learning a neurofuzzy hybrid model.

The third stage is the formation of a system of fuzzy rules to manage the transformation ability of enterprises and to identify change management drivers, due to which changes can be accelerated or slowed down.

As a sample, the authors used data on 26 construction enterprises collected from open sources. A sample of 151 observations was studied. All the enterprises chosen belong to section F of construction of buildings (section 41), construction of buildings (section 42) by the Classifier of economic activity types (KVED 2010). These enterprises

carry out general construction works and road construction. Data on the activity of companies from 2007 to 2020 are used. Among the indicators that characterise the development of enterprises are those that can describe the ability to change the personnel of the enterprise. It is assumed that the adaptation capacity of the construction enterprise “y” depends on the following factors:

P_1 – labor productivity in the investigated period (ratio of revenue from sales of products to the average annual number of employees of the building enterprise).

P_2 – the ratio of administrative expenses to wages in operating expenses.

P_3 – the share of employees with higher education in the total number of management staff.

P_4 – experience of management staff.

P_5 – the ratio of labor costs to wage costs.

For the hybrid network training, the authors used a “hibrid” method with error level 0 and number of cycles 40. For input factors x_1-x_5 and integral y the model “five inputs-one output” was obtained (Fig. 2).

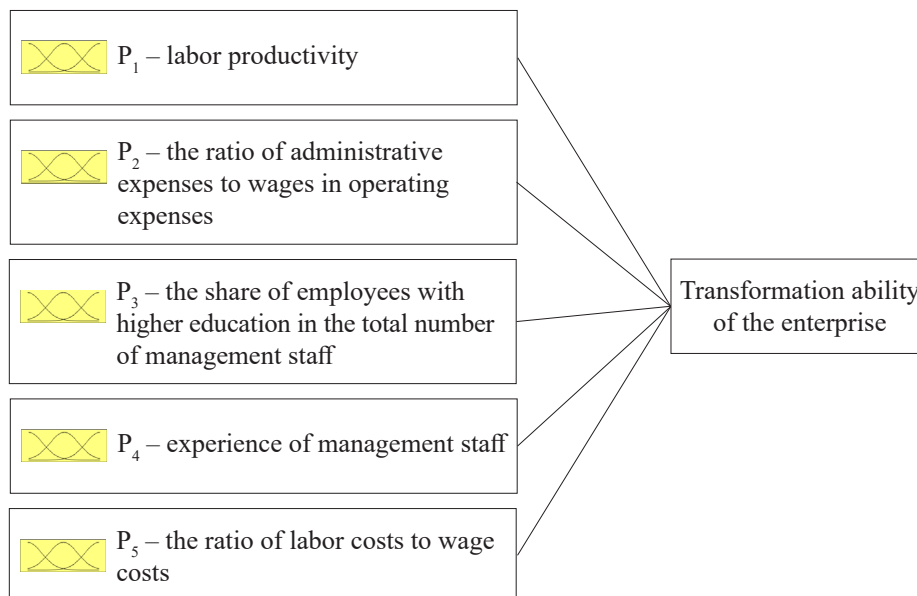


Figure 2. Model of influence of factors x_1-x_5 on the transformation ability of the enterprise

The fuzzification can be provided by means of the membership function of incoming variables, i.e., transition from numerical parameters of incoming variables to fuzzy values of linguistic variables. That is, the membership functions for variables $P_1 - P_5$, which allow for any value from a range of input data to determine its degree of membership to a fuzzy set. To both input variables, the authors set three membership functions of the “gaussmf” type (gaussian function), which sets the combination of membership functions in the form of gaussian curves and has the following appearance (1) [30; 31]:

$$\mu(P) = e^{-\frac{1}{2}\left(\frac{x-c}{\sigma}\right)^2} \quad (1)$$

where σ and c – numeric parameters, at the same time, c – is the coordinate of the maximum, which coincides

with the mathematical expectation of the value in the general assembly; σ – is the concentration or stretching coefficient that is determined based on the distribution of the characteristics in the general assembly. The concentration coefficient influences “the transition point”, a unique value for which the confidence measure is equal to 0.5, reflecting the maximum uncertainty of the investigated factor in some term. The Matlab environment does not explicitly state the formulas of the membership functions, but instead presents a compressed notation of the function’s parameters that are marked as an ordered array of two numbers of the “gaussmf” type: $[\sigma, c]$.

Add-on “Anfis-editor” of Matlab environment develop and test fuzzy conclusion algorithms with rules in which the combination of input variable terms represents

a complete set of all possible combinations of membership functions of the input variable in the design system, and not all of them may be used for further analysis. On the basis of the selected rules, it is proposed to assess the adaptive ability of the personnel, and also assess the impact of factors $P_1 - P_5$ on the transformation ability of the enterprise.

RESULTS AND DISCUSSION

The 7S model was developed by McKinsey employees to assess the effectiveness of the organisation by providing a thorough analysis of seven key elements of the firm: strategy, skills, common values (corporate culture), structure, employees, systems, and style. The model name "7S" is related to the fact that all of its components that are to be evaluated start with the English letter S: Strategy, Skills, Shared Values, Structure, Staff, Systems, Style (Fig. 3).

The key elements of the company, which are classified as "hard" and "soft", are mutually dependent on each

other and thus jointly participate in change management. The "hard" elements of the microenvironment of the company are three components: structure, strategy, and management system of the organisation. "Hard" elements are the easiest to describe, evaluate, and therefore easier to manage. The "soft" elements, which include all other components of the model, are more difficult to manage and evaluate, but they can often provide a long-term competitive advantage [33].

If the classic model is used to assess the effectiveness of company management, to identify the basic components of the effectiveness of any business, then the offered model is adapted to the conditions of dynamic changes, mainly focused on the ability of key elements of business to adapt to changes, avoidance, resistance, or confrontation to negative influences, taking into account the positive trends for the enterprise in the formation and implementation of development plans.

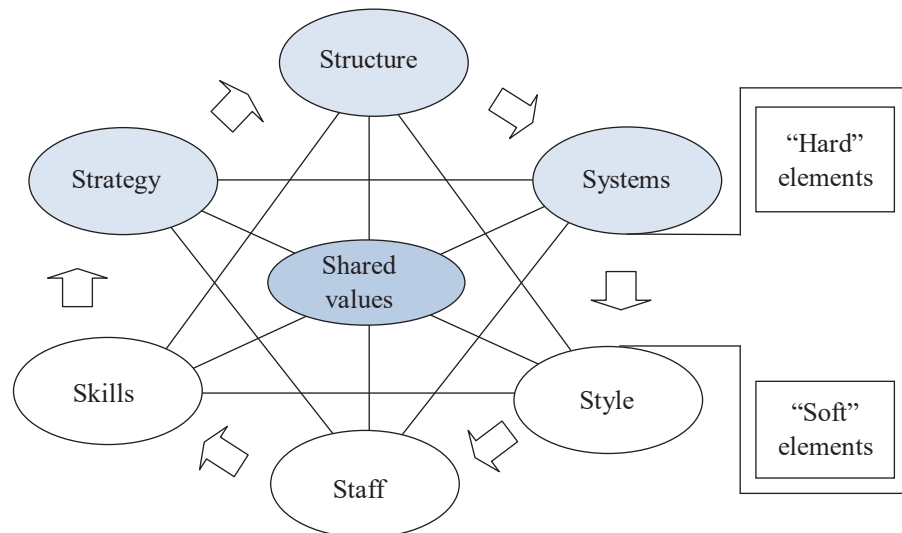


Figure 3. Graphic interpretation of McKinsey "7S" model

Source: [32]

Based on the developed model, the authors propose to expand the interpretation of its elements by incorporating a number of business indicators that define

the content of each component of the model and in general form a complex system of productivity changes in the construction enterprise (Table 1).

Table 1. Matrix of business indicators of productivity of changes in the construction enterprise (based on McKinsey "7S" model)

Model element	Content of BP business indicator	Current situation	Business indicator
Shared values	Availability of the shared values of the enterprise	V_1	V
	Corporate culture level	V_2	
	Corporate social responsibility level	V_3	
Strategy	Flexibility of enterprise strategy	S_1	S
	Competitiveness	S_2	
	Activity effectiveness	S_3	
	The level of adaptability of the construction enterprise	S_4	

Table 1, Continued

Model element	Content of BP business indicator	Current situation	Business indicator
Structure	Type of organisational structure	T_1	T
	The effectiveness of communication between top management and employees of lower management level	T_2	
	Level of digitalisation	T_3	
System	Effectiveness of enterprise subsystem operation	M_1	M
	Sustainability of the financial system of the enterprise	M_2	
	Efficiency of human resources use	M_3	
	Availability of systems of control, monitoring, and evaluation of business processes	M_4	
Style	Availability of corporate style	Y_1	Y
	Management style	Y_2	
	Availability of competition/cooperation between subdivisions	Y_3	
	Involvement of employees in decision-making	Y_4	
Staff	Labor productivity	P_1	P
	Ratio of administrative expenses to wages in operating expenses	P_2	
	Share of employees with higher education among management staff	P_3	
	Experience of management staff	P_4	
	Ratio of labor costs to wage costs	P_5	
Skills	Ratio of number of employees who need new skills to the total number of employees	K_1	K
	Frequency of personnel training	K_2	
	Compliance of employees' qualification with their positions	K_3	
	Effectiveness of the advanced training system (ratio of number of employees who have increased qualification to the number of employees who need advanced training)	K_4	

Source: developed by the authors

Using the indicators defined by each integral indicator of the activity and development of the enterprise, the authors study the discrepancies and inconsistencies between the elements of the general system of operational management that is moving in the stream of constant changes of the internal and external environment.

Thus, using the developed system of business indicators of productivity changes in the operational activity of BP it is possible to find ways to improve internal business processes of the enterprise, optimise the organisational structure, forecast possible changes of each of the seven elements of the enterprise, correctly carry out reorganisation, increase the level of efficiency of resource use and optimise the staff and number of employees, and also to determine the best way and tools of realisation of the strategy of development of enterprises in construction sector.

Within the framework of the conceptual approach set out in the McKinsey model, it is proposed to determine the ability of enterprises to change to use artificial intelligence tools, which are used as an effective means of managing enterprises in the conditions of uncertainty and environmental variability.

Since the purpose of the article is to study the impact of staff adaptability on transformational opportunities of enterprises, only factors $P_1 - P_5$ are selected as factors of influence on the result index, as shown in Table 1. The system of fuzzy logical conclusion by means of the Matlab Fuzzy Logic Toolbox application package was created with the help of the system of the fuzzy output of the Madami type. For the training of a hybrid network, chosen method "hibrid" with error level 0 and number of cycles 40. As a result of the training of a network, the error 0.076 percentage points was obtained (Fig. 4).

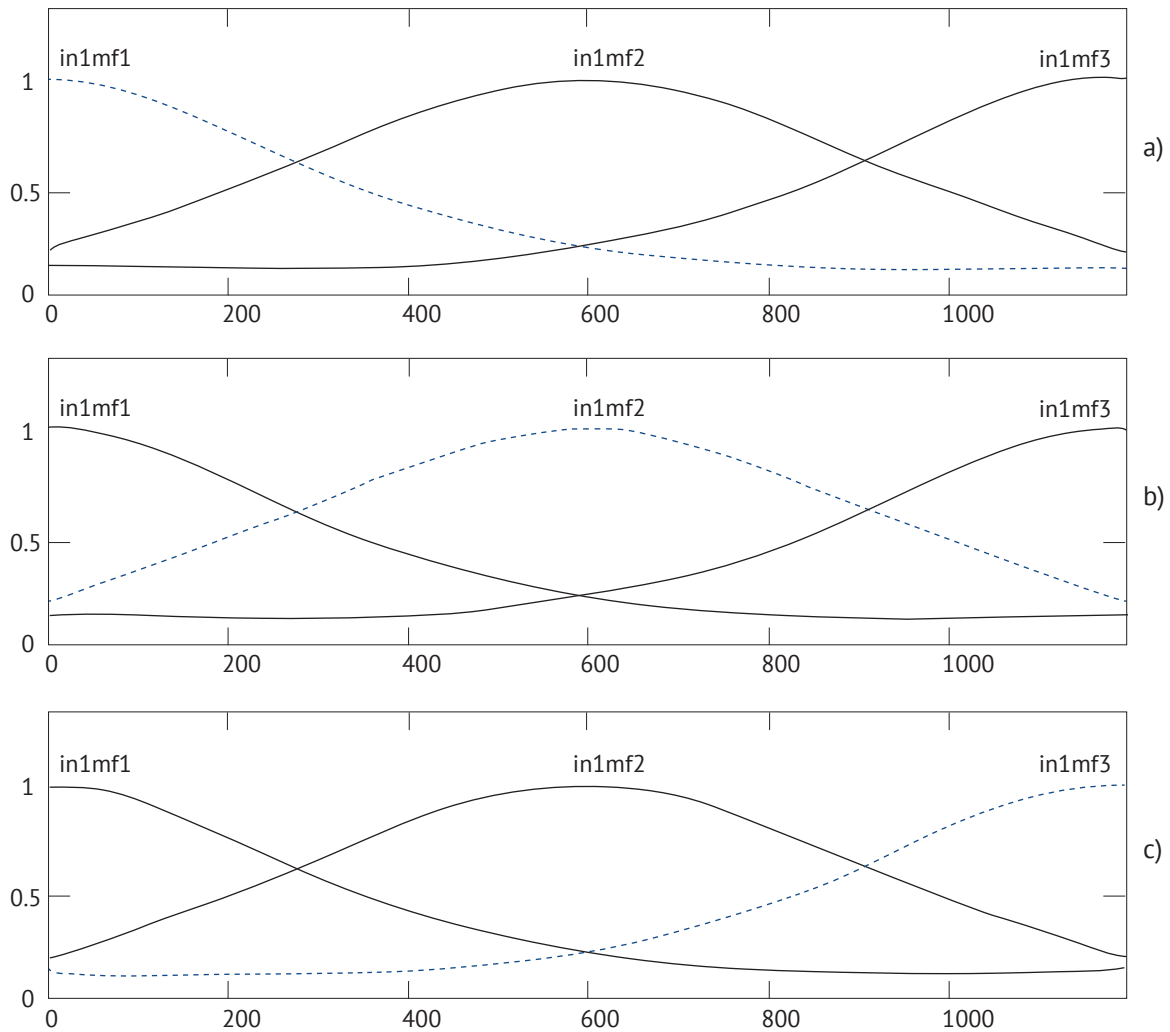


Figure 4. The gaussian membership functions for factor P_1 "labor productivity": a) "low labor productivity"; b) "average labor productivity"; c) "high labor productivity"

Source: calculated by authors

Graphs (Fig. 4 a-c) present the gaussian membership functions for terms "low labor productivity", "average labor productivity", "high labor productivity". As can be seen from Figure 4, the level of labor productivity among the analysed enterprises was ranging from 0 to 1,115.000 UAH/person per year.

According to the graphs in Figure 4, the maximum level of confidence regarding the high level of labor productivity is 1,115.000 UAH/person per year. The highest level of uncertainty about the high or average level of labor productivity in the enterprises studied, which corresponds to a probability of 0.5, with the value of index $P_1 = 882,900$ UAH/person per year. To achieve a high

level of staff adaptability to change, it is necessary to achieve labor productivity above the average level, and the membership function for this indicator goes like (2):

$$\mu_{nec}(P_1) = \begin{cases} e^{-\frac{1}{2} \left(\frac{P_1 - 557.4}{236.7} \right)^2}, & \text{if } P_1 < 557.4 \\ 1, & \text{if } P_1 \geq 557.4 \end{cases} \quad (2)$$

Similarly, the membership functions are calculated for the factors $P_2 - P_5$.

Finally, the membership functions for the other four indicators that characterise terms of type "enough to provide transformational abilities of enterprises" are systematised in Table 2.

Table 2. Membership functions for the other four indicators that characterise terms of type "enough to provide transformational abilities of enterprises"

Indicator	Membership function
P_2 – the ratio of administrative expenses to wages in operating expenses	$\mu_{nec}(P_2) = \begin{cases} e^{-\frac{1}{2} \left(\frac{P_2 - 0.676}{0.1822} \right)^2}, & \text{if } P_2 < 0.1822 \\ e^{-\frac{1}{2} \left(\frac{P_2 - 0.858}{0.1822} \right)^2}, & \text{if } P_2 > 0.676 \\ 1, & \text{if } P_2 \geq 0.1822 \\ 1, & \text{if } P_2 \leq 0.676 \end{cases}$

Table 2, Continued

Indicator	Membership function
P_3 – the share of employees with higher education in the total number of management staff	$\mu_{nec}(P_3) = \begin{cases} e^{-\frac{1}{2}(\frac{P_3-1}{0.4247})^2}, & \text{if } P_3 < 0.4247 \\ 1, & \text{if } P_3 \geq 0.4247 \end{cases}$
P_4 – experience of management staff	$\mu_{nec}(P_4) = \begin{cases} 1, & \text{if } P_4 < 17.49 \\ e^{-\frac{1}{2}(\frac{P_4-42.2}{17.49})^2}, & \text{if } P_4 \geq 17.49 \end{cases}$
P_5 – the ratio of labor costs to wage costs	$\mu_{nec}(P_5) = \begin{cases} 1, & \text{if } P_5 < 0.82 \\ e^{-\frac{1}{2}(\frac{P_5-0.82}{0.05})^2}, & \text{if } P_5 \geq 0.82 \end{cases}$

Source: calculated by authors

By default, the “Anfis-editor” add-on of the Matlab environment develops and tests algorithms of fuzzy conclusion with rules, in which combination of terms of incoming variables represents a complete set of possible

combinations of membership functions of the incoming variable in the design system of Madami. Their substantiation is given in combination with the description of the rules' base of fuzzy logical conclusion (Fig. 5).

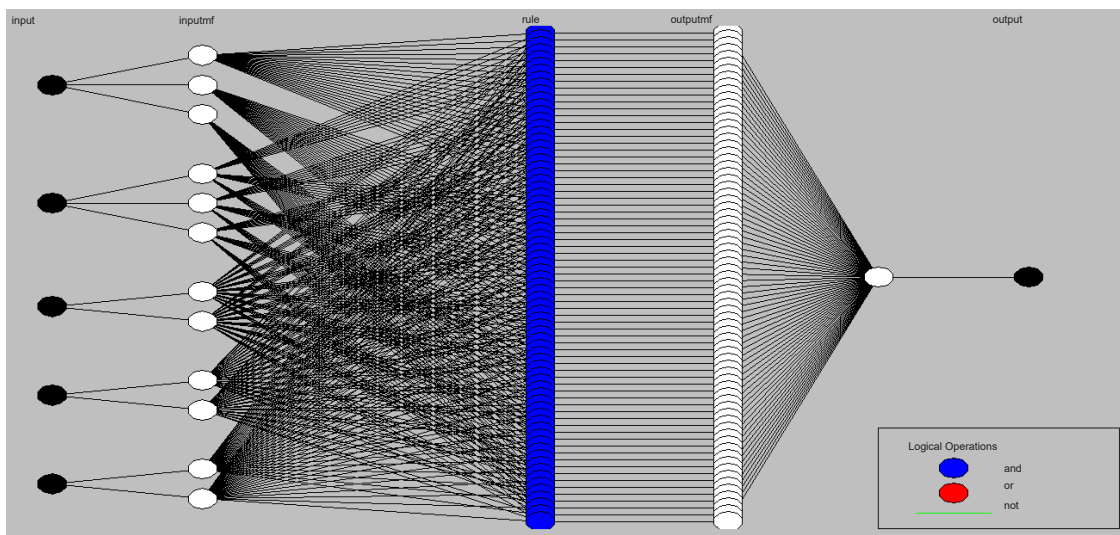


Figure 5. The rules' system of fuzzy conclusion

Source: calculated by authors

Since the system has three input variables, each of which has two terms and three variables have two terms, the maximum number of rules in the knowledge base to the formulation of all possible dependencies between factors and consequences should be $2^3 \cdot 3^2 = 72$. However, such a number of rules is superfluous because it makes management difficult. Besides, not all rules are necessary to adequately reflect the dependence between inputs and output y . In particular, in the works [30, p. 312; 31, p. 48] it is noted that the minimum number of rules can be within 2-3% of their total number.

According to the information provided in the “Rule Editor” dialog, the rules in the knowledge base are equal to 1. In the final version, ten rules were selected that reflect the main impact of the personnel on the transformation opportunities of the enterprise.

The rules are formulated as follows (fragment):

1. If the labor productivity of employees is insufficient AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is less than 47% AND

the average experience of management personnel is more than 17.5 years AND the ratio of labor costs to wage costs is low (less than 0.82) THEN ability to manage changes of the enterprise can be determined by the formula: $mf15 = 0.03468 \cdot P_1 + 6.553 \cdot P_2 + 2.3988 \cdot P_3 + 11.33 \cdot P_4 + 4.855 \cdot P_5 + 0.3359$.

2. If the labor productivity of employees is insufficient AND the ratio of administrative expenses to wages in operating expenses is enough AND the proportion of employees with higher education is less than 47% AND the average experience of management personnel is more than 17.5 years AND the ratio of labor costs to wage costs is more than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf20 = 0.0147 \cdot P_1 + 0.855 \cdot P_2 - 0.011 \cdot P_3 + 5.2 \cdot P_4 + 0.3289 \cdot P_5 + 0.1022$.

3. If the labor productivity of employees is insufficient AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is less than 47% AND the average experience of management personnel is

more than 17.5 years AND the ratio of labor costs to wage costs is less than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf23=0.00677 \cdot P_1 + 0.662 \cdot P_2 + 1.43 \cdot P_3 + 0.1466 \cdot P_4 + 0.6595 \cdot P_5 + 1.122$.

4. If the labor productivity of employees is insufficient AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is more than 47% AND the average experience of management personnel is more than 17.5 years AND the ratio of labor costs to wage costs is more than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf24=0.002328 \cdot P_1 + 0.4482 \cdot P_2 + 0.184 \cdot P_3 + 2.798 \cdot P_4 + 0.018 \cdot P_5 + 0.104$.

5. If the labor productivity of employees is average AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is more than 47% AND the average experience of management personnel is more than 17.5 years AND the ratio of labor costs to wage costs is less than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf34=0.00523 \cdot P_1 + 0.6147 \cdot P_2 + 1.26 \cdot P_3 + 0.68 \cdot P_4 - 2.42 \cdot P_5 + 1.139$.

6. If the labor productivity of employees is average AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is more than 47% AND the average experience of management personnel is more than 17.5 years AND the ratio of labor costs to wage costs is more than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf39=0.02935 \cdot P_1 + 4.147 \cdot P_2 + 1.601 \cdot P_3 + 0.1652 \cdot P_4 + 0.3506 \cdot P_5 + 2.127$.

7. If the labor productivity of employees is average AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is less than 47% AND the average experience of management personnel

is more than 17.5 years AND the ratio of labor costs to wage costs is more than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf44=0.002014 \cdot P_1 + 0.053 \cdot P_2 - 0.00069 \cdot P_3 + 0.3255 \cdot P_4 + 0.0205 \cdot P_5 + 0.0064$.

8. If the labor productivity of employees is average AND the ratio of administrative expenses to wages in operating expenses is high AND the proportion of employees with higher education is less than 47% AND the average experience of management personnel is less than 17.5 years AND the ratio of labor costs to wage costs is more than 0.82 THEN ability to manage changes of the enterprise can be determined by the formula: $mf45=0.0422 \cdot P_1 + 0.4164 \cdot P_2 + 0.09 \cdot P_3 + 0.9203 \cdot P_4 + 0.0418 \cdot P_5 + 0.07$.

9. If the labor productivity of employees is high AND the ratio of administrative expenses to wages in operating expenses is low AND the proportion of employees with higher education is less than 47% AND the average experience of management personnel is less than 17.5 years AND the ratio of labor costs to wage costs is low (less than 0.82) THEN ability to manage changes of the enterprise can be determined by the formula: $mf48=0.01499 \cdot P_1 + 0.0288 \cdot P_2 + 0.012 \cdot P_3 + 0.1763 \cdot P_4 + 0.0012 \cdot P_5 + 0.007$.

10. If the labor productivity of employees is high AND the ratio of administrative expenses to wages in operating expenses is low AND the proportion of employees with higher education is more than 47% AND the average experience of management personnel is less than 17.5 years AND the ratio of labor costs to wage costs is low (less than 0.82) THEN ability to manage changes of the enterprise can be determined by the formula: $mf53=-0.00198 \cdot P_1 + 0.6001 \cdot P_2 + 0.004 \cdot P_3 + 0.0004 \cdot P_4 + 0.00095 \cdot P_5 + 0.005$.

These ten rules reflect the basic provisions of the HR strategy by influencing the factors of staff's adaptive ability. In Figure 6 the influence of factors of labor productivity and administrative burden on wages on the ability of the enterprise to change is shown.

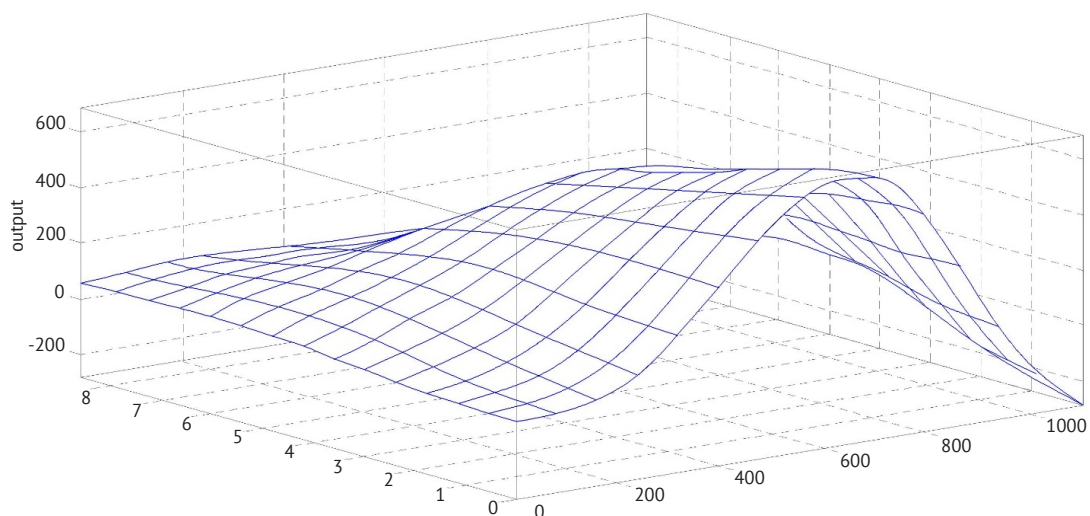


Figure 6. The influence of parameters P_1 and P_2 on the result indicator

Source: calculated by authors

Therefore, the largest level of adaptability to changes can be achieved by enterprises where labor productivity is higher than the average level, and administrative burden on wages is low. With an increased administrative burden, the ability to change at the enterprise is drastically reduced. It is possible to conclude that if it is necessary to change the strategy of the enterprise development, its adaptation to the influence of the surrounding influences in order to increase the adaptive ability of enterprises we should reduce administrative expenses.

Exceptions exist only for enterprises with high labor productivity, for which a low level of administrative burden, will likely reduce the efficiency of the management system, which should have a negative effect on adaptability to changes. For enterprises of this type, it is recommended to keep the average level of administrative load, which will allow to reaching a high level of adaptability, without losing control of the system.

CONCLUSIONS

The identified dependencies allow taking into account the impact of the company's personnel adaptability on the efficiency of changes, flexibility, and effectiveness of the response to changes in the company's external

internal environment. Among the factors of staff adaptability on the efficiency of transformations influence labor productivity, the administrative burden on wages, availability of employees with higher education among management personnel, the experience of management personnel, the ratio of labor costs to wage costs. The proposed system of assessment allowed to identify key factors for the transformation ability of enterprises, which will allow influencing them directly, when necessary, reaching the desired level of flexibility and providing adaptive capabilities of the enterprise system.

The approach proposed in the article for assessing the possibilities of managing changes in enterprises through the factors of the adaptive ability of staff can also be used for other factors of the McKinsey "7S" model. Defining the impact of changes due to fuzzy parameters of the system of indicators will allow to consider transformations through the prism of changes in strategy, skills, shared values (corporate culture), structure, staff, system, and style. This approach will help to model the efficiency of the enterprise development, its propensity to transformations, and the main thing, to identify factors that can prevent changes or vice versa, will reveal drivers of changes in each particular enterprise.

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Оцінювання впливу факторів адаптивності на результативність управління змінами підприємств засобами fuzzy logic

Андрій Васильович Шпаков, Сергій Павлович Стеценко, Ганна Валентинівна Шпакова,
Леся Вікторівна Сорокіна, Роман Борисович Аксельрод

Київський національний університет будівництва і архітектури
03037, просп. Повітрофлотський, 31, м. Київ, Україна

Анотація. Стаття присвячена вирішенню актуального завдання щодо виявлення чинників стимулювання персоналу, які найкращим чином забезпечать гнучкість і можливість управління змінами операційної системи підприємства. Метою дослідження є виявлення залежності здатності до трансформацій підприємств від адаптивних можливостей головного рушія управління змінами – персоналу, та виявлення внутрішніх чинників, які є драйверами змін. Дослідження проведено на прикладі даних українських будівельних підприємств. У якості концептуальної основи для виявлення таких чинників застосовано модель McKinsey «7S», відповідно із якою усі фактори згруповано за ознаками належності до таких складових: стратегії, навичок, спільних цінностей (корпоративної культури), структури, співробітників, систем і стилю. Оскільки метою дослідження є виявлення впливу адаптивних можливостей персоналу на гнучкість і здатність трансформуватись підприємства, то у роботі створено модель впливу чинників групи «персонал» на гнучкість і ефективність впровадження змін підприємства. Моделювання проводилось засобами fuzzy logic. У результаті визначено, що на ефективність трансформацій мають вплив такі показники: продуктивність праці (виробіток), адміністративне навантаження на заробітну плату (відношення адміністративних витрат до заробітної плати персоналу), наявність працівників із вищою освітою серед управлінського персоналу, стаж роботи управлінського персоналу, відношення зобов'язань із оплати праці до витрат на заробітну плату. Запропонована система оцінювання дозволила виявити ключові для трансформаційної здатності підприємств чинники, що дозволить у разі потреби цілеспрямовано впливати на них, досягаючи бажаного рівня гнучкості і забезпечуючи адаптивні можливості системи. Перспективами подальших досліджень мають стати створення моделей на базі нечіткої логіки, які ураховують вплив чинників формування стратегії, навичок, корпоративної культури, структури, систем і стилю на здатність трансформації підприємств

Ключові слова: управління змінами, інструменти нечіткої логіки, персонал, будівельне підприємство, ефективність