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THEORETICAL BASIS FOR STRUCTURING THE COMPOSITION OF THE BUILDING COMPLEX

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Abstract: **The article deals with theoretical substantiation of structuring the construction complex sectors, analysing the sectorial structure of the construction. The authors study the issues of the identification of the sectors relating to , as well as analyse the interrelations of the sectors relating to the construction. The article defines the degree of the importance of the closely relating sectors, studies the structural connections of the construction complex, argues the content of the construction complex, and suggests the algorithm of defining the dominating sectors in the construction. The suggested methodical approach to structuring the closely relating sectors in the construction allows to optimally coordinate the activities of the closely relating sectors of the construction complex. The object of research is the process of establishing the relationship of the construction industry with related sectors. The aim of the study is to increase the effectiveness of the strategic plans for the development of the construction complex by researching and developing an algorithm for structuring the construction complex.**

The established aim is achieved due to the fulfilment of the following tasks:
– to identify the composition of the construction related sectors;
– to analyse the degree of significance of each industry;
– to determine the structural relationships of the construction sector.

The resource integrity, as well as the overall purpose of the construction complex functioning, requires the right approach to determining the composition of the construction complex as a construction system.

Keywords – building complex, stable development, construction, dominant industries

I. INTRODUCTION

The construction complex is the most important sphere of social production determining the production potential and rates of the national economic growth in the state development. The construction complex includes powerful industries and the energy system that influences the resource supply and development of the country's national economy. Herewith, one of the determining factors of the country's economy resource supply is saving the energy. The strategy of developing the construction complex should envisage the enhancement of the energy-saving level. Introducing the energy-saving measures plays an important role in this task. The main potential of the technological energy saving is focused on the most energy consuming industries: ferrous metallurgy; chemical and petrochemical industry; industry of construction materials; agricultural sector, and housing and communal sector. Energy system is tightly connected to the construction complex. Energy consumption affects the country's state and development. Energy intensity is constantly increasing, therefore the energy-saving measures do not have a strong influence on the process of solving the energy-saving issues. An integrated approach to the design, formation and development of capital construction provides for the consideration of the construction complex as an integral system comprising the energy system with its inherent features.

The integrity of resource provision is a necessary and important sign of the integrity of construction systems. The resource integrity is considered as the provision with construction resources in such an assortment and quantity that are necessary and consumed in the process of producing the finished construction products.

II. PROBLEM STATEMENT

A closed internal turnover of material resources is ensured with resource integrity. The construction complex, as the combination of various elements within the boundaries of an integrated system, has a quantitative and qualitative aspect representing an expedient integrity. Consequently, all elements of the complex must be structured to achieve a single national economic or local goal. The factor of business slowdown, which is associated with negative trends in the country and the problems in the energy system, has a significant impact on the general condition of the

construction complex. The uncertainty of the external environment and the lack of a stable political situation and energy issues do not allow preparing the long-term construction plans.

III. OBJECT, PURPOSE AND OBJECTIVES OF THE STUDY

The object of research is the process of establishing the relationship of the construction industry with related sectors. The aim of the study is to increase the effectiveness of the strategic plans for the development of the construction complex by researching and developing an algorithm for structuring the construction complex.

The established aim is achieved due to the fulfilment of the following tasks:

– to identify the composition of the construction related sectors;

– to analyse the degree of significance of each industry;

– to determine the structural relationships of the construction sector. The scientific novelty of the suggested approach on developing the algorithm of the dominating sectors in the construction lies in the determination of the dependence of the structural sectorial components, defining the principles and directions of harmonizing the methodical approaches to structuring the construction complex on its basis.

IV. INFORMATIONAL AND ANALYTICAL TOOLS

The construction complex rightfully refers to the strategic objects of the state, since it: firstly, embodies the basis of the economic cyclical development; secondly, it has close relationships with many basic sectors of the economic complex; thirdly, it acts as a system-forming factor for the development of individual regions. That is why, the construction complex, as a driving factor in the development of the economy, infrastructure and territory, is of particular interest for research in modern conditions.

Over the past decade, significant progress has been made in research on the development of a modern theoretical basis for analyzing the development of the territory, including through the development of system-forming industries and the construction complex. Despite these developments, the results of studies of territorial development indicate the persistence of the problem of uneven distribution and development in the space of production and consumption, which actualizes the role of structural and institutional processes.

In the scientific literature, a complex refers to a set of objects or phenomena that make up one whole, i.e. a complex as an integer, not a random set of its constituent parts. Along with construction industries, the authors include industries that produce products for the needs of the construction industry into the construction complex in S. Bertelsen S.[1], L.Bygballe and M. Ingemansson [4]. These include the industry of building materials, structures and parts; production of sanitary ware, construction glass, etc. At the same time, such a composition of the construction complex is not very consistent with a single goal of functioning. For example, there isn't a whole industry – the industry of construction structures and parts, which means that there is no compliance with the sign of the integrity of resource provision. In the book by M.P. Lemesheva and A.M. Panchenko [7], the composition of the construction complex is defined as a group of sectors of the national economy or separate industries, united by a single goal of their development. G.V. Tersh [9] defines the construction complex as an inter-sector, which includes the building, the industry of construction structures and parts, the industry of construction materials, the production of the woodworking industry, the mechanical engineering subsector for the production of construction equipment and special vehicles. Critical assessments of the development of the territory in their works are expressed by Fine B. [13], Zombart V. [14]. This view is argued for by a change in the value chain that Gereff G. et al. [15].

The spatial organization in construction is the structuring of the construction complex, in which all participants in the construction process interact. At the same time, two characteristics are affected here: spatial and functional. The spatial characteristic reflects the dependence on the location of the construction industry. The functional characteristic reflects the internal interaction of the building complex. Christopher G. et al. [17], John D., et al. [18], Sölvell Ö. et al. [19].

The result of the functioning of the construction complex is closely related not only to its distribution (location) in space, new technologies, but also to other factors: human and physical capital. So, it is possible to imagine the relationship of the structural components of the construction complex in the territory (Fig. 1)

Manual of standard building specifications, european commission [8] the composition of the construction complex is defined as a group of sectors of the national economy or separate industries, united by a single goal of their development.

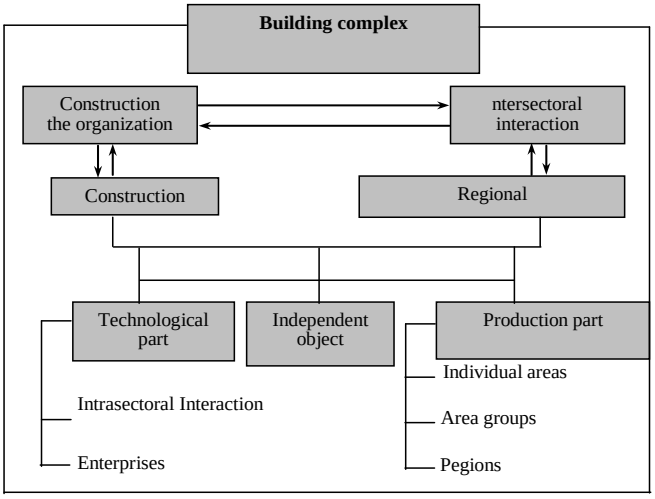

Fig.1: Components of the spatial distribution of the building complex

The resource integrity, as well as the overall purpose of the construction complex functioning, requires the right approach to determining the composition of the construction complex as a construction system. The construction complex is characterized by the fact that the internal links between its

constituent elements are much more stable than the links with the external environment, that is, the system acts as a whole when interacting with the external environment. The complex, as a holistic concept, is characterized by such categories as a part and a whole, a necessity and a sufficiency, a form and a content, which help to reveal the basic essence of the concept. In this case, the authors consider the construction complex with its inherent features.

V. SUBSTANTIATION FROM PREVIOUS LITERATURE

In the scientific literature L. Bygballe [2], H. Hakansson, [5] there are various suggestions on determining the composition of the construction complex. The composition of industries and types of production, as well as the quantitative ratios between them determine the sectoral structure of construction. Industrial relations between industries are characterized by the structure of material costs. A tool for establishing the rational production relationships between the construction related sectors is an inter-sectoral balance of production and distribution. 50% of the production of the construction materials industry, 18% of metal-roll, 40% of saw-timbers, more than 10% of the products of the engineering industry are used in construction. Considering the stages of the construction process (preparation of construction, construction, sale of construction products, i.e., handing over the finished construction object into operation), it is rather difficult to establish the qualitative interdependence of the construction related sectors.

The quantitative expression of the economic relations of each sectors adjacent with the construction industry can be represented as a system of equations:

– horizontally:

$$x_i = \sum_{j=1}^{n} x_{ij} + y_i, \tag{1}$$

– vertically:

$$x_i = \sum_{i=1}^{n} x_{ij} + z_j, \tag{2}$$

where x_i is the gross output of the i^{th} sector;

i is any sector of the production sphere horizontally *(i* = $1,2,\ldots, n$*);*

j is any sector of the production sphere vertically (*j* = $1,2,\ldots, n$*);* x_{ij} is products of sector *i*, consumed by sector *j*;

y_i is the end products of sector *i*, i.e. products used for non-productive consumption, stockpiling and other final needs; z_i is net products of the industry *j*.

The system of equations (1) compiled for all sectors of the balance reflects the use of the products of each sector in construction. The system of equations (2) shows the composition of the products of the sectors of material production at a cost, that is, the sum of the material production costs for manufacturing products of the j^{th} industry, wages and salary z_i. Systems of equations (1) and (2) reflect a linear relationship between costs in construction and output in different sectors, i.e. a system of inter-industry relations quantitatively expressed by the so-called direct costs coefficients a_{ij}

$$a_{ij} = \frac{x_{ij}}{x_j}. \tag{3}$$

The direct cost ratio a_{ij} refers to the cost of production of one sector *i* for the production unit of another industry *j*.

It follows from equation (3) that $x_{ij} = a_{ij} x_j$ and the systems of equations (1) and (2) take the following form:

$$x_i = \sum_{i=1}^{n} a_{ij} x_j + y_i; \tag{4}$$

$$x_j = \sum_{j=1}^{n} a_{ij} x_j + z_j.$$

Cost ratios for each sector can be written in a matrix:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{ij} & \cdots & a_{in} \\ a_{21} & a_{22} & \cdots & a_{2j} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{ji} & a_{i2} & \cdots & a_{ij} & \cdots & a_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{ni} & a_{n2} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix}. \tag{5}$$

Considerable methodological difficulties arise when attributing individual sectors to the building complex. Such sub-sectors of engineering as construction of roads, tractors and automobiles have closer ties with the sectors of the construction complex. A completely legitimate question arises about the inclusion of these sub-sectors into a machine-building or construction complex. In the above mentioned works, the issue is solved in favour of the construction complex. However, a differentiated approach is required here, which makes it possible to reveal the closeness of production ties that is one of the important signs for attributing a sub-sector to the construction complex.

Inter-sector relations are characterized by distribution coefficients h_{ij} showing the share of each consumer sector in the total volume of production. It can be expressed by the formulas:

$$h_{ij} = \frac{x_{ij}}{x_i}, \tag{6}$$

$$h_{ij} = a_{ij} \frac{x_j}{x_i}, \tag{7}$$

$$\sum_{i=1}^{n} h_{ij} x_i + y_i = x_i. \tag{8}$$

Labelling mechanical engineering, ferrous and non-ferrous metallurgy, chemical, forestry and woodworking industries as parts of the construction complex has the basis

for identifying the possibilities of state managements in terms of expanded reproduction.

The composition of the building complex by the authors of the book L. Bygballe [3] is determined as follows:
– construction materials industry;
– production of equipment for the construction materials industry;
– production of equipment for construction and road works;
– construction of industrial facilities;
– construction of non-production facilities;
– special education;
– sector research and design institutes, design bureaus;
– supply and sales bodies;
– specialized enterprises for the repair of construction equipment;
– management bodies of the complex.

Analysing this composition of the construction complex, it is worth noting that the construction is not fully represented in it, the production of metal constructions, wooden structures, etc. are not allocated. The complex should include the production of the construction and technical glass; the production of the construction and technical faïence and porcelain. The engineering industries do not include such sub-industries as construction-road, automobile and tractor engineering. The construction complex should include as well the research and development, as well as design and survey organizations and organizations engaged in training (workers and engineers) for construction.

Construction complex is a group of productive and non-manufacturing sectors which are functionally united and provide material conditions for manufacturing processes. Construction as a sector of material production is the core of the complex. It is advisable to include the same sub-sectors that produce objects of labour and means of labour for construction into the construction complex.

VI. ALGORITHM FOR DETERMINING THE DOMINANT SECTORS IN CONSTRUCTION

Different approaches to determining the composition of the construction complex necessitate the theoretical substantiation of structuring the construction complex

Analysing the considered suggestions on the composition of the construction complex, it should be noted that the inclusion of the engineering sub-sectors into the construction complex (although they supply the machines and equipment for construction) is not consistent with the integrity of the complex. The machine-building sub-sectors mentioned above belong to the machine-building complex, and they supply the means of production for the construction complex. In practice, achieving a balanced construction in the regions is an extremely difficult task. The problem is that the degree of inter-regional economic interaction is very ambiguous and a part of material and financial resources is formed through exchange with other territories of the country.

For the first time, an indicator of spatial intensity of the territory's development was presented in Discussion Papers on Entrepreneurship [11], which takes into account the ratio of the volume of economic activity and the geographical range. The spatial range is measured by the average distance from the center of the territory to the location of the subject, which indicates the degree of dispersion of business activity.

Modernization processes in the modern world affect the country's national economy, which includes the construction complex. This position is noted in his work by A. Kasych [6]. Therefore, the indicator of construction activity will continue to be the main indicator of the regional development in the near future O.M. Zalunina [10,11].

The sectoral structure of construction means dividing it into indicators characterizing the process of forming the capital investment. These indicators include the stage of the sector development; the degree of the integration of manufacturers; the technology change rate; the total profitability of fixed assets; the technological level of the industry.

The rating of the main industries should be calculated at the first stage to define the dominating interrelated industries of the construction complex. The authors calculate the rating on the formula:

$$R_j = \sqrt{\sum_{i=1}^{m}(1 - x_{ij})^2}, \quad (9)$$

The calculations result in

$a_1 = 0.30$; $a_2 = 0.72$;
$a_3 = 0.58$; $a_4 = 0.51$;
$a_5 = 0.06$.

The preparation and justification of management decisions is required to be done based on a comprehensive analysis.

Afterwards, they combine the table of the normalized data on the main indicators of the neighbouring industries to calculate the coefficient of the pair correlation that allows defining the main ones (Table 1).

TABLE I
NORMALIZED DATA ON INDICATORS OF CONSTRUCTION RELATED SECTORS

№	Indicators	a-1	a-2	a-3	a-4	a-5
1	Stage of the sector development	1	0.9	0.9	0.9	1
2	Manufacturers integration rate	0.9	0.9	1	0.9	1
3	Technology change rate	0.8	0.5	0.6	0.6	1
4	Overall return on fixed assets	1	0.9	1	1	0.9
5	Technological level of the sector	0.8	0.5	0.6	0.7	1

After determining the ratings of construction related sectors, the main ones are revealed by calculating the pair correlation coefficients at the second stage. Having calculated the pair correlations, the authors determine the four most significant industries for the development of the construction complex. According to the results of the calculation of paired correlation coefficients, four sectors have the greatest impact on the construction (x1, x2, x3, x4), (Fig. 2.).

	y	x1	x2	x3	x4	x5
y		-0.93218	0.872051	0.871373	-0.90237	-0.47442
x1	*		-0.73951	-0.70719	0.900981	0.411711
x2	*	*		0.737783	-0.74582	-0.38804
x3	*	*	*		-0.6849	0.612226
x4	*	*	*	*		0.612226
x5	*	*	*	*	*	

Fig.2: The results of the calculation of paired correlation coefficients

A subsystem of individual units and a territorial scheme of the construction management are developed on the basis of the production structure.

It is obvious, that construction is closely connected with all sectors of the national economy, especially with industry. On the one hand, the increase in construction depends on the development of the sectors that provide its technical equipment (machines, materials, structures, electricity, etc.), on the other hand, construction organizations are inextricably linked to the activities of customers when performing construction and installation work for other sectors A number of other industries act in relation to the construction both as suppliers and as consumers of construction products. Therefore, construction is the most material-intensive industry and needs to be clearly structured.

VII. CONCLUSIONS

The conducted research results in the suggested algorithm of structuring the content of the construction complex to define the dominating sectors in the construction. It includes defining the content of the sectors, determining the structural interrelations and the degree of the importance of each sector.

The received calculation result allows concluding on the absence of contradictions in the interrelation between the dominating sectors of the construction complex.

The defined interrelation of the structural components of the construction complex allows developing the organizational and methodical basis to structure the construction complex.

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