Creating a structure to calculate the organizational and technological process control effectiveness during redeployment

Azariy Abramovich Lapidus *,

Moscow State University of Civil Engineering, Moscow, Russia.

Abstract.- According to the UN forecast, more than 60 % of the world's population will live in cities by 2035. Thus, the burden on the structure of housing and communal services, transport, security, health care, education, and other infrastructure components will increase as the number of residents. Many, especially old, industrial enterprises are unable to withstand competition and the economic dimension of their existence and are unable to provide an adequate environment. In this regard, the most rational and mutually beneficial solution is to transfer such enterprises beyond the line of cities, or to specially allocated industrial areas with the subsequent reassignment of the liberated territory for the needs of the city itself, construction of housing, or socio-cultural or business facilities. The main purpose of this article is to assess the relevance and timeliness of consideration of the problems of organizing production during the redevelopment of industrial territories of the urban environment. The basic prerequisites for the formation of a phenomenon such as redevelopment are discussed, and parameters that have a major impact on decision-making about methods for changing the functional purpose of urban industrial areas are also identified. Likewise, common trends are identified in the relocation of industrial areas in the urban environment in Russia and abroad. To implement such projects, it is necessary to form at the design stage a system of organizational decisions aimed at effectively addressing environmental issues, re-equipping production forces, and also solving social urban problems.

Keywords: construction control; redeployment of industrial facilities; redevelopment of industrial areas; scientific and technical renovation substantiation; urban development.

Creación de una estructura de cálculo para el proceso de control de efectividad tecnológica y organizacional durante reubicaciones

Resumen.- Según la previsión de la ONU, más del 60 % de la población mundial vivirá en ciudades para 2035. Por lo tanto, la carga sobre la estructura de la vivienda y los servicios comunales, el transporte, la seguridad, la atención de la salud, la educación y otros componentes de infraestructura aumentará a medida que aumente el número de residentes. Muchas empresas industriales, especialmente antiguas, son incapaces de resistir la competencia y la dimensión económica de su existencia y son incapaces de proporcionar un entorno ambiental adecuado. En este sentido, la solución más racional y mutuamente beneficiosa es trasladar dichas empresas más allá de la línea de las ciudades, o a zonas industriales especialmente asignadas con la posterior reasignación del territorio liberado para las necesidades de la propia ciudad, construcción de viviendas o instalaciones socioculturales o empresariales. El objetivo principal de este artículo es evaluar la relevancia y oportunidad de considerar los problemas de organización de la producción durante la reurbanización de los territorios industriales del entorno urbano. Se analizan los requisitos previos básicos para la formación de un fenómeno como la reurbanización, y también se identifican los parámetros que tienen un impacto importante en la toma de decisiones sobre los métodos para cambiar el propósito funcional de las áreas urbanas industriales. Así mismo, se identifican tendencias comunes en la reubicación de las áreas industriales del entorno urbano en Rusia y en el extranjero. Para llevar a cabo este proyecto, es necesario formar en la etapa de diseño un sistema de decisiones organizativas destinadas a abordar eficazmente los problemas ambientales, reequipar las fuerzas de producción y también resolver los problemas urbanísticos sociales.

Palabras clave: control de construcciones; redistribución de instalaciones industriales; remodelación de zonas industriales; fundamentación científica y técnica de renovación; desarrollo urbano.

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* Correspondence author:
*e-mail:*azariy.lapidus@yandex.ru (A. A. Lapidus)

1. Introduction

One of the most controversial issues in the re-profiling is the optimal direction of implementation of such projects, which should take into account

the complex issues of urban planning, functional, social, organizational, technical, economic, and environmental character. Cultural experts and historians are concerned about the preservation of ancient historical artifacts and *industrial heritage*, urban planners, and architects of new layout of these territories and their organic inclusion into the environment and infrastructure, developers and investors-–development of such territory from the point of view of its conversion to more efficient use, which enhance its attractiveness, investment, successful development of the allocated funds, and increase the value of the land and constructed or reconstructed buildings.

Most often, industrial buildings are repurposed into creative clusters, office, and multifunctional complexes. Currently, the weaving factory on the Obvodny canal in St. Petersburg functions as a multifunctional cultural platform–creative space–*Weavers* (total area is 1.3000 m^2), which includes both retail space and art galleries, offices, and exhibition space for cultural and educational processes. In the historical square within the Yekaterinburg plant, which now consists of a landscape Park on the right Bank of the Iseti river and a Museum complex on the left Bank, where many residents of the city spend their time, mass events are held. The former distillery in Tula, currently operates as a multifunctional complex *Likerka Loft*. The former industrial premises are repurposed for trade, entertainment area, supermarkets, offices, fitness centers, and schools, according to Table 1. In Lodz (Poland), the factory complex of Israel poznań was repurposed into a multifunctional cultural, commercial, sports, and entertainment center with a total area of 150.000 m^2, of which 100.000 m^2 accounts for retail, 20.000 m^2 for hotels and offices, 21.000 m^2 for entertainment, 8.000 m^2 for museums, and 1.000 m^2 for children's play complex. However, the complex occupies an area of 30 Hectares and is a place of attraction of human flows, meeting the interests of local residents and tourists.

The re-profiling volumes of the urban areas clusters are constantly increasing; harmonious interaction of the state and private companies is important for successful PCGT and rational use of the urban areas, since the re-profiling projects can be implemented only on the terms of acceptable profitability of all participants and investment attractiveness of objects. It is important to develop the scientifically-based methods that provide effective management decisions to develop residential and commercial real estate in the territories of old industrial enterprises.

The volumes of the re-profiling of the urban areas clusters are constantly increasing and thus harmonious interaction of the state and private companies is important in the successful and rational use of the urban areas because the re-profiling projects can be implemented only on the terms of acceptable profitability of all participants and investment attractiveness of objects. Organizational and technical processes during the construction and installation works in the course of the conversion of real estate and the use of industrial territory for a new purpose are of high importance.

Hence, it is necessary to have digital repurposing information systems (DRIS) that allow repurposing process participants to assess at each stage of decision-making the factors influencing the project forecasting and implementation. In this regard, DRIS is one of the key factors of decision-making by the re-profiling participants, both at the pre-investment stage and in the process of design, construction, operation of a new facility, and the factor of investment attractiveness of the territory, which reduce the risks of incorrect information and the respective problems. It is notable that the possibility of advanced organizational and technological modeling of construction and installation works (CIW) at the re-profiling facility will allow to take into account all key parameters and, thus, increase the overall efficiency in decision-making for both the investor and the potential customer. To do this, it is necessary to systematically study the main factors and processes in CIW in the repurposing of industrial facilities in order to form a methodology that will provide *smart* modeling of CIW. Such modeling is advisable to coordinate with the state program *Digital economy of the Russian Federation*, which treats the digital economy as a business activity, in which the

Table 1: Share of production clusters of urban areas in the structure of the Land Fund of the largest Russian and foreign cities, in 2018.

Russian cities	Share of urban industrial zones in city area, %	Foreign cities	Share of urban industrial zones in city area, %
Moscow (within the boundaries of old Moscow)	20	Paris	5
St. Petersburg	13	NewYork	4
Yekaterinburg	14	Boston	3
Nizhny Novgorod	12	Seoul	6
Perm	11	Singapore	3

key role is played by data in digital format and contributes to the formation of a single information space, development of information infrastructure in municipalities, economic sectors, and in the country as a whole. Thus, the digital economy should form a new technological basis for the entire socio-economic sphere.

In order to be successful and compete in a complex market, redevelopment should take place as one of the ecosystems, the operator of which at the top level should be the state and specific municipalities, which have full information about industrial areas as potential objects of redevelopment, and at the next levels, such ecosystems should be complemented around themselves by ecosystems such as an information system for redevelopment investors, supervisory and licensing authorities, realtors, architects, and design organizations, construction companies, real estate operators, real estate tenants, ecosystem of life–style services, and so forth. The leaders of ecosystem services in Russia are currently banks, which recently have been forming ecosystem sets around themselves and adding new sets of services to their business.

The structures listed above are not the construction organizations and these examples are united by a digital technological component. In fact, ecosystem participants prefer a digital business model and seek to use the digitized processes. Finally, participants interact with each other using a single digital platform for the community, which becomes a trusted environment for collaboration.

In order to get acquainted with the current state of affairs in the issue under consideration, as well as to study the latest developments in the given field, it is necessary to refer to scientific publications by Russian and foreign scholars. The paper considers the articles by such authors as D.V. Topchiy, A.I. Meneyluk, L.V. Lobakova, I. Abramov, A. Lapidus, S. Newton, V.A. Pukhkal, A.B. Mottaeva and others.

However, Zueva [1] argue that neither at the planning stage nor at the implementation stage in Russia there are no effective, scientifically based systems. To solve this problem, the authors consider the use of information complex interaction system consisting of a large number of different functional subsystems and modules that are investment, organizational, technological and information [2]. Meneylyuk and Lobakova [3] state that the technology of re-profiling or changing the purpose of the building is significantly different from new construction and has its own characteristics, which confirms the conclusions made in this work.

As the most general factors that influence the planning of the re-profiling process and have interrelation, such parameters as the cost of the project, the number of working shifts a day, the number of working days a week, the coefficient of combination of works, and financing conditions are specified. In [3] authors recommend to perform the relationship between these parameters by using the mathematical theory of experiment planning, which is a fundamental part of the theory of experimental and statistical modeling.

2. Methodology

The main regulatory document describing the construction control and its implementation is the town planning code of the Russian Federation. Article 53 of the Civil Code of the Russian Federation refers to the quality control goals, determines the responsible persons and describes the procedure for notifying the state construction supervision authorities about cases of emergencies in a capital construction project [2].

In general, the facilities under control are described [3]. Stages and composition of the construction control by the contractor and customer at the redeployed facility are performed in accordance with the decree of the Government of the Russian Federation of June 21, 2010 No. 468. Upon the analysis of this document, the composition may be briefly described, and the degree of regulatory work control is determined.

Stage 1. Input control. Quality control of the building materials, products, structures, and equipment supplied for the capital construction facility construction. When evaluating quality control measures, a point system must be used. In this case, the following procedures are regulated at this stage [4]:

1. Checking the availability and content of the suppliers' documents containing information about the quality of their products;

2. Its compliance with the requirements of working documentation, technical regulations, standards, and codes of practice. The stage is assessed with two points.

Stage 2. Control of storage rules. Verification of the compliance with the established standards and rules to store the used products [5]: identification of violations of the established norms and product storage rules.The stage is assessed with one point.

Stage 3. Control of technological operations. Verification of the compliance with the sequence and composition of technological operations during the capital construction facility construction [6]:

1. Compliance with the sequence and composition of technological operations.

2. Compliance with the technological operations in accordance with the requirements of technical regulations, standards, codes of practice, design documentation, engineering surveys, and urban planning of a land plot.

3. Correspondence of the quality of the technological operations and their results to the requirements of the design and working documentation based on it.The stage is assessed with three points.

Stage 4. Control of the hidden work and critical structures. Examination of the work hidden by the subsequent work and intermediate acceptance of the building structures erected affecting the safety of the capital construction facilities and sections of engineering networks together with the customer [7]:

1. Control of the ban on the premature execution of the subsequent work and preparation of an act on the hidden work examination.

2. Drawing up an intermediate critical structure control certificate. The stage is assessed with two points.

Stage 5. Control of the work stages. Acceptance of the finished work types (stages): drawing up a certificate on the control measure and its results. Filling out the general work log with the relevant acts attached. The stage is assessed with one point.

Stage 6. Control of the documentation compliance. Checking the compliance of a completed construction facility with the design requirements and working documentation based on it, the results of the engineering surveys, urban land plot development, plan requirements, and technical regulations together with the customer [1]: drawing up a certificate on the control measure and its results. The stage is assessed with one point.

According to the regulatory documentation, there are 10 points for construction control measures. The question about the number of

measures (the number of the construction and installation control degree points) at the redeployed facilities remains open. Since there is no normative document to redeploy the industrial facilities, a scientific study must be conducted with the aim of the development of a mathematical model determining the construction and installation quality control degree.

The points governing the implementation of various work control procedures during the redeployment represent various measures, among which there is, for instance, additional control during the construction phase, additional verification of the suppliers' documents containing information about the materials supplied, and additional control over the sequence and composition of technological operations.

The standard number of workers performing the construction control regarding the base price level transfer as of 1 January 2000 up to the 1st quarter of 2019 is 1 person for every 112 million rubles of the estimated cost according to the decree of No. 468 (Appendix 1) and the letter of the ministry of construction of the Russian Federation No. 1408-LS/09 of 22.01.2019 [8, 9].

Currently, redeployment of industrial buildings as one of the modern components of technological progress is the subject of several scientific studies. For example, control of the organizational and technological processes is one of the study areas in this direction.

3. Results

Life cycle of the capital construction facilities for industrial purposes, capital construction objects (including individual buildings, structures, and town-planning formations for industrial use) are classified as the construction products. Construction products in the format of buildings and structures for industrial purposes are the object environment of a long (long-term, determined by the service life) period of use. In fact, the degree of conformity of actual safety indicators and functional efficiency of the completed construction projects with the established design and regulatory values determines the quality of the construction products [10]. The main feature of the construction products (especially unique and/or technologically complex industrial facilities) as a material subject of the productive and reproductive activity is also significant (e.g., duration, complexity,the amount of the costs required for its formation (construction) and subsequent operation). However, it is a complex job to ensure the functional quality of the construction products, the solution of which is implemented over a long period, during which there is a constant transformation of the properties and conditions of construction objects. Thus, the considered time is called the life cycle of the construction products (including industrial construction projects). Figure 1 shows the life cycle of a construction object in the form of a temporary logical structure, characterized by a sequential change in the states (stages, periods) included in the structure of the structure.

The life cycle of an industrial construction object has the form of a consistent, hierarchical, and strictly oriented structure and includes the following main stages or mandatory steps, including *Construction surveys*, *Design*, *Construction* (new construction, reconstruction, expansion), and *Exploitation*.

One of the features of the life cycle of the construction products is the fact that the efficiency of each subsequent stage is determined by the quality of the organizational and technological solutions implemented at the previous period [11].

Thus, the performance indicators of the production processes as well as the state of bearing and enclosing structural elements of the production building or structure are characterized by the quality of adoption and practical implementation of composite, structural organizational and technological solutions developed at the previous *design* and *construction* stages. Hence, efficiency of the decisions taken and implemented can be adequately assessed only at the end of all periods of its life cycle.

Moreover, the life cycle stage of the type *Construction Surveys* provides for a set of measures aimed at the analysis of the economic and engineering factors necessary for making a fundamental decision on the expediency of forming

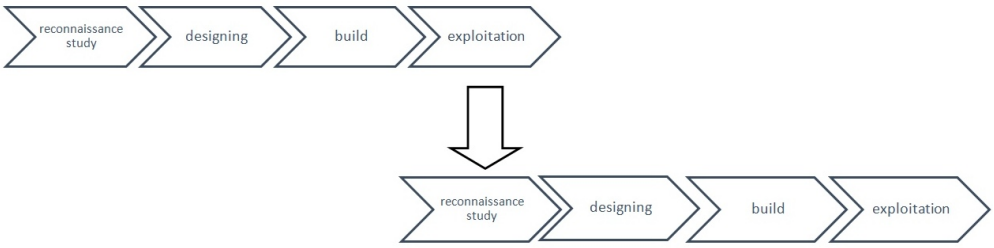

Figure 1: The life cycle of a construction object.

construction products of a certain functional purpose.

Design stage is a set of works and processes, during the implementation of which the design is developed, which shows the solutions necessary for preparation and construction of the construction facility under the construction site conditions. Design works are conducted based on the design task and depending on the complexity of the construction object are performed in one or two stages [12].

Construction stage defines the format of a practical implementation of the design solutions of the construction objects in one of the possible formats: new construction, reconstruction, expansion, and technical modernization.

Operation stage is intended to organize the operation of the facility for construction of industrial purpose under the established environmental conditions by complying with the regulated set of measures aimed at maintaining the quality of the facility completed by construction and its structural elements: reliable works of separate structural elements and object, in general; providing normal sanitary and hygienic conditions and parameters of internal space; ensuring implementation of the rules and standards of the fire safety; decrease or minimization of an environmental pressure from the technological processes and/or processes of activity, and restoration of the lost quality by a systematic observation and carrying out a planned repair work.

Operation of the erected construction facility is permitted if the actual characteristics correspond to the established values. In order to ensure the proper technical condition of the construction facility, an operational monitoring and repair system is developed, which allows assessing and maintaining the technical condition, quality indicators, and reliability at the specified level [13].

In a significant majority of cases, it is the duration of service life that determines the life cycle of the construction object, and therefore it is an objective criterion or indicator of the quality of the design solutions and the quality of construction production.

4. Discussion

The rational category of causes includes:signs of a satisfactory technical condition of the main structural elements; the features of the space-planning decisions allowing to realize modernization of initial function or provide conditions for new function of a production and/or non-productive look; the level of necessary technical and economic expenses at reconstruction of an object for production; existence of the status of *object of cultural and historical heritage*, and possible attraction of additional investments into the development of a town-planning situation due to the formation of new architectural objects of various functional purposes.

The emotional category of causes includes danger of loss of town-planning appearance and historical memory of the corresponding building; possible loss of the existing harmony and ways of visual interaction with the surrounding artificial and natural landscape, and threats to increase the environmental burden on the environment due to the dismantling of the existing construction site and new construction [14],[15].

The information model should provide prompt search, unambiguous identification, and comprehensive up-to-date characteristic of the technical condition of the structural elements, parts, and systems of the construction object. Formation of an information support to develop organizational and technological sequence of the reprofiling of a production facility is a complex, multi-stage process (especially with regard to the buildings and structures classified as objects of cultural and historical heritage and/or cultural and historical significance).

5. Conclusion

The field of practical activity related to the improvement of the quality of construction facilities is quite diverse and allows the use of modern (innovative) architectural concepts, construction materials, and technological techniques of construction.

Formation of the information model of the construction object, which differs as complete and reliable information as possible, allows optimizing the composition and efficiency of the organizational and technological solutions.

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