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Analysis of methods of architectural and spatial adaptation of industrial enterprises to the environmental requirements of the modern urban environment

G. Maulenova[1]*, M. Mustafa[1], U. Tariq[2]

[1]Kazakh National Research Technical University named after K.I. Satpayev, Almaty, Kazakhstan
[2]University of the West of England, UK

*(E-mail: *g.maulenova@satbayev.university)*

Abstract. This article discusses the issues of improving the quality parameters of industrial areas with the liquidation or preservation of their functional purpose. The research methodology includes an analysis of methods for the reconstruction of industrial buildings in domestic context, on the example of Almaty, and foreign practice, with the example of Germany and Poland. The current ideology underlying today the architecture of such structures and ways of effective and harmonious integration of utilitarian industrial objects into the urban environment are considered. The analysis is carried out according to the urban planning, functional and compositional characteristics of industrial facilities using a multifactorial comparison method. Different approaches to architectural and spatial adaptation, such as preservation, renovation, and reconstruction are analysed. The article notes that the choice of adaptation method depends on a number of factors, including the condition of the object, historical and architectural value, and the intended purpose of the object after renovation. The promising development of industrial architecture lies in its possible and rapid adaptation to developing technologies. The article is of interest to architects, urban planners, as well as for all those who are interested in the issues of renovation of industrial facilities. For the renovation of industrial facilities, it is necessary to clearly establish the stages of adaptation of industrial facilities.

Keywords: renovation of industrial areas, industrial facilities, analysis of global adaptation, industrial architecture, revitalization.

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[1]the corresponding author

Introduction

The creation of favorable conditions and compliance with functional purposes are primary requirements for the design of any architectural structure (McGuire and Schiffer, 1983). The task of the architect is to carefully study the life process and its patterns when designing a building. Given the trends in the development of building design, when calculating the service life, it is also necessary to take into account the actual state of the process itself. In this regard, it is necessary to conduct the following preliminary studies: a thorough study the world and domestic experience of constructing and operating similar structures. The analytical method of working with literary sources, implemented projects in the public domain, and photo-fixations of similar objects. Further, the most important material for this study was the in-kind studies of structures in the process of operation, which make it possible to evaluate the implementation of functional processes and understand the quality of conditions for workers of these enterprises at various parts of the production cycle. This is relevant not only for newly designed objects, but also for existing structures that require various levels of renovation and reconstruction, that is, giving such objects a “second life” (Bani et al., 2009). During this work, it is also important to study in detail the building's layout, design features and equipment used.

Nowadays, many people continue to migrate to urban areas, thereby strengthening the processes of urbanization, which have both positive and negative consequences. It is important to constantly monitor the processes of interaction of various aspects of urbanization processes in the process of their development. In order to direct the process of urbanization in the most positive direction, that is, not to lose sight of the preservation of its familiar and established image, to understand how the potential of the city can be developed, it is important to establish the right scenarios for the development of this process. And here one of the most significant elements can be called the analysis of the historical and cultural content of the urban environment. Understanding of historical events in the context of their integration into modern urban space requires architects and researchers to use appropriate methods that take into account ‘dimensional, planning, substantive elements of the city and the interaction between them’ (Khalykov, K. et al., 2015).

As for the adaptation of industrial enterprises in the urban environment, it is important to take into account the natural and urban conditions, i.e., the natural features of the area, the size and shape of the industrial zone, and its connection with the adjacent territory and buildings, and, of course, the significance of the building in the architectural ensemble (Drebezgova et al., 2022). Adaptation of buildings in architecture is the ability of buildings to change their characteristics in accordance with changes in operating conditions, presenting fundamentally new requirements for architecture (Keenan, 2014). In the context of Kazakhstan, it is relevant in the territories of factories and plants that were built in the last century, which stopped for economic reasons, to design shopping and entertainment centers, malls that have already become boring to everyone (Auganbai et al., 2019). The main argument is that why Kazakhstan is not using the example of world experience, repurpose abandoned industrial buildings, try to "breathe life" into dying enterprises?

First of all, it is necessary to pay attention to how harmonious the existence of industrial architecture in the surrounding buildings, its "dialogue" with society and the environment

(Kellert et al., 2011). Taking into account the vast areas occupied by industrial production facilities that have fallen into decay or require modernization require a qualitative assessment of the situation and ways of an economically beneficial and socially significant solution (Zolina and Tsitman, 2019). It is important to understand that industrial architecture must evolve along with society and its growing needs (Fiksel, 2003). Industrial modernization is a key action for a sustainable development strategy (Sánchez-Montañés Benito & Castilla, Manuel V., 2020).

For the competent transformation of industrial structures, one should not forget that among the buildings that were left without proper care they collapsed: the structures rusted, the finishes collapsed, engineering communications stopped working, there may be valuable examples of architecture of past centuries (Högberg, 2011). In such buildings, in addition to the possibility of revitalization, it is also necessary to carry out reconstruction. Revitalization (from Latin re… - renewal and vita - life, literally: the return of life) in the context of urban studies refers to the process of recreating and revitalizing urban space (Wikipedia, The free Encyclopedia., 2023).

Today, the problem of lack of territories in large cities is a significant problem. And in this aspect, areas of abandoned industrial zones can become the most important reserve for the growth and development of not only adjacent territories, but also the entire urban system (Jadach-Sepioło et al., 2016). Many cities were formed by large industrial enterprises that were conveniently located in the urban structure with a complex and efficient transport infrastructure. However, the era of post-industrialization also affected the most important city-forming segments of the economy. Many industrial enterprises closed due to economic problems; some were moved outside the expanded city. The territories of such structures in many cases fell into disrepair, and therefore became unprofitable and depressed. In addition to the purely economic aspects of such desolation, such territories create enclaves of crime in the city, which negatively affects the overall quality of urban space.

Despite the neglect of such objects, they have great potential for development. These are both developed transport systems and reliable structures that are used in the construction of industrial buildings. Where the structural framework has not lost its load-bearing capacity, it is possible to use the object for a variety of functions from office space to extreme sports.

Reorganization of such territories allows not only to create new jobs and improve the level of education by creating jobs of higher qualifications. Creating a favorable environment for living and working allows raising the level of innovative and technological development of the city, creating conditions for growth in the long term.

In addition, urbanized territories of abandoned industries compact the urban environment, preventing it from growing uncontrollably beyond existing boundaries, and capturing areas of the natural environment. Therefore, this study closely examines these global trends using the example of cities in Kazakhstan.

The relevance of research

The relevance of this study is determined, firstly, by global trends towards the introduction of sustainable development principles into the development of urban areas, including unused industrial zones (Del Giudice et al., 2020). Coastal areas are of particular interest in this context,

as they are a kind of buffer zone between natural and urbanized spaces. The main principle of revitalization can be formulated as follows: to maximally reveal new opportunities for unused spaces by creating new functions. It is important to use a comprehensive approach in the revitalization process, which will make it possible, if necessary, to preserve the original identity of the structure, but at the same time set the vector of its new development through modern filling (Tsydypova M.A. & Alekseev A.A., 2022).

Any revitalization project must first of all correspond to the general plan of the city and the entire region, and also be part of the overall concept of territorial development (Rodina et al., 2018). An important factor in successful revitalization is the ability of the object to act as a new center of public spaces in the urban structure. The ability to develop innovative areas in the economic activity of the city, to act as a catalyst for educational and cultural and leisure life of the urban environment is an important indicator of the high-quality adaptation of ineffective parts of the city. In order to achieve this, it is necessary to maximally and comprehensively involve local communities and residents in the design at all its stages. Therefore, revitalization can be considered one of the most important tools for sustainable development, since this process makes it possible to create a high-quality and favorable environment for residents of modern cities, and at the same time provide them with the opportunity for personal and professional growth in the context of active social activity (Gouda et al., 2018). "Demand creates supply", which is why the relevance of this topic is quite high. Firstly: on the territory of Kazakhstan, there is a considerable number of abandoned or dilapidated industrial enterprises, there are also completely unused or underutilized industrial zones. Secondly: in the conditions of the economic crisis, Kazakhstan is working on the issue of import substitution and the establishment of its own production. The state intends to establish production in the fields of mechanical engineering, the chemical industry, the production of building materials and many others (Biyatov E., 2022).

Based on the above aspects, it is necessary to start acting towards the development of adaptation of industrial enterprises in the urban environment (Karipova et al., 2020). At the same time, when reconstructing and modernizing industrial zones, it is necessary to consider environmental standards. To revitalize such objects, various conceptual projects that are valuable and relevant for citizens can be used. It is possible to formulate the most important criteria for the high-quality work of the design team in working on the most effective solution:

1) Maximum high quality of comfort for people in the process of performing their work and household functions, such as the dimensions and proportions of the premises, their convenient interconnection, ergonomically located equipment and furniture, clear and easy to read orientation both in the internal and external space. In addition, compliance with all sanitary standards (insolation, ventilation, heating and air conditioning).

2) Structural integrity and cost-effectiveness of the system, which is able to ensure stability, durability and variability depending on changing functions and real needs in a specific period of operation. It is important to use the most modern innovative materials and technologies at all stages of creation from the creation of the project to its construction and operation.

3) High aesthetic requirements for the creation of a unique architectural image that meets the functional purpose and artistic criteria of society.

The methodology

The methodology of the presented study is based on an analytical method that identifies the most successful examples of industrial facility reconstruction in global and domestic practices, compares their techniques, analyzes methods and results. Archival and bibliographic sources were also used. Based on all this data, the most significant and relative ways of adapting industrial facilities to the needs of a modern city were formulated. The author's natural studies made it possible to identify the techniques and factors that make it possible to preserve the original function of the structure or create a new functionality. It was concluded that the choice of the method of adapting an object is determined by various factors: physical condition, historical and architectural value, and also the need for a particular new function in the reconstructed territory.

Experience of foreign countries

Abandoned industrial buildings in Europe are increasingly being turned into art spaces. Some of them are more than commercially successful (Mironova Y., 2017) A common problem of countries that experienced the era of change in the 1990s is the social, economic, urban and architectural consequences of the decline of large industrial enterprises. These phenomena are not new. For example, in the Ruhr region in Germany, projects to restructure industrial facilities were already underway in the sixties, and the first plans to free the region from heavy industry appeared at the same time. At the turn of the century, the Ruhr area, once home to many mines and factories, was already a cultural center with museums, science parks and perfectly suited to the new needs of the architecture of the industrial age, which in 2001 was included in the list of UNESCO World Heritage Sites (Cymer A., 2019).

The trend to adapt industrial facilities to new needs continues to this day. Over the past decade, dozens of such buildings have changed their functions throughout Poland, and similar projects are being implemented in large cities and smaller towns. In Gdansk, Krakow, Wroclaw, Warsaw, residential and office areas appear on former industrial territories. In the town of Pabianice there is a hotel built on the site of a former cotton manufactory. In Kalisz, the piano factory Calisia, which operated until 2007, has now closed, and it building now houses shops and offices. The premises of the EC1 power plant in Łódź host a science center with an interactive exposition, and the main building of a private university is located in the building of an old electrical equipment factory in Warsaw (Cymer A., 2019).

In 2008, Poland was represented at the Venice Architecture Biennale by the exhibition Houses. Life after life." Its curators, Grzegorz Piatek and Jaroslav Trybus, tried to answer the question of whether there is an architectural life after death. Nicolas Grospierre photographs iconic modern Polish objects, and they write scenarios of what could happen to these objects if their original function lost its relevance. All these photographs of Grospierre and scenarios of curators - was brought together by Kobas Lax using the collage technique. Thus, the library building of Warsaw University has turned into a shopping center. The glass office center Rondo-1 has turned into a columbarium and detention center. The Warsaw airport terminal has turned into a farm. The Basilica of the Blessed Virgin Mary of Lichen has turned into a water park. The elite residential

complex Marina Mokotów has turned into a waste dump. The exhibition received the "Golden Lion" of the Biennale for showing in an easy and accessible form a phenomenon that concerns all buildings in the world: they are erected for centuries, but it happens that they lose their meaning of existence (Cymer A., 2019)/

Analysis of domestic experience (Kazakhstan)

During Soviet times, the city of Alma-Ata was the largest industrial center in Kazakhstan. There were a lot of industrial facilities, plants, factories, organizations that carried out various orders. Some facilities are discussed in Table 1.

Table 1. Analysis of existing adapted industrial facilities in Almaty, Kazakhstan

Industrial enterprise	Enterprise function	Current state	Building area
Almaty Electrotechnical Plant (AETP)	Manufacture of lamps, irons and other peaceful products	SEC "Mart", parking, warehouses	27000 m^2
Almaty Cotton Mill (ACM)	Manufacture of fabric, yarn, bed linen, overalls	Shopping centers "Armada" and "Grand Park"	215910 m^2
Alma-Ata carpet factory	Manufacture of machine-made jacquard carpets, hand-woven pile carpets, rugs	Trading house with furniture and interior items, cafes, beauty salons, warehouses	10500 m^2
Almaty House-Building Plant (AHBP)	Manufacture of reinforced concrete products	Shopping and entertainment complex ADK	45000 m^2

The Almaty Electrotechnical Plant (AETP), as shown in figure 1, was established in 1941 on the basis of the Transsvyaz plant evacuated to Alma-Ata from Kharkov. Along with the equipment, trains arrived and their specialists in the amount of 385 people. During the war years, the plant produced products for the front: batteries, communication and telephone sets, military bowlers. At the time of the Union, AETP was a dual-use enterprise. According to public information, he produced lamps, irons and other peaceful products, but, in addition to irons, boards and microelectronics for Soviet missiles, parts for the military industry were produced in his secret workshops. In secret reports, the plant was listed under the name "Mailbox No. 7", and no more information. The plant successfully developed and operated until the 90s. When there was no big country of the USSR, a huge enterprise ordered a long life. Its main administrative building stood abandoned for many years, the workshops were in deep conservation, and a paid overnight parking lot appeared in the courtyard.

After 2011, with the country's recovery from the crisis, AETP began a second life: its administrative building was sold and rebuilt into the Mart shopping center, the area with the dismantled overhead crane was converted into a parking lot, and all workshops and utility rooms were handed over to private investors for warehouses. The former AETP, the current SEC "Mart", as shown in figure 2, is located at the address: Richard Sorge, 18 (Hyun O., 2020).

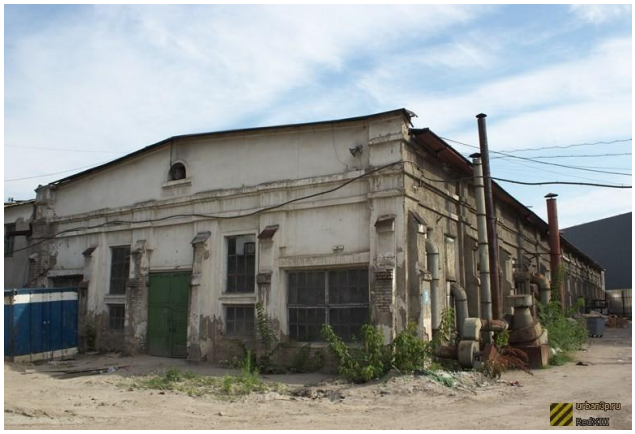

Figure 1. The Almaty Electrotechnical Plant (before adaptation)

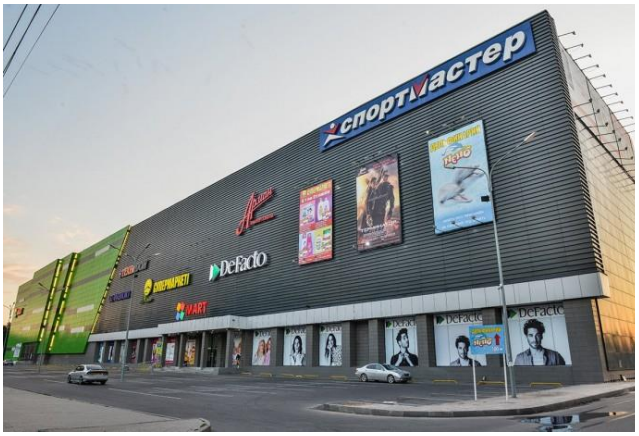

Figure 2. SEC "Mart" (after adaptation)

In the 1990s, the light industry giant Almaty Cotton Mill (ACM), as shown in figure 3, like many enterprises, came to a standstill and 10,000 people were left without work. Since 2003, part of the production area has been turned into the Armada shopping center, while the other part of the buildings has been spontaneously dismantled. Cotton came here from all the southern republics of the USSR and was processed into fabrics, and then the products were distributed throughout the Union and even to far-abroad countries. In 2016, the Grand Park shopping center, as shown in figure 4, was opened on the site of the second former workshop of ACM. Now these are endless shopping galleries with countless boutiques: for 4 years, many have remained half empty without finding their tenants (Minogarov K., 2020).

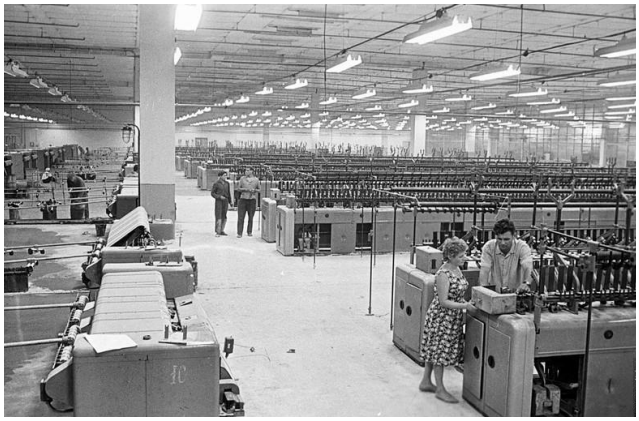

Figure 3. Almaty Cotton Mill (before adaptation)

Figure 4. Shopping centers "Armada" and "Grand Park" (after adaptation)

The Alma-Ata carpet factory (figure 5) was established in 1936 as a cooperative trade artel "Kovrovshchitsa". In 1960, the artel turned into the Alma-Ata carpet and weaving factory, in 1964 it was named after V. Tereshkova. The carpet factory was established in 1936 on the basis of the artel "Kovrovshchitsa". The enterprise was engaged in the production of carpets and carpets of various types from natural sheep, camel and goat wool. In 1962, the enterprise

was modernized, the old manual looms were replaced with new, mechanical ones. In Soviet times, the factory had 7 main production workshops. The main products of the enterprise were machine-made jacquard carpets, hand-woven pile carpets, carpet runners. On special orders, the factory produced carpets with portraits of Abai, Zhambyl, Auezov, Seifullin, Mukanov and other famous personalities.

In 1992, the Alma-Ata carpet factory was privatized, equipped with new German equipment and transformed into a private joint-stock company Almaty Kilem JSC. Today, the carpet factory does not exist: all equipment, machines, workshops have been sold. Since 2007, the former production areas have been used as a trading house with furniture and interior items, cafes, beauty salons, and warehouses, as shown in figure 6. There are also carpets here, but they are no longer made in Kazakhstan. The former carpet factory named after V. Tereshkova is located at Tole Bi, 187. Only a panel depicting weavers in national dress remains from the former enterprise (Miroshnichenko F., 2020).

Figure 5. Alma-Ata carpet factory (before adaptation)

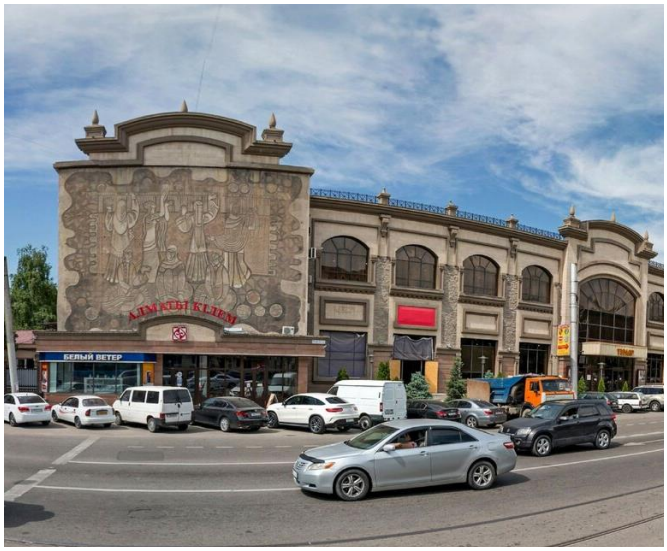

Figure 6. Trading house (present condition)

The largest construction organization in the republic, the Almaty House-Building Plant (AHBP), as shown in figure 7, was established in 1956. The enterprise had 10 self-supporting construction repair departments, a plant for the production of reinforced concrete products, a plant for the processing of non-metallic materials, a large car depot and other divisions. Reinforced concrete products were made here, from which entire micro districts were later built. Half of Alma-Ata and residential buildings in other cities of Kazakhstan and the USSR were built from concrete panels of AHBP. They also went to friendly Cuba. When the Soviet Union ceased to exist, orders for AHBP became less and less: in a crisis, the construction industry suffers first. In the 90s and 2000s, the plant's workshops were dismantled one by one. In 2011, a shopping and entertainment complex was opened on the site of the flagship of housing construction in Kazakhstan, and an auto-dismantling of Japanese cars appeared on the site of

the former car depot of the plant. In 2015, construction of a residential complex began on the remaining production areas. In 2018, the last workshops were dismantled. The object is no more. He inherited only three letters – ADK (Figure 8) (Miroshnichenko F., 2020).

Figure 7. Almaty House-Building Plant (before adaptation)

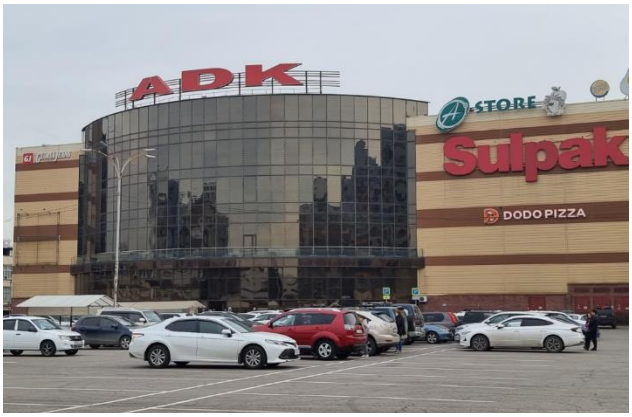

Figure 8. Shopping and entertainment complex ADK (after adaptation)

Findings/Discussion

The main problem facing modern urbanism is to find a new understanding of the role and place of industrial areas in the urban structure that would meet all modern challenges, be both aesthetically filled and economically feasible, that is, have socially approved qualities. The saturation of spatial units of modern cities with various functions, from territories to individual structures, makes it possible to use production facilities as part of large urban complexes. This makes it possible to formulate the basic principles of designing industrial facilities that would be universal in nature and could be used both in new construction and in the renovation of old buildings.

To carry out a full-fledged and high-quality renovation, an important factor can be called the establishment of clear stages of work. At the first stage, it is necessary to conduct a comprehensive analysis of the entire territory of the facility, its place in the citywide structure with the marking of adjacent buildings. It is important to record all transport and pedestrian links. The second stage requires a comprehensive analysis of world experience in creating similar projects. At this stage, it is important to choose a strategy for the development of the territory in general, and the functional development of a particular building. The final stage can be called the development of a strategy for further development and activation of processes within this fragment of the urban environment. At this stage, it is advisable to rebrand the designed territory. Here it is important to involve the public and residents of the territories as much as possible. For this purpose, it is necessary to prepare various sites and coworking spaces for public events and other activities, it is possible to use elements of graphic design and visualization. Thus, a new industrial cluster is gradually created, which clearly demonstrates the implementation of the principles of the value approach and social activity at all levels of the architectural environment

of the city. All these actions lead to comprehension and understanding of the fact that industrial territories from the exclusion zone can turn into open and comfortable urban spaces.

The professional community of architects, urban planners and urbanists is actively discussing the development prospects of industrial areas that have lost their economic feasibility and, in many cases, relevance. In this regard, three types of adaptation of industrial facilities are common according to the degree of preservation of primary functions:

i) full preservation of basic functions;

ii) partial preservation of basic functions;

iii) replacing the basic function with a new one.

The world experience of reorganization of industrial facilities demonstrates a large number of methods, the most relevant can be called the following trends, in which production functions are preserved to one degree or another.

a) creation of a conglomerate of science and production (using the example of a technology park);

b) symbiosis of housing, production and scientific functions (using the example of a technopolis);

c) combination of reconstructed production facilities with scientific centers and other companies. Integration of the entire complex into the urban fabric (using innovative urban clusters, technology parks, and business parks as examples);

d) s the unification of modern mass industrial production and objects of artistic applied art or handicraft production.

Industrial structures for adaptation by replacing the main function can be classified according to the type of function created:

(i) residential properties (student residences, housing for the elderly, workers' housing complexes, and elite housing);

(ii) public buildings.

With all the variety of types of modernization of industrial facilities, the need to preserve the basic function of the facility has been actively discussed in the professional community lately. In this regard, the process of deindustrialization in some European countries is beginning to change towards reindustrialization, but taking into account modern requirements and trends for the creation of large scientific and industrial complexes with the inclusion of socially significant buildings. Thus, the current criterion for the social adaptation of industrial heritage sites can be considered their level of integration into the modern urban fabric, the degree of "openness" (Votinov, M.A., 2014). Regardless of the function and industry of the industrial facility, the most important thing for the entire urban landscape is the ability to attract as many people as possible to the designed areas. The most high-quality results are demonstrated by complex projects in which all components of the urban space are taken into account. Thus, as a result of professional work and the involvement of an active public community, an old abandoned plant is transformed into a new open space filled with new meanings).

Conclusion

Contemporary architecture and urbanism are entering a new period, which is characterized by the process of transition from deindustrialization to reindustrialization. Thus, industrial buildings, which at a certain period became the source of urban problems, are returning their value to the city as new types of urban spaces. With this approach, preference is given to some basic functions, there is an opportunity to modernize the inclusion of processes due to research functions, office and social facilities. The conducted analysis of domestic experience in the development of industrial facilities in the territory of Almaty allows us to provide methods applicable to our conditions. Today, many production areas are used as shopping centers. Compared to foreign adaptation experience, all significant facilities in Almaty have lost their industrial function. According to the analysis of the world experience of adaptation, several directions, methods and ways of adapting industrial facilities to the needs of modern cities with a long history have been identified. The promising development of industrial architecture lies in its possible and rapid adaptation to developing technologies. This can be achieved through the re-functionalization of industrial facilities, saturating them with new functions. For most cities in our state, revitalization projects are a relevant method of restoring the urban environment. Non-functioning industrial enterprises, which were once city-forming, can bring new functional, economic, educational and innovative opportunities for the region and its inhabitants.

Conflict of interest. There is no conflict of interest between the authors.

The contribution of the authors.

Maulenova G.D.: contribution to the concept; execution of the claimed scientific research; creation of a scientific article.

Mustafa M.A.: contribution to the concept.

Tariq U.: interpretation of the claimed scientific research.

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Г.Д. Мауленова*[1], М.А. Мустафа[1], У. Тарик[2]

[1]Қ.И.Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университеті, Алматы, Қазақстан

[2]Батыс Англия университеті, Ұлыбритания

Қазіргі қала ортасының экологиялық талаптарына өнеркәсіп кәсіпорындарының сәулеттік-кеңістік бейімдеру әдістерін талдау

Аңдатпа. Бұл мақалада өнеркәсіптік аумақтарды жою немесе олардың функционалдық мақсатын сақтай отырып, олардың сапа көрсеткіштерін жақсарту мәселелері қарастырылады. Зерттеу әдістемесі Алматы мысалында отандық өндірістік ғимараттарды қайта құру әдістерін және Германия мен Польша мысалында шетелдік тәжірибені талдауды қамтиды. Бүгінгі таңда мұндай құрылымдардың архитектурасының негізінде жатқан өзекті идеология және утилитарлы өндірістік объектілерді қалалық ортаға тиімді және үйлесімді біріктіру жолдары қарастырылады. Талдау көп факторлы салыстыру әдісін қолдана отырып, өнеркәсіптік нысандардың қала құрылысы, функционалдық және композициялық сипаттамалары бойынша жүргізіледі, сонымен қатар консервация, жаңарту, реконструкциялау сияқты сәулеттік-кеңістіктік бейімделудің әртүрлі тәсілдері талданады. Мақалада бейімдеу әдісін таңдау бірқатар факторларға, соның ішінде нысанның жай-күйіне, тарихи-сәулеттік құндылығына және жөндеуден кейінгі нысанның мақсатты мақсатына байланысты екендігі атап өтілген. Өнеркәсіптік архитектураның перспективалы дамуы оның дамып келе жатқан технологияларға мүмкін және жылдам бейімделуінде жатыр. Мақала сәулетшілерді, қала құрылысын салушыларды, сондай-ақ өнеркәсіптік нысандарды жаңарту мәселелеріне қызығушылық танытқандардың барлығын қызықтырады. Өндірістік нысандарды жаңарту үшін өндірістік объектілерді бейімдеу кезеңдерін нақты белгілеу қажет.

Түйін сөздер: өнеркәсіптік аймақтарды, өндірістік нысандарды жаңарту, жаһандық бейімделуді талдау, өнеркәсіптік архитектура, жандандыру.

Г.Д. Мауленова*[1], М.А. Мустафа[1], У.Тарик[2]

[1]Казахских национальный исследовательский технический университет имени К.И .Сатбаева, Алматы, Казахстан

[2]Университет Западной Англии, Великобритания

Анализ методов архитектурно-пространственной адаптации промышленных предприятий к экологическим требованиям современной городской среды

Аннотация. В данной статье рассматриваются вопросы повышения качественных параметров промышленных территорий при ликвидации или сохранении их функционального назначения. Методология исследования включает анализ методов реконструкции промышленных зданий в отечественной, на примере г. Алматы, и зарубежной практике, на примере Германии и Польши. Рассматриваются актуальная идеология, лежащая сегодня в основе архитектуры таких сооружений, и способы эффективной и гармоничной интеграции утилитарных промышленных объектов в городскую среду. Анализ проводится по градостроительным, функциональным и композиционным характеристикам промышленных объектов с использованием метода многофакторного сравнения, также анализируются различные подходы к архитектурно-пространственной адаптации, такие как сохранение, реновация, реконструкция. В статье отмечается, что выбор метода адаптации зависит от ряда факторов, среди которых состояние объекта, историческая и архитектурная ценность, а также целевое назначение объекта после реновации. Перспективность развития промышленной архитектуры заключается в ее возможной и быстрой адаптации к развивающимся технологиям. Статья представляет интерес для архитекторов, градостроителей, а также для всех, кто интересуется вопросами реновации промышленных объектов. Для реновации промышленных объектов необходимо четко установить этапы адаптации промышленных объектов.

Ключевые слова: реновация промышленных территорий, промышленные объекты, анализ глобальной адаптации, промышленная архитектура, ревитализация.

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Information about the authors:

***Maulenova Gulnara Dzhuparbekovna* –** Professor, Department of Architecture, Kazakh National Technical University named after K. Satpayev, Almaty, Kazakhstan.

Mustafa Marzhan Askarkyzy – Master, Kazakh National Technical University named after K. Satpayev ,Almaty, Kazakhstan.

Tariq Umar – PhD, CEng, MICE, FHEA, Senior Lecturer (Architecture and the Built Environment), University of the West of England: Bristol, Bristol, GB.

***Мауленова Г.Д.* –** «Сәулет» кафедрасының профессоры, Қ.И.Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университеті, 050013, Алматы, Қазақстан.

E-mail: gulem69@gmail.com

ORCHID: 0000-0002-3738-914X.

***Мустафа М.А.* –** магистр, Қ.И.Сәтбаев атындағы Қазақ ұлттық зерттеу техникалық университеті, 050013, Алматы, Қазақстан.

***Тарик У.* –** аға оқытушы (архитектура және салынған орта), Батыс Англия университеті: Бристоль, Бристоль, Ұлыбритания

Мауленова Г.Д. – профессор кафедры «Архитектура», Казахский национальный технический университет им. К. Сатпаева, 050013, Алматы, Казахстан.

E-mail:g.maulenova@satbayev.university

ORCID 0000-0002-3738-914X.

Мустафа М.А. – магистр, Казахский национальный технический университет им.К. Сатпаева, 050013, Алматы, Казахстан.

***Тарик У.* –** старший преподаватель, Университет Западной Англии: Бристоль, Бристоль, Великобритания.