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Typical projects for atypical urban formations: The science city Piatykhatky

Abstract. Science cities, as specialised scientific production complexes, were a unique phenomenon of Soviet urban planning, formed in the 1950s-1980s. These settlements were planned to provide optimal conditions for the work of scientific institutions and comfortable living for their employees. One of the vivid examples of such formation was the science town Piatykhatky in Kharkiv, created to maintain the functioning of the Kharkiv Institute of Physics and Technology. The aim of this article was to examine the architectural and urban planning evolution of the Piatykhatky science city in Kharkiv, identifying stage-based development and analysing unique and standardised features at both urban and building scales. The results of the study demonstrated that the Piatykhatky area exhibited the key characteristics of a classic science city: a satellite location, a closed structure, individual master planning, a high level of landscaping, and a balanced combination of residential, industrial, and recreational infrastructure. These features emphasised the scientific and state priorities underlying its design. However, the architectural component of the area reflected the characteristic features of mass construction of the era, expressed in the use of standard projects for residential and public buildings. This combination of unique urban status and typical buildings formed contrast, demonstrating a pragmatic approach to architectural solutions in the context of limited resources. Of particular interest was the study of the functional and spatial complex of Piatykhatky, encompassing social, educational, sports, and transport elements, as well as its potential as a cultural heritage site. This research highlighted the necessity of modernising outdated infrastructure, while preserving valuable spatial and compositional solutions that continue to serve elements of the urban environment

Keywords: research-oriented settlement; mono-industrial town; post-Soviet built legacy; unique urban structure; standard design

INTRODUCTION

From the 1950s through the 1980s, post-war industrialisation and state socialist planning enabled the large-scale production of functionally specialised, often enterprise-dependent settlements and new districts across the USSR and

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the broader socialist block. The expansion of industrialised construction coincided with the development of research-oriented urban areas closely linked to strategic scientific institutions. These settlements were characterised by a deliberate planning structure combined with widely replicated building types. One such environment evolved in Kharkiv around a major physics research centre, forming a distinct urban entity within the city's fabric. In the context of contemporary challenges to the preservation of 20th century built environments, systematic academic reflection on these planned formations was essential for understanding their internal organisation, architectural composition, and long-term development.

Scholarly discourse increasingly addressed the urbanistic, architectural, and socio-spatial legacy of post-socialist mass housing estates, industrial legacy and monotowns. A significant contribution to the understanding of post-Soviet residential environments was made by O. Buryak & O. Vigdorovich (2023), who emphasised the importance of protecting the spatial configuration of large-scale industrial housing developments, particularly in Kharkiv, and argued for innovative heritage-oriented approaches to their conservation. H. Antypenko *et al.* (2021) further explored post-1991 transformations of Kharkiv's large housing estates, demonstrating how socio-economic change had reshaped their functional and spatial structures. A foundational overview of mass housing development in Eastern Europe was provided by L. Shevchenko (2022), who examined Ukrainian mass housing of the second half of the 20th century, emphasising its typological uniformity, standardised construction methods, and long-term urban implications.

M. Drėmaitė (2023) analysed Lithuanian mass housing estates, focusing on architects' strategies to mitigate monotony within socialist planning frameworks. The author's study highlighted the role of design agency within highly regulated systems, offering insights relevant to the spatial identity of monotowns. Issues of adaptation and functional diversification were further explored by H. Antypenko & M. Benkő (2022), who demonstrated how large housing estates responded to contemporary socio-economic pressures. I. Serhiiuk & I. Kalakoski (2023) critically discussed demolition versus adaptation strategies for post-industrial buildings in Ukraine. Processes of decay and renewal were further conceptualised by O. Remizova & K. Bozhko (2025), who analysed ruinisation and revitalisation in modernist industrial architecture. The challenges of aging Soviet-era building stock were addressed by E. Grinevich *et al.* (2021), who analysed reconstruction problems of residential buildings from the 1960s-1970s. Broader post-industrial trajectories were examined by R. Hajduková & A. Sopirová (2022), who studied Eastern Slovak towns and landscapes, emphasising the spatial consequences of industrial decline.

Also, attention was given to nuclear city in Lithuania: S. Liubimau (2019) framed Visaginas as a multi-scalar infrastructural product of Soviet nuclear urbanisation, arguing its post-1991 trajectory reflects enduring links between infrastructure, sovereignty and urbanity. Researcher distinguished Cold War, imperial and Soviet-welfare "nuclear" dimensions shaping futures amid decommissioning. Scientists N. Mažeikienė & E. Gerulaitienė (2022) showed how Visaginas' post-nuclear identity was negotiated through tourism as an interpretive practice. Participatory action research on a virtual route revealed tensions between empowerment and commodification, critique of legacies and self-exoticising narratives. L. Kachemtseva *et al.* (2022) identified urban planning characteristics of Ukrainian science cities, including Piatykhatky, while leaving their detailed architectural and urban planning characteristics insufficiently explored, particularly regarding the development stages and unique and standardised components of Piatykhatky science city. The aim of this article was to describe the architectural and urban planning characteristics and features of the Piatykhatky science city in Kharkiv at each stage of its construction, and to identify its unique and standardised components at both the urban planning level and the level of individual buildings.

MATERIALS AND METHODS

To achieve the aim of this study, a systematic, logical, and analytical research approach were employed, enabling the identification of spatial, compositional, and functional characteristics of urban planning solutions, as well as the architectural features of individual buildings within the Piatykhatky science city. The research examined planning approaches at both the urban scale and the scale of individual buildings. The investigations were conducted during the period of 2021-2025. Data were collected through route-based observation and in situ recording and processed through inventory building, categorisation by function/type/condition, and cross-source comparison. Contemporary Google Maps imagery was compared with historical plans to identify continuities and transformations in the residential urban fabric. The research was carried out in several stages: first – the collection and critical review of historical and contemporary sources; second – systematic analysis of urban planning layouts and architectural forms; and third – synthesis and comparison of unique and standardised components across different stages of the city's development. To generalise the findings and ensure methodological rigor, the method of information systematisation was applied, supported by the integration of field observations and archival evidence. This approach enabled a comprehensive understanding of both macro-level urban organisation and micro-level architectural composition, providing a robust framework for evaluating the development patterns and distinctive features of Piatykhatky science city.

Historical publications were used as follows: V. Ashykhmin & V. Stepina (2008) was used as a contextual, publication-based account of the establishment of the scientific-production base associated with Kharkiv Institute of Physics and Technology and the Piatykhatky area, supporting the reconstruction of the project's chronology and institutional factors of its development. V. Tolok (2004) provided a peer-reviewed historical overview of physics in

Kharkiv and the role of the KIPT in the city's scientific system, which was used to form the socio-institutional rationale for the emergence of the Piatykhatky residential area. Archive of NSC KIPT (1963) was examined to extract the phase-I planning scheme and plans of selected buildings; Archive of NSC KIPT (1987) was examined to extract the phase-II block layouts, building plans, and the explanatory note covering the development. Empirical field materials were used as follows: semi-structured interviews with local residents and NSC KIPT (National Science Centre of Kharkiv Institute of Physics and Technology) employees provided narrative evidence on everyday mobility, use of public spaces, and perceived transformations of Piatykhatky (The Declaration of Helsinki, 2013). Field investigations in the Piatykhatky residential area (housing microdistricts, dormitories, retail and everyday services, socio-cultural facilities, and public open spaces) generated systematic photo documentation, field notes, and route maps, enabling the assessment of current building conditions, functional changes, and the comparison of observed urban fabric with archival plans and published accounts.

RESULTS AND DISCUSSION

In the mid-1950s, urban planning in the USSR became centralised. At the 20th CPSU Congress (1956), the sixth five-year plan directives emphasised the industrialisation and standardisation of construction and set ambitious near-term targets for state-funded housing (Communist Party of the Soviet Union, 1956). A key policy instrument was the joint Decree of the CPSU Central Committee and the USSR Council of Ministers of 31 July 1957, which formalised the shift toward industrial mass housing and standardised design principles (Drėmaitė, 2022). This marked the beginning of a period of mass housing development across the USSR. From that point forward, residential and public construction relied on the industrialised method of building standardised housing designs. Elite architectural projects disappeared, while the primary focus shifted to the location of buildings, logistical convenience, and the inclusion of recreational and cultural zones. These transformations impacted all Soviet republics, including Ukraine. In the 1950s-1960s, unique urban formations known as science cities ("naukograd") emerged across the Soviet republics. Commonly referred to as "closed cities" or "mailboxes", these settlements were established to facilitate scientific research and development in various fields, including nuclear physics, rocketry, and other high-tech industries. Strictly controlled by the state, these cities were shrouded in secrecy, with access heavily restricted and information about them largely unknown to the general public for an extended period.

One of the defining features of science cities that distinguished them from other urban structures was, for example, that these cities often functioned as satellites of large urban centres, playing a role in metropolitan agglomerations as integral components of current and future settlement patterns (Kachemtseva *et al.*, 2022). When a science city was situated at a considerable distance from its "parent" city, it was consistently provided with reliable and regular transportation links to ensure connectivity. These cities (or at least their research and experimental centres) were frequently surrounded by controlled zones. It was isolated from other settlements and surrounding areas by forests and often located in picturesque settings, such as along scenic lakeshores or navigable rivers. A distinctive feature emphasising the introverted nature of science cities was their lack of through traffic, making them self-contained and inward-focused. These cities represented a new type of settlement emerging during the era of the scientific and technological revolution, reflecting a qualitative leap in the advancement of science and technology. Their exceptional intellectual potential facilitated the creation of cutting-edge facilities that outpaced broader Soviet trends in areas such as environmental sustainability, services, and culture. Residents of science cities enjoyed a high quality of life, with work, housing, leisure, and services harmoniously integrated. The foundation of science cities comprised research institutes, project bureaus, experimental factories, and testing sites. These cities were equipped with the most advanced technical infrastructure, and their laboratories featured state-of-the-art innovations. These resources were available to highly skilled personnel, including scientists, engineers, and technicians, capable of executing the most complex programmes. Special attention was given to developing a favourable architectural and urban environment, which contributed to the enhancement of the nation's scientific potential. However, despite the emphasis on thoughtful urban planning and a tailored approach, standardised designs for residential and public buildings were frequently employed. It was important to note that, in the case of residential buildings, projects with improved layouts were frequently used, often including mandatory storage rooms for each apartment in the basement. The main components of these cities included: research institution(s) and laboratories; residential quarters with standardised multi-apartment buildings; public buildings: kindergartens, schools, hospitals, and clinics; social infrastructure facilities: stores, cultural centres, sports complexes, recreational areas. Seven key areas of science cities development included aviation, rocket engineering and space research, electronics and radio engineering, automation, machine and instrument engineering, chemistry and physicochemical research for the creation of innovative materials, the nuclear sector, energy, as well as biology and biotechnology.

In Ukraine, there were several cities that have become important centres of innovation and technological progress. However, most of Ukraine's scientific cities have acquired narrow specialisations and belong to the category of so-called "atomograds" – cities built around nuclear energy facilities. These included Pripyat, Enerhodar, Netishyn, Varash, Pivdennoukrainsk, and Slavutych, the latter one was standing apart as it was constructed for the evacuation of Pripyat's residents. A key urban planning feature of this

type of city was the mandatory presence of a water body within the city to provide necessary reactor cooling, as well as the placement of the nuclear power plant at a significant distance from the residential and infrastructure areas. In Ukraine, there were also science cities focused on other scientific disciplines, such as Kyiv's Akademmistechko, which was built on the outskirts of the city in the 1960s-1970s and included more than 15 multidisciplinary research institutions, or the Zhukovsky settlement near Kharkiv Aviation Institute (KhAI), which served as a hub for scientists, educators, and aviation industry workers. An important part of the study was the analysis of the scientific city of Piatykhatky, home to one of the leading centres for physical research – the National Scientific Centre "Kharkiv Institute of Physics and Technology".

Although atomograds such as Pripyat, Slavutych, and Enerhodar held unique significance and specific purposes, their construction predominantly relied on standard Soviet designs. Nevertheless, urban planning at these sites incorporated individualised solutions. Among these cities, Slavutych stood out as the location, where the largest number of atypical architectural approaches were implemented. These ones and mentioned earlier atomograds emerged as a response to the rapid growth of nuclear energy in the USSR during the 1960s-1980s. It was built near nuclear power plants to support the energy complex, offering housing and social services for nuclear power plant workers and their families. Pripyat, founded in 1970 to accommodate workers of the Chernobyl nuclear power plant, was designed for a population of 50,000, with a focus on establishing comprehensive infrastructure for comfortable living (Wendland, 2020). There were public buildings, commercial facilities, and cultural institutions, surrounded by residential blocks. Enerhodar, also established in 1970 to serve the Zaporizhzhia nuclear power plant, represented another example of an atomic town. Situated on the banks of the Kakhovka reservoir, Enerhodar was planned with functional zoning principles, incorporating industrial, residential, and socio-cultural zones, much like other atomograds. Slavutych was constructed in 1986 following the Chernobyl disaster as a response to the need for relocating power plant workers from the contaminated zone. Its planning adhered to Soviet urban development traditions, while incorporating more modern approaches to ecology and comfort. The city was designed with considerations for environmental safety and radiation protection. Green spaces and parks occupied a significant portion of Slavutych, contributing to an improved ecological environment. Slavutych was organised into microdistricts, each characterised by unique architectural features reflecting the republics of the USSR that contributed to its construction. The architecture of these urban developments adhered to the principles of mass construction and industrialisation. Pripyat was built using prefabricated panel construction technologies, with multi-story apartment buildings organised into microdistricts that included spaces for recreation and social activities. Similarly, the architectural solutions in Enerhodar were based on standard Soviet designs. However, its proximity to water bodies and green spaces enhanced the city's aesthetic appeal, featuring numerous parks and public gardens.

Slavutych's districts designs was created by architects from various Soviet republics, including Lithuania, Estonia, Latvia, Georgia, Armenia, Azerbaijan. This approach introduced diversity to the appearance of residential buildings. In Pripyat, prefabricated panel housing dominated, with series 84, 121, and 111 being the most common, including II-60 designs for residential complexes. The "Prometheus" cinema was constructed following the 264-13-53 project plan. In Enerhodar, typical housing series such as 84, 87, 121, and 125 were prevalent, alongside series 224 schools and series 214 kindergartens. The "Sovremennik" cultural centre was built according to the 264-12-50 project. In Slavutych, standard panel housing series were also employed; however, architects sought to introduce variety through the distinct design of different districts. In these districts, one can observe buildings featuring architectural elements characteristic of the corresponding Soviet republics, such as balconies and façades styled to reflect regional aesthetics. As a result, Slavutych utilised both common Soviet-era housing series (91, 121, 84, 119, 94) and uniquely designed architectural structures (PhotoBuildings, n.d).

The settlement of Piatykhatky in Kharkiv served as a prominent example of a science city. Its core institution held a special status and conducted research in nuclear physics, a field of significant military and defense importance. This elevated status necessitated a distinctive approach to the architectural and urban planning framework. While the urban design aligned with the unique stature of a science city, the architectural components reflected standardisation and uniformity. Residential and public buildings in Piatykhatky were constructed based on standardised designs, albeit occasionally featuring improved layouts. From 2022, one of the foremost priorities was the documentation and scholarly integration of design and archival materials related to Ukraine's architectural and urban planning heritage. Kharkiv, as a border city, has been subjected to relentless and severe bombardment since the early days of the russian-Ukrainian war (from 2022), with Piatykhatky emerging as one of the city's most heavily affected districts. The unique urban entity of the Piatykhatky science city should be documented as a striking example of the interplay between specific urban planning structures and standardised architectural forms. Ensuring the sustainable development of urban structures established during the 1960s-1980s requires a focused effort on identifying and preserving such urban planning and spatial-compositional solutions. While infrastructure modernisation was imperative, it was critical to recognise and safeguard these significant elements as part of the nation's cultural heritage.

Piatykhatky exemplified a scientific settlement specialising in atomic science, where research and development of nuclear reactors and nuclear weapons were conducted. Its origins date back to the 1930s, and this science

city continued its activities as of 2025. The establishment of the Ukrainian Research Institute under the Supreme Council of the National Economy of the Ukrainian SSR and the approval of its composition and staff schedule were enacted by a Decree of the Council of People's Commissars of the Ukrainian SSR on October 30, 1928. Construction of the main building of the Ukrainian Institute of Physics and Technology, along with residential houses and workshops, was completed on September 1, 1930, in central Kharkiv (Kachemtseva *et al.*, 2022). Work on creating the technical infrastructure for conducting experiments in nuclear physics began in 1931, and an experiment on the "splitting" of the atomic nucleus was conducted as early as 1932 (Ashykhmin & Stepina, 2008). The territory selected for the construction of Piatykhatky was located in the Northern part of Kharkiv and had previously been a farmstead belonging to the village of Cherkaska Lozova. It was separated from the city by a green belt of forest-park zone. In the early 1950s, the Ukrainian Institute of Physics and Technology was assigned new tasks related to the development of nuclear weapons, various types of nuclear reactors, and space programmes. This required a significant expansion of the institute's scientific and technical potential, an increase in staff numbers, and the development of its scientific, industrial, and social infrastructure. In the mid-1950s, work began on designing and constructing the Piatykhatky complex, which included laboratory, industrial, residential, and engineering buildings, as well as socio-cultural facilities. By 1958-1959, the first residents began to settle in the area. During this period, the first kindergarten was opened, and a school was built. In the Northeastern part of this Piatykhatky territory, the building of the Ukrainian Institute of Physics and Technology was later constructed (Fig. 1). In the 1980s-1990s, additional blocks were developed in the Northeastern part of the settlement.

a)  b)  c) 

Figure 1. Piatykhatky buildings
Note: a – main building of KhIPT, Piatykhatky; b – residential building, 17 Akademik Kurchatov Avenue; c – school No. 62, 2 Walter Street
Source: photos by the authors

Since its inception, the Kharkiv Institute of Physics and Technology (NSC KIPT) held a special status and was located adjacent to a purpose-built residential area. Data of interview indicated that Piatykhatky offered a comparatively high standard of living, where stable employment and housing were accompanied by well-supplied local retail; residents noted that people travelled from Kharkiv to buy food and consumer goods that were scarce in the city. The planning and design of such entities were carried out centrally and classified as secret, often referred to as "mailboxes", directives and orders were issued from Moscow. Even when the master plan and design were delegated to a local institute, such as in Kharkiv, where the work was executed by a branch of the State Design Institute in Dniprodzerzhynsk (now DneprodzerzhinskCivilProject, Kamiansk), all documentation was ultimately reviewed and approved by Moscow authorities and subsequently archived there. This process also applied to the design of the NSC KIPT territory. As of 2025, only limited information about the designers and builders can be reconstructed, primarily based on the testimonies of NSC KIPT employees, who witnessed the planning and early construction of the settlement (Archive of NSC KIPT, 1963; Archive of NSC KhIPT, 1987).

The city featured a unique two-winged structure, with a trapezoidal core block at the intersection and rectangular blocks along the sides. To the Northwest and Southeast of enclosed area were the first and second phases of Piatykhatky's residential development. The district was characterised by a clear division into residential quarters: the first phase predominantly features low-rise buildings (three-five stories, with occasional nine-story structures, erected in 1970s), while the second phase primarily consisted of nine-story buildings, with the exception of a kindergarten. The street network was predominantly orthogonal, forming a grid of blocks along the main arterial road, which runs along the Southeastern perimeter (Akademik Kurchatov Avenue and Kharkiv Highway). This arterial road had a slight bend, where Kharkiv Highway transitions into Akademik Kurchatov Avenue, creating a trapezoidal core within the first-phase residential area. This core comprised

trapezoidal block at the intersection, and the remaining blocks follow a free-plan layout with rectangular shapes. The wing oriented toward the southeast experienced the most intensive development during the 1980s-1990s, encompassing the second-phase construction. This trapezoidal core, developed in the 1950s-1960s, comprised two trapezoidal sub-blocks, which were the only ones with a perimeter block development pattern. The second phase of development reflected the urban planning trends of the 1970s-1980s, when block structures were replaced by free-plan microdistricts. The intra-block spaces in the first-phase development, as well as the open spaces of the second phase, incorporated green areas. Pedestrian green streets run along all main transport connections, and within the trapezoidal core block, the pedestrian Myru Boulevard connected Akademik Kurchatov Avenue and Akademik Walter Street through a green corridor. Greenery also lined the main arterial road and adjacent streets. Additionally, recreational spaces originally planned for the district were complemented by the presence of a forested area on the opposite side of the main road, contributing to the ecological balance of the district.

Consistent with the characteristics of science cities, a section of Akademik Kurchatov Avenue was a dead-end in the Southwest direction. The district's social infrastructure included schools, kindergartens, commercial buildings, and sports facilities, which were integrated into the residential quarters. These structures were generally free-standing buildings. The blocks, in addition to residential functions, included socio-cultural, domestic, and educational facilities necessary for the autonomous functioning of the city. When discussing master planning, it was important to note the high level of secrecy that restricted access to original blueprints and their copies, while documentary information about residential and service zones was available in significantly larger volumes. The working blueprints for the master plan and buildings (or rather their integration into the landscape) were developed by Kharkiv's Gorstroyproject in 1957 (Archive of NSC KIPT, 1963). While Piatykhatky's master plan adhered to the urban planning characteristics typical of science cities the city was constructed with standard buildings for residential and service sectors. Residential buildings followed standard series such as 1-438, 1-258, 87; dormitories used series 1-251-1, kindergartens followed series 2-04-32, and cafeterias used series 9001, among others (Archive of NSC KIPT, 1963; Archive of NSC KIPT, 1987).

The typification and centralisation of standard project development, and their dissemination across the territory of the former USSR, were fully realised there. For example, residential buildings of series 1-438 can be found in the Volyn, Dnipropetrovsk, and Poltava regions, constructed between 1955 and 1960. Series 87 can be found not only in various regions of Ukraine but also in Belarus and Lithuania (Archive of NSC KIPT, 1963; Archive of NSC KIPT, 1987). Therefore, the development of the science city of Piatykhatky can be divided into two main periods: the Soviet period and the period of independence. The Soviet period was characterised by construction and development, further divided into two stages: the 1950s to 1970s, and the 1980s to 1991. The period of independence began in 1992 and continued to the present day. This period was further divided into two phases: 1992 to 2022, and the period starting from February 2022 (Fig. 2).

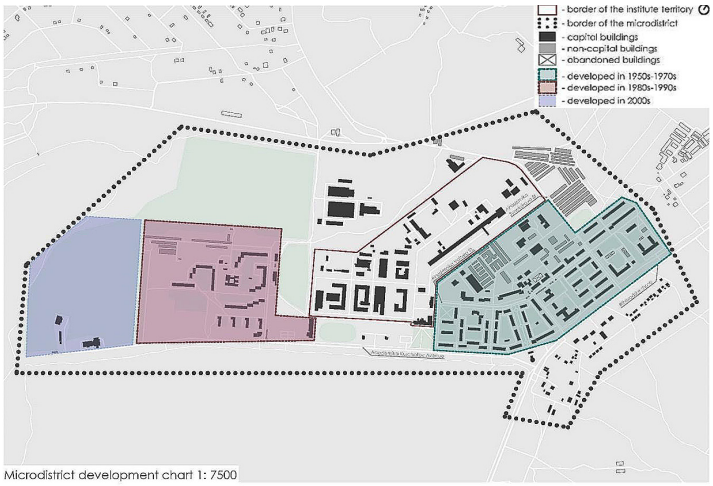

Figure 2. Piatykhatky master plan with construction stages
Source: developed by the authors

During the 1950s-1960s, 41 buildings were constructed and commissioned in the territory of Piatykhatky, including 15 laboratory buildings. At the same time, the construction of the residential settlement continued, which was equipped with all the necessary social and cultural infrastructure. The settlement featured stores, a household services centre, a club with a cinema hall, a post office, a telephone exchange, cafes, a medical centre with a clinic and hospital, a pharmacy, a fire station, a sports complex, and other institutions. By the early 1950s-1960s,

the first phase of construction was completed. Residential blocks were being built, the construction of the Eastern part of the settlement continued into the 1970s. The first area to be developed was Block 3 – the section between Akademichna, Walter, Volkov, and Kurchatov Streets. The construction of this district began among the earliest and was completed by 1963, including 10 residential buildings, 2 kindergartens, and a school. Residential buildings on 7, 9 and 11 Kurchatov Avenue were built according to the standard design of series 1-424 (Fig. 3), while residential buildings on 1 Akademik Volkov Street, 1 and 2 Yevpatoriya Lane followed the standard design of series 1-258-2. 3 Yevpatoriya Lane and 3 Akademik Volkov Street were built according to the standard design of series 1-258-1, and the residential building on 5 Yevpatoriya Lane followed series 1-438-2. On 5 Kurchatov Avenue, the building followed series 1-438-6, and the school on 2 Akademik Walter Street was built according to series 2-02-19.

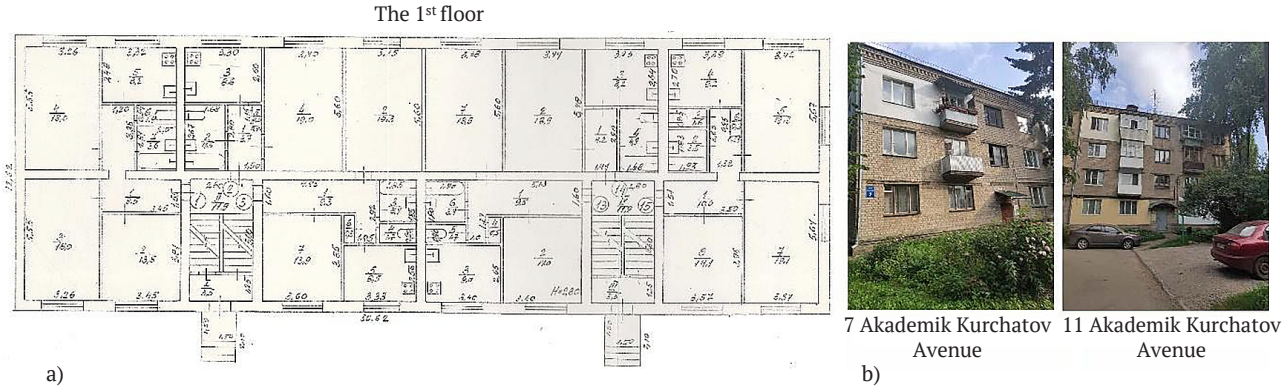

Figure 3. Plan and photos of residential buildings on Akademik Kurchatov Avenue, Piatykhatky
Note: a – plan of the 1st floor of residential buildings on 7 and 11 Akademik Kurchatov Avenue; b – photos of the residential buildings on 7 and 11 Akademik Kurchatov Avenue
Source: Archive of NSC KIPT (1963), photos by the authors

The next phase of development was the construction of Block 2. It was located between Akademik Kurchatov Avenue, Akademik Volkov Street, Akademik Walter Street, and Harkusha Street. By 1963, seven residential buildings and a kindergarten had been completed, while an outbuilding and two residential buildings were under construction, and four residential buildings and an outbuilding were in the design stage. The left half of Block 2 was developed first. As of February 1963, six residential buildings, one dormitory, a kindergarten, and a public-commercial building had been completed. The residential buildings on 13 and 17 Kurchatov Avenue, four stories each, were designed according to series 1-424, and those on 1 and 3 Myru Boulevard, five stories each, followed series 1-438 (project 1-438-9). The dormitory on 6 Volkov Street, three stories, was built according to the standard design 1-251-9. Residential buildings on 2 and 4 Volkov Street, three stories each, followed the standard design 1-258-2. The public and commercial section, three stories, was built according to series 2 on 4 Akademik Walter Street, and the kindergarten on 15 Kurchatov Avenue was designed according to the standard series 2-24-32 (Archive of NSC KIPT, 1963). The buildings in the right half of Block 2, as of February 1963, were either under construction or in the design stage. At the construction stage were residential buildings on 3 Harkusha Street (project 1-438-6) and on 4 Myru Boulevard (project 1-438-9). Six residential buildings and a so-called utility insert or household service facility were planned for this area. As a result, the following were built: a five-story residential building on 4 Myru Boulevard, project 1-438-9, series 1-438; a five-story residential building on 2 Myru Boulevard, project 1-438-36K, series 1-438A; and later, the nine-story residential building on 21 Akademik Kurchatov Avenue, project 447C-47 (series 1-447C), as well as a food service building, series 2-438U-3-1, 2-438U-3-3 (Archive of NSC KIPT, 1963; PhotoBuildings, n.d.).

The third area to be developed was Block 4, located between Akademik Walter Street, Transportna Street, and Akademik Sinelnikov Street. By 1963, it was more than half built: five residential buildings were constructed along Akademik Walter Street, and six auxiliary buildings were built deeper within the block. The development along Akademik Walter Street consisted of three-story houses. Nine-story building was constructed, specifically, the following buildings were erected: on 17 Akademik Walter Street, three stories – project 1-251-7 (series 1-251); on 15 Akademik Walter Street, three stories – standard project 1-251-9 (series 1-251); on 13 Akademik Walter Street, four stories – project 1-438-4 (series 1-438); on 7 Akademik Walter Street, nine stories – series 87; on 11 Akademik Walter Street, three stories – project 1-251-9 (series 1-251); and on 9 Akademik Walter Street, three stories – project 1-251-7 (series 1-251) (Archive of NSC KIPT, 1963; PhotoBuildings, n.d.). Block 4a included a fire station (planned) and a garage (constructed by 1963). Also, following buildings were added to Block 4a: at 3 Akademik Walter Street, a telecommunications building (formerly ATS No. 335), and at 5 Akademik Walter Street, a residential

building of the 87 series. The fourth area to be developed was Block 1, located between Harkusha Street, Sinelnikov Street, Akademik Walter Street, and Kharkiv Highway. By 1963, plans were in place for the construction of nine residential buildings, a canteen, a children's nursery, a school, workshops, and a sports ground, which were completed in the late 1960s to early 1970s. Specifically, the following buildings were constructed: at 27 Akademik Kurchatov Avenue, five stories – project 1-438-19 (series 1-438); at 25 Akademik Kurchatov Avenue, five stories – project 1-438-9 (series 1-438); at 12 and 10 Akademik Walter Street – projects 1-438-6 and 1-438-6M (series 1-438); at 1 and 3 Akademik Sinelnikov Street (five stories) – project 1-438-16 (series 1-438); at 5 Akademik Sinelnikov Street, five stories – project 1-438-5 (series 1-438); at 25A Akademik Kurchatov Avenue – project 1-438-9; at 10A Akademik Walter Street, five stories – project 1-438-9 (series 1-438); and at 23 Akademik Kurchatov Avenue, a school based on the standard project 2-02-960U.

The territory in the Northeastern part of the district was developed last and was conditionally referred to as Block 5. It was bounded to the Southwest by Akademik Sinelnikov Street, to the southeast by Kharkiv Highway, and was divided by Akademik Walter Street. In the late 1970s and early 1980s, the Eastern-Northern part of the area between Kharkiv Highway, Akademik Sinelnikov Street, and Akademik Walter Street saw the construction of buildings for the Physics and Technology Department of Karazin University, a dormitory, a canteen, and a medical and sanitary unit. The dormitory, with five stories, was built according to project 1-300-2 (series 1-300). On the Northern side of Akademik Walter Street in this block, residential buildings, a store, and a sports ground were constructed. The residential buildings at 19 and 21 Akademik Walter Street, with five stories, were based on project 1U-438A-35K (series 1U-438A), while the building at 19A Akademik Walter Street, with nine stories, was of series 87, and the building at 21A Akademik Walter Street, with five stories, was built according to project 1U-438A-35K (series 1U-438A). In the 1980s, the second phase of construction during the Soviet period began – the design and construction of the Western part of the settlement, the second stage of development of Piatykhatky. A master plan was developed, which, unlike the plan for the Eastern part of the settlement, was not fully realised and underwent many modifications. The layout of the Western part was divided into several blocks. In 1987, the graphic part of the architectural and planning task for designing residential Block 2 was released, which was constructed in the late 1980s to early 1990s. According to the master plan, the development of the second stage featured an open layout with residential blocks that were spatially and functionally connected to the social and service facilities of the first and second stages.

According to the "Design proposal for the development of the microdistrict in the Western part of the Piatykhatky settlement" (Blocks 1 and 2 on Akademik Kurchatov Avenue), it was recommended to use standard designs for residential buildings and other structures, with subsequent site-specific adaptation: 15 residential buildings (standard design No. 87-019/75.2), 24 residential buildings (standard design No. 87-021/75.2), 3 residential buildings (standard design No. 87-094/12), 2 schools (standard design No. 224-1-434.85), a kindergarten-nursery (standard design No. 214-1-285.84), and two swimming pools (standard designs No. 294-3-30 and No. 294-3-37.85). The pools were to be located at the schools and one of the kindergartens-nurseries, which was never built. A large stadium and a vocational-technical school were also planned (Archive of NSC KIPT, 1987; PhotoBuildings, n.d.). In Block 2, the plans included a sports building, a vocational-technical school for 720 students, a thermal distribution point, a dispatch point, public and commercial enterprises according to individual plans, as well as a parking lot and a bus terminal. The design also envisioned a rich green area with coniferous and deciduous trees, shrubs, flowerbeds, climbing plants, and a living hedge. In the end, only part of the planned objects was constructed: nine nine-story residential buildings and one 320-capacity kindergarten-nursery. The remaining facilities were not built, meaning less than 50% of the planned development was realised. The undeveloped areas were used by residents for gardening until a golf club was established during the period of independence (Fig. 4).

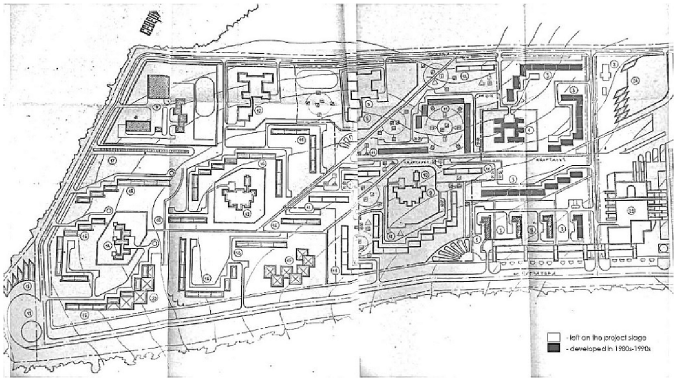

Figure 4. The planned development and the built one, 2nd stage
Note: Piatykhatky, 1980s-1990s
Source: Archive of NSC KIPT (1987)

The following buildings were eventually constructed and were the typical ones: residential buildings at 4, 6, 8, 8A Akademik Kurchatov Avenue – series 87, sections 87-094 and 87-021; at 10 Akademik KurchatovaAvenue – series 87, sections 87-0120 and 87-019; at 12 Akademik Kurchatov Avenue – series 87, sections 87-021, 87-019, 87-020; at 1, 7, 7A, 7B Gatsev Street – series 87; at 28 Akademik Kurchatov Avenue 28 – series 87, project 114-87-2.75.2; and the kindergarten-nursery at 12A Akademik Kurchatov Avenue 12A – standard project 214-2-72 (Archive of NSC KIPT, 1987). After the collapse of the Soviet Union, funding for science cities was discontinued, forcing them to find alternative methods of operation and financing. As a result, the settlement was not completed as originally planned and, like many other science cities, it went through a crisis during the transitional period. After 1991, when Ukraine declared its independence, the settlement continued to function as an autonomous residential district of the city, equipped with shops, pharmacies, medical and educational institutions, a library, a gas station, an electric charging station, a fire department, a police station, emergency services, and various household service and equipment repair enterprises. The centre of the settlement remained lively and functionally well-equipped, although abandoned buildings and areas began to appear within the former science city. This primarily concerned the Northeastern part, between the Physics and Technology Faculty of KhNU and Medical Facility No. 13, as well as the Southwestern areas between the newly established golf course in the 2000s and the residential buildings from the second construction phase of the 1980s, including informal residents' allotment gardens (Fig. 5).

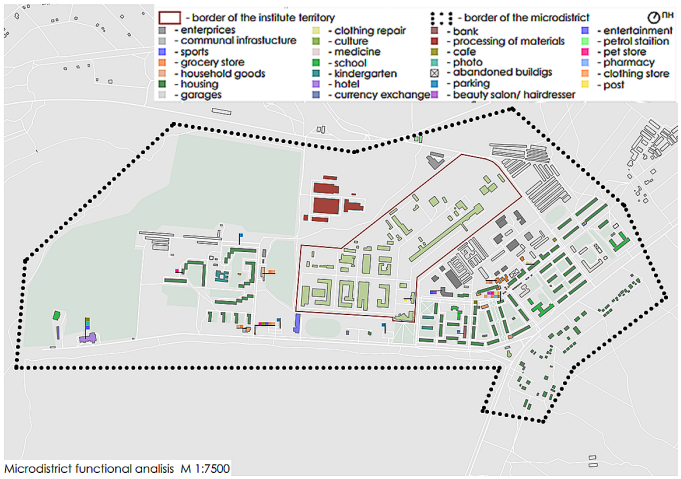

Figure 5. Piatykhatky master plan with functional analysis
Source: developed by the authors

After the outbreak of russia's full-scale war against Ukraine from 2022, the Piatykhatky suffered significant damage. Buildings at the NSC KPTI, which houses a nuclear facility, were destroyed. While the reactor itself was not damaged, several critical components of the facility were destroyed by the missile shockwave, including the power transformer, which was essential for its continued operation. The residential infrastructure was also affected, with buildings on 7, 11, 19A, 21A Akademik Walter Street, Akademik Kurchatov Avenue, and others being partially destroyed. The Kharkiv specialised school No. 62, located at 23 Akademik Kurchatov Avenue, was partially damaged, as well as were grocery stores and other buildings (Pecherskyi, 2023; Dotsiak, 2023). Thus, the research demonstrated that Piatykhatky was a unique urban formation that reflected key characteristics of a science city: its satellite nature, the presence of a city-forming institution – a large research centre, its enclosed structure, individualised urban planning, a high level of amenities, as well as a harmonious combination of residential, industrial, and recreational infrastructure, which emphasised its state significance and scientific potential. However, despite the urban uniqueness of Piatykhatky, it predominantly employed standardised designs typical of Soviet construction from the late 1950s to the 1980s. This created a contrast between the innovative status of the science city and the standard approach to architectural objects, reflecting the practical impetus for mass construction in the context of limited resources.

Research on specialised urban formations and scienceoriented settlements provided a comparative framework for interpreting the findings of this study. M. Harlov-Csortán & M. Tamáska (2025), in their comparative analysis of Dunaújváros and Paks, showed how technological purpose fundamentally shaped urban structure, reinforcing observation that researchoriented functions were central to Piatykhatky's spatial organisation. K. Stanilov (2007) situated such transformations within broader patterns of postsocialist urban form, supporting the interpretation of historical planning trajectories at Piatykhatky. J. Jaczewska *et al.* (2022) demonstrated how sustainable mobility and densification strategies influenced postsocialist spatial adaptation, which parallels

Piatykhatky's infrastructure distribution. D. Dijokienė & A. Paškauskienė (2022) examined the interaction between urban form, natural environment, and cultural identity, providing a contemporary lens to analyse how Piatykhatky's spatial organisation and design contributed to the city's unique historical and functional identity. S. Berger (2019) emphasised the role of industrial heritage and regional identity in shaping post-industrial urban landscapes, providing insights into Piatykhatky's historical and scientific legacy within Kharkiv's urban context. Scientists V. Kulić *et al.* (2014) discussed the sanctioning of modernist urban forms, highlighting how standardised architectural solutions coexisted with functional specialisation – parallels that were evident in Piatykhatky's combination of research facilities, residential zones, and recreational areas. Socialist new towns as post-utopian urban formations were examined by K. Kissfazekas & M. Benkő (2022), who analysed Dunaújváros as a case of rebranding and symbolic transformation. This theme was expanded in the edited volume by V. Mihaylov & M. Ilchenko (2022), which examined case studies of planned socialist cities in Central Europe and the Balkans undergoing post-socialist transformations. Collectively, these works situated Piatykhatky within an international scholarship on planned scienceoriented urban forms, support findings of this research, and elucidated broader implications for urban regeneration theory and practice.

CONCLUSIONS

Piatykhatky science city was established for KIPT employees and represented a significant monument of Ukrainian scientific culture. Its functional-spatial complex, including social, educational, sports, and transport infrastructure, required thorough analysis and preservation. Piatykhatky represented a unique science city, characterised by its satellite nature, a major research institution, enclosed layout, and integrated infrastructure. Despite its urban distinctiveness, residential and public buildings largely used standardised Soviet designs, highlighting a contrast between the city's scientific significance and practical mass-construction approaches. Ensuring the sustainable development of 1960s-1980s urban structures required assessing their planning, spatial, and compositional features. While technical upgrades were needed, the city's compositional and spatial elements remained valuable, stable, and worthy of preservation as cultural heritage. After 1991, following the discontinuation of centralised Soviet-era funding for science cities, Piatykhatky was not completed according to the original plan and experienced a crisis, yet it continued to function as an autonomous residential district with an active service core. The settlement's centre remained functionally well-equipped; however, underused areas emerged. In the South-Western sector, some of these areas were subsequently redeveloped for a golf course established in the 2000s, while others were appropriated by residents for informal allotment gardening. Piatykhatky's urban planning offered lessons for modern regeneration, especially in post-industrial and science-driven districts. Its integration of research institutions with residential areas, balanced green spaces, and phased transition from perimeter blocks to open-plan microdistricts illustrated sustainable, flexible urban design. Studying its spatial organisation, street network, and social infrastructure provided strategies for combining scientific, residential, and recreational functions in contemporary urban renewal projects. Future research on Piatykhatky should explore its sustainable development, adaptation to modern environmental and technological standards, preservation of scientific heritage, and its role in fostering high-tech clusters and attracting investment in research and innovation within contemporary urban contexts.

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CONFLICT OF INTEREST

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Типові проєкти для нетипових містобудівних утворень: наукоград П'ятихатки

Анотація. Наукогради як спеціалізовані науково-виробничі комплекси були унікальним явищем радянського містобудування, сформованим у 1950-1980-х роках. Ці поселення проєктувалися з метою створення оптимальних умов для діяльності наукових установ і комфортного проживання їхніх працівників. Одним із яскравих прикладів такого утворення був наукоград П'ятихатки у Харкові, створений для забезпечення функціонування Харківського фізико-технічного інституту. Метою цієї статті стало дослідження архітектурної та містобудівної еволюції наукограда П'ятихатки у Харкові шляхом визначення етапів його розвитку та аналізу унікальних і стандартизованих рис на містобудівному рівні та на рівні окремих будівель. Результати дослідження показали, що територія П'ятихаток продемонструвала ключові характеристики класичного наукограда: супутникове розташування, закриту структуру, індивідуальне генеральне планування, високий рівень озеленення, а також збалансоване поєднання житлової, виробничої та рекреаційної інфраструктури. Ці риси підкреслили наукові й державні пріоритети, закладені в основу його формування. Водночас архітектурна складова району відображала характерні риси масового будівництва відповідної епохи, що проявлялися у використанні типових проєктів житлових і громадських будівель. Таке поєднання унікального містобудівного статусу та типової забудови сформувало контраст і продемонструвало прагматичний підхід до архітектурних рішень в умовах обмежених ресурсів. Особливий інтерес становило дослідження функціонально-просторового комплексу П'ятихаток, який охоплював соціальні, освітні, спортивні та транспортні елементи, а також аналіз його потенціалу як об'єкта культурної спадщини. Проведене дослідження підкреслило необхідність модернізації застарілої інфраструктури з одночасним збереженням цінних просторових і композиційних рішень, що й надалі формують елементи міського середовища

Ключові слова: науково орієнтоване поселення; моноіндустріальне місто; пострадянська забудована спадщина; унікальна містобудівна структура; типовий проєкт