

## URBAN PLANNING ANALYSIS OF THE NEIGHBORHOOD IN ASTANA CITY

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**Abstract.** *The authors investigated urban planning challenges in Astana by examining design documents, conducting a field survey of the territory, and conducting a sociological survey. Based on the analysis of the data obtained, four distinct groups of problems have been identified: those related to urban planning, which are linked to the growth of the urban population and the development of transportation infrastructure; those resulting from deviations from regulations and the use of unreasonably standardized coefficients in local design; those related to scientific and technical issues, which arise from the optimization of construction and installation work and lead to uncomfortable conditions; and environmental problems that arise from the reduction of green spaces. All identified problems affect the level of social comfort in the living environment. An analysis of the emergence of these problems reveals a weakness in urban design. In a detailed planning project, architectural schematicity and instability lead to the fact that individual infill developments can edit primary urban planning decisions according to the number of floors, configuration of the residential complex, functional affiliation of the site, development of transport schemes, etc. Consequently, recommendations have been put forth to forego infill development and instead prioritize neighborhood development and the necessity of establishing local planning authorities.*

**Keywords:** *residential development, masterplan, detailed planning project, infill development.*

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## АСТАНА ҚАЛАСЫНДАҒЫ АУДАННЫҢ ҚАЛА ҚҰРЫЛЫСЫН ТАЛДАУ

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**Аңдатпа.** Авторлар жобалық құжаттаманы зерделеу, аумақты далалық зерттеу және социологиялық зерттеу жүргізу арқылы Астана қаласының қала құрылысы мәселелерін зерттеді. Алынған мәліметтерді талдау негізінде проблемалардың төрт бөлек тобы анықталды: қала халқының өсуімен және көлік инфрақұрылымының дамуымен байланысты қала құрылысы; нормативтерден ауытқумен және жергілікті жобалауда негізсіз нормаланған коэффициенттерді қолданумен байланысты; құрылыс-монтаж жұмыстарын оңтайландыру кезінде туындайтын және ыңғайсыз жағдайларға әкелетін ғылыми-техникалық мәселелерге байланысты; жасыл аумақтардың қысқаруынан туындайтын экологиялық. Барлық анықталған проблемалар өмір сүру ортасындағы әлеуметтік жайлылық деңгейіне әсер етеді. Осы проблемалардың пайда болуын талдау қала құрылысының әлсіз жақтарын көрсетеді. Егжей-тегжейлі жоспарлау жобасында сәулеттік эскиздік пен тұрақсыздық жеке дамудың қабаттар санына, тұрғын үй кешенінің конфигурациясына, учаскенің функционалдығына, көлік схемаларын әзірлеуге және т. Осыған байланысты ықшамаудандарды дамытуға басымдық бере отырып, толтыру құрылысынан бас тарту және жергілікті жоспарлау органдарын құру қажеттігі туралы ұсыныстар берілді.

**Түйін сөздер:** тұрғын үй құрылысы, бас жоспар, егжей-тегжейлі жоспарлау жобасы, толтыру құрылысы.


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## ГРАДОСТРОИТЕЛЬНЫЙ АНАЛИЗ МИКРОРАЙОНА В ГОРОДЕ АСТАНА

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**Аннотация.** Авторы исследовали проблемы градостроительства в Астане, изучив проектную документацию, проведя полевое обследование территории и социологический опрос. На основе анализа полученных данных были выделены четыре отдельные группы проблем: градостроительные, связанные с ростом городского населения и развитием транспортной инфраструктуры; связанные с отступлениями от нормативов и использованием необоснованно нормированных коэффициентов при проектировании на местах; связанные с научно-техническими вопросами, возникающие при оптимизации строительно-монтажных работ и приводящие к некомфортным условиям; экологические, возникающие из-за сокращения зеленых насаждений. Все выявленные проблемы влияют на уровень социального комфорта в жилой среде. Анализ возникновения этих проблем выявляет слабые места в городском дизайне. В проекте детального планирования архитектурная схематичность и нестабильность приводят к тому, что индивидуальная застройка может редактировать первичные градостроительные решения по этажности, конфигурации жилого комплекса, функциональной принадлежности участка, развитию транспортных схем и т.д. В связи с этим были выдвинуты рекомендации отказаться от точечной застройки, отдав предпочтение развитию микрорайонов и необходимости создания местных органов планирования.

**Ключевые слова:** жилая застройка, мастер-план, проект детальной планировки, точечная застройка.

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#### **CONFLICT OF INTEREST**

The authors state that there is no conflict of interest.

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#### **АЛҒЫС / ҚАРЖЫЛАНДЫРУ КӨЗІ**

Зерттеу жеке қаржыландыру көздерін пайдалана отырып жүргізілді.

#### **МҮДДЕЛЕР ҚАҚТЫҒЫСЫ**

Авторлар мүдделер қақтығысы жоқ деп мәлімдейді.

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#### **БЛАГОДАРНОСТИ/ИСТОЧНИК ФИНАНСИРОВАНИЯ**

Исследование проводилось с использованием частных источников финансирования.

#### **КОНФЛИКТ ИНТЕРЕСОВ**

Авторы заявляют, что конфликта интересов нет.

## 1 INTRODUCTION

The city is a functional and spatial environment comprising integrated planning elements; residential, public, and industrial areas; buildings and structures; green spaces; and public open spaces. The main structural component of the city is the residential neighborhood (Kain and Quigley, 1970). When designing a residential micro-district, the project's main task is to create an urban environment for the residential area (Konsti-Laakso and Tero Rantala 2019). This should consider all the engineering, technical, social, domestic, architectural, and planning requirements. The design should be characterized by high-quality architectural and spatial composition, meeting the convenience requirements for living and the population's life.

Following the economic downturn, Kazakhstan experienced revitalization of architectural and urban planning activities. The transfer of the republic's capital to Astana and the city's associated intensive reconstruction and development provided new impetus to this sphere. The master plan for the new capital was developed through international competition that involved prominent architects from Europe, Australia, Japan, and Kazakhstan. However, the plan must consider several indicators crucial for creating a comfortable living environment. This oversight became apparent because of Astana's rapid population growth and expansion.

This study aimed to identify normative inconsistencies in urban planning documents at different levels. The authors conducted a field survey of one of the city's micro-districts and compared the findings with city officials' detailed planning plans.

## 2 LITERATURE REVIEW

Domestic scientists have studied problems with the formation of urban elements and methods of their interaction. For example, in the article "Features of the Social Infrastructure Formation of Astana City," the authors analyzed the current state of the city's social infrastructure and showed that this element of urban development at the district and local levels affects the population's living conditions. At the same time, the authors do not study design solutions of regional significance and do not consider the close interaction of the social infrastructure with the residential area (Sarsembayeva et al., 2023).

In the work "Development of the Architecture of Residential Buildings from the Beginning of XX to XXI Century (By the Example of Astana)," the group of authors shows the features of the construction of residential buildings, as well as their formation in the course of the search for new architectural, planning, volumetric and urban solutions in the context of socio-economic transformations in the development of society. However, this work focuses on examining small complexes, leaving aside the issues of their interaction with each other and other urban elements (Toishiyeva et al., 2023).

It should be noted that the scientific community often highlights the need to use underground spaces. In an article titled "Planning an Adaptive Reuse Development of Underutilized Urban Underground Infrastructures: A Case Study of Qingdao, China," the authors stated that urban underground infrastructure is vital to urban sustainability (Qiao, 2023).

Thus, this study differs from existing works in its consistent analysis of urban spaces, from design solutions to their actual implementation, a comparative analysis of theoretical material and the results of a field survey, and a wide range of studies on urban elements.

## 3 MATERIALS AND METHODS

### 3.1 Study design

To achieve this research objective, this study used a mixed-methods research design based on a combination of data collection and analysis requirements. In particular, the authors considered the

peculiarities of the combinatorics of the elements of qualitative and quantitative approaches within the framework of one study.

### 3.2 Document analysis

Thematic materials were collected during the research process, and scientific research, literary sources, archival, and design documentation in urban planning were analyzed. These materials form the basis for research in the search for urban planning problems.

### 3.3 Survey

To investigate the existing construction and regulatory documentation regarding applied coefficients in designing local areas and determining parking spaces, a survey of 410 people was conducted. Public opinion was assessed in 50 residential complexes under different urban planning scenarios, varying in housing classification, residential density, and functional structures. The survey comprised 12 questions that generated an impartial depiction of the feasibility of specific standards. During the population survey, face-to-face interviews were employed; respondents completed questionnaires individually or as part of a group discussion. Data analysis of the sociological survey uncovered patterns for each queried item.

### 3.4 Field survey

The study employed a field survey method to investigate the city area's architectural and urban planning solutions under examination. The study covered over 15 urban planning areas, streets, and public spaces. The collected data were arranged in a comparative table.

### 3.5 Graphical analysis

This method was utilized to undertake a comparative analysis of design documents and field surveys, forming a table that consistently highlights urban planning issues.

## 4 RESULTS AND DISCUSSION

The population of Astana has steadily increased because of its diverse political and socioeconomic conditions. According to an expert forecast, the urban population is estimated to reach approximately 3 million by 2050, which is approximately 12% of the nation's total population (Mamedov 2022).

As the population expands, the number of urban development initiatives and the city's territory increases. Consequently, new architectural and urban planning documents and projects have emerged. One of the principal urban planning documents is the master settlement plan, a general urban planning document at the local level that establishes the priorities, directions, and strategy for a settlement's integrated urban development; the primary functional use of its territories; the primary parameters for engineering, transport, and social infrastructure development; and the conditions necessary to form a safe and favorable living environment.

The master plan of the settlement was developed following the main directions of the state urban planning policy, considering the socio-economic planning and forecasts of the development of the country and its administrative-territorial units, existing international, national, regional, local, territorial, and sectoral programs.

The urban environment parameters, such as the anticipated population size and socio-demographic structure, are determined through the master plan of the settlement. The plan considers suburban areas while establishing directions and boundaries for territorial development. It also proposes functional zoning and territory planning, territorial organization, and parameters for developing residential, industrial, social engineering, transport, and other infrastructure. The plan also prioritizes and reserves development areas for populated and suburban regions, ensures safety, and creates a comfortable living environment, while protecting natural objects, complexes, and historical and cultural values. After the development of the master plan for the city, the subsequent stage of

urban planning commences—the detailed planning project (hereafter referred to as the DPP) - which is an urban planning endeavor conceived for specific subdivisions of territories and functional zones within settlements, as well as areas positioned outside of settlements. DPP and development projects were developed in accordance with the settlement's master plan. This plan is established under the planning structure elements outlined in the master plans, town planning regulations, and the concept of unified architectural style. Additionally, these projects are based on the planning structure elements and town planning regulations outlined in the Rules of the Organization established in the master plan of settlement development. The DPP comprises graphic materials depicting the layout of the planned territory within the city system, organization of the road network and transportation, vertical planning and engineering preparation of the territory, engineering support, conceptual development, urban zoning plan, red-line layout plan, reference plan, and cross-sectional profiles of streets. Furthermore, the DPP aims to address the challenge of creating accessible conditions for individuals with limited mobility to access social and other amenities without hindrances.

Once the DPP has been approved, an infill development project (the final design stage) begins. An infill development project is a project with individual architectural and urban design solutions that is conducted considering the DPP and the existing or planned environment. These projects are located on designated urban sites issued by government agencies and their design must be based on the DPP.

To identify urban planning issues, a site in Astana was chosen in the area encompassing Charles de Gaulle, A. Tokpanova streets, and Tauelsizdik and B. Momyshuly avenues. The site was selected for its potential to reveal weaknesses in the current planning strategies. Historically, the site was situated on the outskirts of the city and consisted of one-story garages. Nonetheless, owing to the steady expansion of the capital, it has been repositioned as an urban hub with thriving social amenities and a triathlon park providing a recreational area for visitors. Consequently, the rapid progression of the area marked its landscape.

During the field survey of a selected site, clusters of issues with four distinct categories were recognized: urban planning, normative, environmental, and scientific-technical. It is important to note that these issues impact social well-being, and many of them can affect multiple groups of people.

The urban planning category encompasses issues related to the decline in available residential areas in cities caused by the ongoing urbanization process. This necessity dictates that we augment development intensity by increasing density (Kornilova & Saekova 2018).

Additionally, there are queries concerning architectural and urban planning concepts, as well as the functional equipment of this location. Challenges arise concerning compliance with urban planning regulations and addressing the impact of infill development on the surroundings.

Field analysis indicated the need for architectural, stylistic, and urban planning concepts. The DPP requires accents and ideas for urban planning. The primary content of this urban planning document is displayed through loosely arranged architectural volumes, without perspective formation. The residential developments currently under construction or have been completed do not align with the established DPP regarding the number of stories (Figure 1; Figure 2), nor do they comply with the plan layout and the required distance from the red line and building line.

A comparison of DPP and field survey analyses revealed a reduction in recreational areas. In some cases, a residential complex is located in areas designated as green areas (Figure 1; Photo 4); in others, the built-in premises of the complex are located in public green spaces (Figure 1; Photo 5). Each site was designed as a functionally independent urban element. However, there is only one five-story office building in this area (Figure 1; Photo 6), and social infrastructure facilities such as schools and kindergartens still need to be built. In contrast, many residential complexes have been constructed (Figure 1; Photo 7), while others are under construction. The DPP also mentions residential developments featuring kindergartens but omits details regarding the type of preschool institution and number of groups. Meanwhile, a field survey revealed the absence of preschool education organizations within the specified residential complex.

The absence of coordinated planning, wherein an architect of a residential complex fails to consider the architectural designs of another construction site, results in inconsistent vertical markings

(Figure 1; Photo 8), as well as the emergence of fences and retaining walls, eventually leading to the creation of an abandoned area (Figure 1; Photo 9).

There was a low level of pedestrian accessibility comfort, as shown in Photos 10 and 11 (Figure 1), for both completed and under-construction objects in the study area. This is because of the need for sidewalks and inconvenient movement caused by parking or construction fencing. These fences should be positioned along the red line instead of encroaching on sidewalk boundaries.

The normative group comprised issues related to the deviation of actual decisions from the existing construction regulatory framework. Under the general provisions of Building Regulations 3.01-01Ac-2007:

- The distances between residential buildings, parking lots, entrances, and exits should follow the specifications listed in Table 13.25. To comply with this standard, there should be at least 10 m between open and ramp-type surface parking lots depending on their capacity. However, this standard is often not met in this area, as shown in Photo 12 (Figure 1).

According to Table 6.5, the minimum provision of green areas in a residential group, micro-district, or residential area should be met. The table indicates that the number of green spaces in the surrounding areas, specifically unconstructed land within the confines of the red lines, should be at least 5 m<sup>2</sup> per person. Images of the adjacent regions show a negligible segment of the green zones, which span less than 30 m<sup>2</sup> (Figure 1; Photo 13).

- paragraph 6.0.3: When planning and constructing residential areas, pedestrian access to public green spaces such as squares, boulevards, and gardens should be at most 400 m. Currently, there are no green spaces in the area.

- paragraph 6.1.9: The green spaces adjacent to areas for children to play and adults to relax should adhere to the minimum standards in tables 6.4 and 6.5. Areas designated for games and recreation should be designed at a rate of 0.5-0.7 m<sup>2</sup> per person. The distance between the windows of the houses and the boundaries of recreational areas should be a minimum of 10 and 12 m for games. It is recommended that the placement of sports grounds is designed at a rate of 0.8-0.9 m<sup>2</sup>/person, considering the area of sports grounds in built-in and built-in-attached parts of buildings that are at a minimum of 0.4-0.45 m<sup>2</sup>/person, while ensuring the minimum standard of green spaces in adjacent areas. It is easier to verify these prerequisites using the necessary design documentation. Nevertheless, based on the number of flats, we can infer that the territory's area does not fulfill these requirements.

The current state is alarming in numerous cities - residential constructions morph into solid asphalt blocks, functioning as parking spaces for multiple private vehicles (Yanovskaya & Merenkov 2023).

The provision coefficient for parking spaces was routinely adjusted in this regard. According to Order No.32-NK issued on March 1, 2023, normative requires further information by adding the availability of parking spaces for one apartment in the parking lot as follows: for class I–2, class II–1, class III–0.5, and class IV–0.5. Failure to consider the number of rooms or living spaces when determining this coefficient would result in an underestimated number of parking spaces in the design. Based on a sociological survey, most residents in class III and IV residential complexes own cars. Furthermore, large families residing in apartments with three or more rooms have two vehicles. Additionally, elite residential complexes allocated the same coefficient of two car spaces for one-room to six-room apartments.

Environmental issues are closely related to the placement and quantity of green spaces. The primary sources of noise pollution in urban areas are transportation, industry, construction, roads, loading and unloading machinery, attractions, stadiums, children's play areas, and sports grounds. Approximately 30%–40% of the global urban population lives in conditions of acoustic discomfort (Chelnokov et al., 2015). Acoustic discomfort can result in various diseases, including psychoneurological, cardiovascular, and hearing impairment. Furthermore, it can cause a decline in individual performance (Potaev 2014). Thus, in the area being reviewed, no sanitary protection zone exists between the residential complexes and the construction market (Figure 2; Photo 14). As



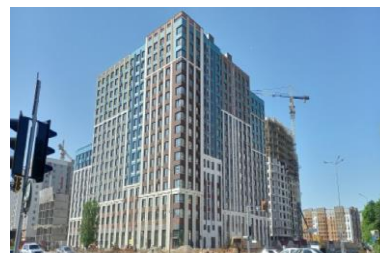
described in the DPP, road landscaping is symbolic because it mainly consists of small lawn areas without trees (Figures 2; Photo 15).



*Photo 1. Failure of the urban planning to comply with the DPP and the construction site*



*Photo 2. Unmanaged blend of developed and undeveloped zones*



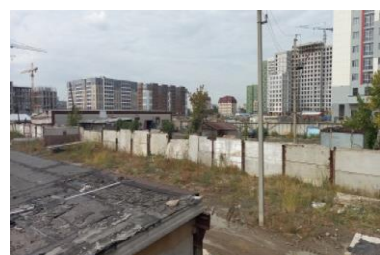
*Photo 3. Non-compliance with height regulations outlined in the DPP*



*Photo 5. Increased provision of built-in spaces in place of recreational areas*



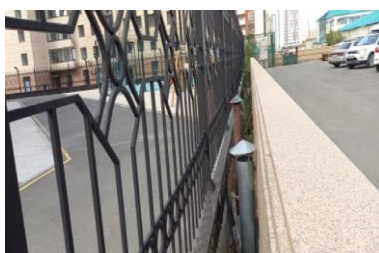
*Photo 6. Scope of business function*



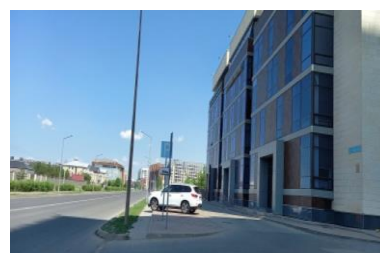
*Photo 7. Construction of social infrastructure facilities*



*Photo 8. Difference in vertical marks*



*Photo 9. Residential developments are segmented from each other, with distinct boundaries and limited physical connections*



*Photo 10. Parking spaces pose a hindrance to pedestrians*



*Photo 11. Pedestrian accessibility and station condition*



*Photo 12. Parking spaces are located near the complex*



*Photo 13. Adjacent area to the residential complex*

**Figure 1** – Searching for urban planning problems (author’s material).

Transport is a fundamental component of a city's functional framework. It facilitates the movement of people and goods throughout the city and serves as a reliable indicator of economic and social status and growth (Chelnokov et al., 2015).

Transport is a crucial element in modern urban areas, as it serves two primary functions: facilitating efficient movement within city limits and connecting the municipality with adjacent

territories. Since transport enables the exchange of human, material, energy, and other assets across different areas of the region, it is the cornerstone of infrastructural development within settlements. Transportation flows ensure that settlements are supplied with the necessary provisions and distribute labor throughout the urban environment (Roy, 2023).

Despite the undeniable need for transportation routes, they must be designed logically. Duplication of roads to each complex and paved car park reduces the natural areas that can be used for green spaces (Figure 2; Photo 16).

The close proximity of high-rise residential buildings can significantly worsen sanitary and hygienic conditions, such as inadequate ventilation and reduced sunlight exposure. For instance, in Photo 17, a 25-story building under construction is located adjacent to a 9-story block, with a mere 19-meter separation, which may also impact the psychological well-being of the occupants.

According to experts from the World Health Organization (WHO), environmental factors are responsible for 23% of all disease cases and 25% of cancer cases, with two-thirds of those affecting childhood morbidity. Furthermore, unfavorable environmental conditions lead to 3 million children under five being affected annually.

The engineering and technical challenges category encompasses problems related to complex construction solutions, primarily underground work and specialized equipment for parking facilities and systems. The differences in vertical road elevations result in the formation of ramps, stairs, and the flooding of low-lying areas due to ineffective stormwater drainage operations. Additionally, the increased utilization of underground space for parking has led to the creation of large ramps and asphalt courtyards. However, the current standards must guide the use of underground space, which is ultimately determined by the construction client's requirements specified in the design brief.

The comprehensive assessment revealed disparities between the proposed architectural and urban planning solutions and those implemented in reality. Specifically, incorporating additional residential buildings and floors resulted in escalated population density and the consequent compression of the area, leading to diminished recreational facilities and imposing an additional burden on social and transport infrastructure.

Inadequate development of the area, as construction of a fresh facility starts near an existing residential complex, results in deteriorating sanitary and hygienic conditions for inhabitants due to dust, dirt, noise, and construction and installation work near the house (Diez Roux & Mair 2010). It should also be highlighted that there is a need for more social infrastructure amenities, like preschool and educational facilities, to be established at municipal expense.

The identified structures are intended to be at the district's heart. The surrounding area is heavily populated with no city facilities under construction. This will lead to adverse future living conditions.

Deviation from prescribed norms in design, construction, and installation work adversely affects the overall comfort level of urban development facilities. Simultaneously, compliance with the present construction regulatory framework for local areas is challenging and uneconomical for customers in smaller regions due to requirements such as the landscape area, sports grounds per person, and indentation of residential buildings from sports areas. In this regard, these areas are expected to be inadequately planned and, in some instances, significantly reduced in size. In addition, the predefined formulas for calculating parking occupancy still need to be completed and fail to factor in the current environment.

The absence of proper sanitary protection zones and spaces for leisure activities is primarily attributed to the inadequate availability of regulatory documents and authorities governing the construction and environmental sectors. Any region, excluding areas with asphalt concrete pavement, may be deemed suitable for recreational purposes, while grassy zones without trees may serve as recreational and hygiene zones. Multiple access scenarios were devised for particular urban planning objects and elements to establish a comfortable transportation environment. However, these scenarios can negatively affect the environment.

In modern conditions, there is a need to construct additional zones within residential structures (Pickett & Pearl 2001). Parts of these zones, such as parking, utility, and storage areas, do not require

natural light. Hence, there is a requirement to actively encourage underground growth and to position such zones below ground level.

Many individual projects lead to many social problems associated with a lack of green spaces, inconvenient use of pedestrian walkways, and residential areas.

Thus, urban planning problems can be traced back to the master plan, which defines the development direction. This document adopts a global approach using traditional urban planning methods to structure cities; however, this approach results in the categorizing of urban areas into functional and residential blocks organized by number of floors. Modern urban planning trends emphasize multifunctionality and compactness, where each district is self-sufficient in functionality and residential complexes comprise multi-story blocks (Levy 2016; Webster et al., 2005).



Photo 14. There is insufficient provision of an area designated for sanitary protection



Photo 15. Green spaces near the road



Photo 16. Duplication of passages



Photo 17. The incline leading from the main thoroughfare is angled towards the perimeter of the housing development



Photo 18. Underground space is not used

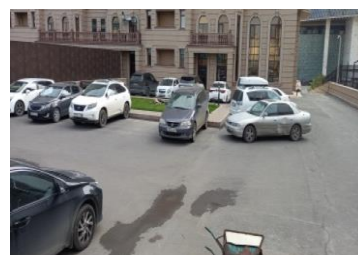


Photo 19. Parking shortage



Photo 20. Increase of asphalt-concrete surfaces



Photo 21. Artificial turf and fenced areas



Photo 22. Instead of the initially planned 9 floors, according to the DPP, a residential complex with 9-16 storeys will be constructed



Photo 23. Combination of architectural styles



Photo 24. The distance between apartment blocks is less than 20 meters

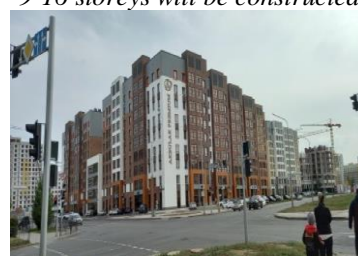


Photo 25. A residential complex comprising integrated facilities and a nursery

Figure 2 – Searching for urban planning problems (author's material).

The detailed planning project presents a challenge: architectural schematics at the district level establish boundaries between each site, resulting in urban fragmentation and incoherence of the elements within a given area.

Then comes the problem of infill development, an isolated object in urban planning that is developed individually. At this stage, the environmental weakness of the design solutions is particularly noticeable, as well as their tendency to independence due to their own "fence," yard, road, essential facilities (shops), etc.

It is also necessary to note the need for more current building regulations in urban planning and the design of residential complexes. Due to the lack of clear definitions of terms and their components, architectural and urban planning schemes explain their practical application—the validity of the applied coefficients and certain distances and areas.

## 5 CONCLUSIONS

Based on the analysis of the identified problems, proposals are made to improve the urban environment as follows:

(1) Revision of the primary methods of urban planning and, consequently, of the structure and purpose of the master plan, in which equivalent blocks will appear and objects of special urban significance (shopping and entertainment complexes, parks, etc.) will be equally distributed;

(2) Combining a DPP and infill development into a more extensive area action plan or neighborhood plan, i.e., a Development Plan Document that should be displayed on the master plan of the city of Astana. A Neighborhood Development Plan or Area Action Plan is a comprehensive architectural and urban planning project for an entire city area, with all the necessary social infrastructure except for specialized urban facilities. This solution allows for the coherent development of the urban area, as well as the architectural and urban connection of all elements of the project, which improves the social and environmental aspects of living;

(3) Adjusting the current building regulations in the field of urban planning, which will make it possible to create an algorithm for the formation of a new type of urban development and to determine the minimum indicators of the degree of comfort of the living environment;

(4) Create an urban regulation model that monitors the compliance of design decisions with relevant standards and their implementation.

Each proposal requires a separate study that will gradually determine the principles of architectural and urban design in neighborhood development.

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