OPPORTUNITIES FOR THE IMPLEMENTATION OF NEUROARCHITECTURE PRINCIPLES IN UZBEKISTAN'S URBAN PLANNING

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Abstract: *This article is devoted to analysing the opportunities for introducing neuroarchitecture principles into the practice of urban planning in Uzbekistan. The scientific relevance of the research lies in the fact that consideration of human psychological well-being and the emotional impact of the urban environment has become one of the key directions in global urban planning theory in the 20th–21st centuries. The article evaluates both contemporary and historical districts of major cities such as Tashkent, Samarkand, and Bukhara on the basis of empirical observations and stratified surveys. The methodological framework of the study includes comparative analysis, correlation of international standards (WELL Building Standard, ISO 9241-210) with national regulations, sociological surveys, and statistical analysis. A five-stage conceptual model adapted to the context of Uzbekistan was developed, encompassing scientific-analytical research, normative-legal integration, pilot projects, a monitoring system, and large-scale implementation. The results of the study substantiate the theoretical and practical effectiveness of this approach.*

Keywords: *Neuroarchitecture, urban environment, human psychology, urban design, cultural heritage, sustainable development.*

INTRODUCTION

In recent years, issues of psychological health and emotional well-being in the urban environment have become one of the leading directions in the fields of urban planning and architecture on a global scale. The concept of neuroarchitecture emerged in the late 20th and early 21st centuries. It is regarded primarily as a scientific discipline aimed at studying the impact of the external environment on human perception, memory, and emotions [1]. In this regard, the renowned researcher Mallgrave highlighted the neurobiological foundations of architecture, while Kandel's (2013) scholarly work demonstrated that the functioning of the human brain is intrinsically linked to aesthetic experience [2]. In Scandinavian countries, urban design has been applied in projects aimed at promoting mental health and reducing stress [3].

In Uzbekistan, in recent years, researchers have conducted studies exploring the relationship between human health, psychology, and urban planning [4–7]. In particular, scientific articles published by Uzbek scholars between 2020 and 2024 have examined the aesthetic appearance of public spaces, the psychological impact of green

areas on urban residents, and the role of historical ensembles in strengthening national identity. These developments can be regarded as initial steps toward the application of neuroarchitecture principles in the context of Uzbekistan.

In the context of Uzbekistan, this scientific field is considered relatively new. The existing regulatory documents [8,9] are largely limited to the technical and functional requirements of the urban environment, with almost no criteria addressing human psychology and emotional needs. Therefore, this article is aimed at developing the scientific foundations for introducing neuroarchitecture principles into national urban planning practice. Its main objective is to create a conceptual model designed to enhance psychophysiological comfort, reduce stress, and strengthen national identity in Uzbek cities.

Methods. To ensure the reliability and objectivity of the scientific results, this study employed a comprehensive methodological approach. First and foremost, the method of comparative analysis was applied to systematically compare international standards [10,11] with the current regulations of Uzbekistan (ShNK 2.01.01-19 "Urban planning. Planning standards"). Through this comparison, gaps related to psychological well-being within the framework of national normative documents were identified, and opportunities for harmonisation with international practices were evaluated. For instance, the 'Mind' section of the WELL Building Standard defines indicators aimed at reducing stress and improving cognitive performance. In contrast, the current ShNK regulations of Uzbekistan were found to lack such requirements, as revealed during the observation process.

At the second stage, empirical observation and a stratified sociological survey were conducted. The stratification method was applied in the selection of respondents. A total of 300 participants were selected based on quotas by age group (18–30, 31–45, 46–60), gender (male and female), and occupational category (student, employee, creative professional, retiree). In addition to descriptive methods, statistical analysis employed Pearson's correlation, the chi-square test, and ANOVA to verify the reliability of relationships between groups. In the cities of Tashkent, Samarkand, and Bukhara, 300 respondents (aged 18–60, differentiated by gender and occupational group) were surveyed. Their emotional experiences within the urban environment were assessed using a five-point Likert scale. During the observation process, indicators of mood, stress level, and emotional well-being were recorded in public parks, historical ensembles, and transport infrastructure. This approach made it possible to collect objective evidence.

As the third method, statistical analysis was applied. The survey results were summarised using descriptive statistics, while correlation analysis was used to identify relationships between the emotional assessments of different age and gender groups toward the urban environment. For example, respondents aged 25–35 were more likely to report feeling comfortable in public parks, whereas respondents over 50 years

old demonstrated a stronger appreciation for the aesthetic impact of historical ensembles.

The fourth method was content analysis, which involved the systematic examination of international scientific articles, recent publications in leading journals on urban studies, and Uzbekistan's regulatory documents. This approach made it possible to strengthen the scientific foundations of neuroarchitecture principles and adapt them to the national context.

In addition, pilot observational experiments were carried out within the methodological framework. In the City Park area of Tashkent, small-scale experiments were conducted to observe how different lighting intensities and architectural elements incorporating national ornaments influenced people's stress levels. These observations were implemented using sensor systems that recorded psychophysiological indicators such as heart rate and facial expressions.

Overall, the methodological framework of the study was shaped through the integration of several approaches: theoretical comparison, empirical survey, statistical analysis, and content analysis. This combination ensured a high level of reliability and scientific validity of the results.

Results. Data obtained during the empirical stage of the study demonstrated that the urban environment directly influences people's emotional well-being, and this impact is closely linked to the typology, functional organisation, and aesthetic characteristics of the area. In Tashkent's City Park, 72 percent of respondents reported feeling calm and comfortable, while 65 percent noted a decrease in stress levels. These findings indicate that the harmony of landscape design and functional planning has a positive effect on psychological health.

Surveys conducted at the Silk Road Samarkand complex also yielded noteworthy results. The majority of respondents indicated that the presence of historical and cultural elements enhanced aesthetic resonance and reinforced their sense of personal identity. In particular, the integration of traditional architectural motifs and national ornaments with modern design solutions was found to increase feelings of psychological uplift and social cohesion among participants.

In the city of Bukhara, historical ensembles and architectural heritage sites were found to have a significant impact on human emotions. According to the survey results, 68 percent of respondents emphasised that spending time in historical areas enhanced their sense of inner tranquillity. In particular, the unique harmony of national ornamentation and natural lighting in the Registan and Ark complexes emerged as a key factor in intensifying the aesthetic experience.

In addition, the use of national ornaments and lighting design in Tashkent metro stations was also evaluated positively. Approximately 60 percent of survey participants reported that the artistic elements in the metro stations had a favourable effect on their mood. In particular, the artistic solutions implemented in the

"Kosmonavtlar" and "Paxtakor" stations were found to have a distinctly positive impact on emotional resonance.

Significant differences were observed in the levels of emotional well-being among respondents in Tashkent, Samarkand, and Bukhara. According to ANOVA results ($p < 0.05$), respondents in Tashkent expressed greater appreciation for open public spaces, while in Samarkand and Bukhara higher evaluations were given to historical environments. Pearson's correlation analysis revealed a moderate positive relationship between age and aesthetic resonance, with a coefficient of $r = 0.46$. Observations further showed that in Tashkent's City Park, when light intensity ranged between 500–700 lx, respondents' stress levels decreased by an average of 18 percent.

The results of statistical analysis also confirmed the empirical observations. According to descriptive statistics, open public spaces played an important role in enhancing emotional well-being for younger respondents (aged 18–30), whereas middle-aged and older groups (over 40) showed a preference for historical environments. Correlation analysis further revealed gender differences: women were more attentive to aesthetic components such as lighting, colours, and ornamentation, while men demonstrated greater sensitivity to functional convenience and transport infrastructure.

Based on these empirical results, a five-stage conceptual model adapted to the context of Uzbekistan was developed: conducting scientific-analytical studies to systematically assess the level of psychophysiological comfort in cities; integrating neuroarchitecture principles into national regulatory documents, including the revision of ShNK and UzDSt standards; implementing pilot projects by introducing neuroarchitecture elements in parks, public centres, and transport stations in Tashkent, Samarkand, and Bukhara; creating a monitoring system to regularly evaluate users' psychological conditions, including measuring stress and well-being indicators through sensor technologies; and scaling up successful practices to form national design standards. The findings show that neuroarchitecture elements can serve as an effective tool for enhancing emotional well-being in Uzbek cities. They not only reduce stress but also contribute to strengthening national identity and fostering social cohesion within the urban environment.

Discussion. The results of this study on the introduction of neuroarchitecture principles into urban planning in Uzbekistan, when compared with international experience, highlight several important scientific and practical conclusions. First and foremost, it was established that the urban environment has a direct impact on human psychological health and emotional well-being. The findings obtained in the research are consistent with the scholarly perspectives of Mallgrave (2010) and Kandel (2013). Their works provided an in-depth substantiation of the neurobiological foundations of the environment and its influence on brain activity,

and our empirical observations confirmed the validity of this phenomenon within the context of Uzbekistan.

At the same time, it should be noted that neuroarchitecture has not yet been widely applied in urban practice in Uzbekistan. Although the current regulatory documents define technical and functional requirements, they lack criteria related to human psychological needs and psychophysiological well-being. This creates a significant gap between international standards and national regulations. For example, the WELL Building Standard includes specific criteria for stress reduction, alignment of lighting with biological rhythms, and the promotion of social activity, whereas such aspects are not addressed in the ShNK norms.

Another important aspect observed during the research concerns economic capacity and resources. The large-scale implementation of neuroarchitecture solutions requires significant financial investment. In Uzbekistan's urban planning practice, the widespread application of new materials, innovative technologies, and sensor systems is still limited. Therefore, at the initial stage, it is advisable to conduct pilot projects as trial initiatives. By implementing such pilot projects in public parks in Tashkent and in historical areas of Samarkand and Bukhara, the practical effectiveness of neuroarchitecture can be assessed.

A number of gaps were identified when comparing national and international standards. For example, international frameworks such as the WELL Building Standard and ISO 9241-210 include indicators related to human emotional needs, as well as requirements for lighting and acoustic comfort. However, in Uzbekistan's current regulatory document ShNK 2.01.01-19, such provisions are absent. As a result, the urban environment is regulated primarily from technical and functional perspectives. Therefore, updating national standards on the basis of international experience emerges as a pressing issue.

In addition, the study results revealed differences in emotional experiences among various social groups. While the younger generation preferred open public spaces, older respondents derived more positive impressions from historical architectural ensembles. This indicates that neuroarchitectural approaches must be developed in alignment with the needs of different socio-demographic groups. Gender differences also play an important role: women tend to focus more on aesthetic components, whereas men pay greater attention to functional convenience. These aspects require diverse approaches when formulating design solutions.

Based on the discussion results, it should be emphasised that if neuroarchitecture principles are gradually integrated into Uzbekistan's urban planning policy and practice, they can become an effective tool for enhancing psychological well-being, reducing stress, and strengthening national identity. At the same time, this process requires additional scientific research, the development of specialised educational programmes, and the improvement of professional training

systems. Universities and research institutes should introduce dedicated courses on neuroarchitecture, while professional development programmes for architects and urban planners need to be established.

Overall, this study has demonstrated the potential for linking the theoretical foundations of neuroarchitecture with practical applications in the context of Uzbekistan. However, further development of this field will require a comprehensive state policy, economic support mechanisms, and measures aimed at raising public awareness of the concept.

Conclusion. The results of the study indicate that although the integration of neuroarchitecture principles into urban planning in Uzbekistan has not yet been systematically established, certain practical experiences already demonstrate positive elements. Public parks in Tashkent, modern tourist complexes in Samarkand, and historical ensembles in Bukhara play a significant role in enhancing human emotional well-being. These cases confirm that when the aesthetic, functional, and psychological components of the urban environment are harmonised, mental health and social engagement are further strengthened.

Based on scientific analyses and comparative studies of international experience, the five-stage conceptual model developed in this research provides both a theoretical and practical foundation for the gradual introduction of neuroarchitectural approaches in Uzbekistan. At the first stage, it is necessary to expand scientific-analytical studies and systematically examine the level of psychophysiological comfort. In the subsequent stages, neuroarchitecture principles should be integrated into the content of national regulatory documents, tested through pilot projects in practice, and supported by the establishment of a monitoring system. Ultimately, by scaling up successful experiences, it will be possible to create national design standards.

At the same time, the study identified several limitations to the widespread introduction of neuroarchitecture principles in Uzbekistan. These include the absence of relevant requirements in regulatory documents, limited economic resources, and low public awareness of the concept. To overcome these obstacles, it is necessary to introduce additional economic support mechanisms within the framework of state policy, establish specialised educational programmes in research institutes and higher education institutions, and promote broader public awareness of neuroarchitecture.

Based on the findings, the following recommendations can be made: regulatory documents on urban planning should include provisions that take into account human psychology and emotional needs; pilot projects should be organised to test the application of neuroarchitecture principles in sites such as the "New Uzbekistan Park" in Tashkent and the new tourist areas of Samarkand; and the establishment of specialised laboratories and educational programmes in the field of neuroarchitecture,

along with the training of professionals, will accelerate the implementation of the conceptual model in Uzbekistan.

In conclusion, neuroarchitecture provides a new perspective not only on urban planning theory but also on the social, cultural, and psychological dimensions of the urban environment. For Uzbekistan, this approach can serve as an effective tool for strengthening mental health, enriching national identity, and improving the quality of urban life. Therefore, the conceptual model developed in this article offers a solid foundation for further scientific research, state policy, and practical project implementation.

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