RIGA TECHNICAL
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Regina Veckalne

EVALUATION OF URBAN SUSTAINABILITY OF UZBEKISTAN IN THE CONTEXT OF REGIONAL DEVELOPMENT

Summary of the Doctoral Thesis

RIGA TECHNICAL UNIVERSITY

Faculty of Engineering Economics and Management

Regina Veckalne

Doctoral Student of the Study Program "Management Science and Economics"

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Scientific supervisor
Professor Dr. oec.
TATJANA TAMBOVCEVA

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DOCTORAL THESIS PROPOSED TO RIGA TECHNICAL UNIVERSITY FOR PROMOTION TO THE SCIENTIFIC DEGREE OF DOCTOR OF SCIENCE

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OFFICIAL REVIEWERS

Professor Dr. oec. Armands Auziņš
Riga Technical University

Associate Professor Dr. adm. Natālija Cudečka-Puriņa
BA School of Business and Finance, Latvia

Professor Dr. oec. Leonid Melnyk
Sumy State University, Ukraine

DECLARATION OF ACADEMIC INTEGRITY

I, Regina Veckalne, hereby declare that the Doctoral Thesis submitted for review to Riga Technical University for promotion to the Ph. D. in Social Sciences is my own. I confirm that this Doctoral Thesis has not been submitted to any other university for promotion to a scientific degree.

Regina Veckalne ……………………………. (signature)
Date: ………………………

The Doctoral Thesis has been written in English. It consists of an Introduction, three chapters, Conclusions and Proposals, 58 figures, 30 tables, and 15 appendices; the total number of pages is 218, including appendices. The Bibliography contains 367 titles.

ANNOTATION

Purpose. The preservation and sustainable use of natural resources, considering the social, economic, and ecological elements, are increasingly important in urban environments. This research is designed to fill a gap in the scientific understanding of urban sustainability in Central Asian regions, specifically Uzbekistan. The research develops a new methodological approach to assess urban sustainability in this context, taking into account regional peculiarities, awareness levels among citizens, and the role of gender equality.

Research Design/Methodology/Approach. The research employs a blend of qualitative and quantitative methods, including statistical methods, comparative analysis, online surveys, interviews, and focus group discussions. Tools such as Microsoft Excel, RStudio, SPSS, and SmartPLS are used for data analysis. The author conducts a comprehensive literature review via the PRISMA method as well as bibliometric analysis using VoSViewer and RStudio. Further in this research, the author conducted a survey to assess the level of sustainability awareness among the Uzbek population. Structural equation modelling (SEM) was then applied to analyse the survey results and to test the hypotheses developed from the theoretical analysis.

Research results. The research proposes new definitions for the terms "urban," "sustainability," and "urban sustainability" that address existing gaps in the literature. It also identifies and classifies urban sustainability indicators specifically for Uzbekistan, highlighting the unique regional elements. Furthermore, it develops a methodology for evaluating urban sustainability in Uzbekistan.

Novelty. This research introduces novel propositions for understanding urban sustainability, offers a unique set of indicators for Uzbekistan, and provides a newly developed evaluation methodology. It also reveals the crucial role of sustainability awareness among citizens and the importance of gender equality in achieving sustainable urban development.

Keywords: *gender equality, sustainability awareness, sustainability evaluation, sustainable development, urban sustainability, Uzbekistan*

CONTENTS

INTRODUCTION

Research topicality

Natural resources and natural conditions are the basis of material production and the life of the population. The state of the environment and the quality level of resource use, protection, and reproduction largely determine the rates of economic growth and production efficiency. Economic growth, associated with obtaining only the maximum final benefit from production in the current period with ineffective use of natural resources and the environment, has practically exhausted itself. At the present stage of the development of society, consideration of the ecological factor when making decisions on the sustainable development of territories is becoming especially relevant.

As more and more people live in cities around the world, sustainable development is a notion that is becoming increasingly important for metropolitan regions. Urban sustainability, which takes into account economic, environmental, and social challenges, is becoming increasingly necessary as a result of this transformation.

The demand for more sustainable methods of economic development and the growing awareness of environmental degradation led to the birth of the idea of sustainable development in the 1980s (WCED, 1987). Since then, the idea has expanded to include social and cultural factors as well, demonstrating a more comprehensive grasp of sustainability (UNESCO, 2014). Strategy development for urban sustainability has become a crucial component of implementing sustainable development in cities and urban regions.

Economic growth, social advancement, and environmental preservation must all be balanced in order for sustainable development to take place (WCED, 1987). In the 1980s, the idea of sustainable development became widely known, and it has since been a crucial consideration in the formulation of world policy (UN, 2015). But, putting sustainable development into practice is still difficult, particularly in urban areas where resource consumption, population increase, and environmental deterioration are all on the rise (Glaeser, 2014).

Currently, at the state level, some methods imply taking into account the environmental and social factors in national statistics. Still, they have not yet received widespread use in developing countries in the Central Asian region, firstly, due to significant differences in development between individual regions, and, secondly, since they are only a tool for reflecting the current situation and are not built into the mechanism for managing specific territories. At

the same time, the increasing technogenic load on the environment around the world and, in particular, in the aforementioned region makes it necessary to consider the environmental and social factors when developing regions and justifying investment projects. In this regard, studies that are aimed at assessing the state of specific ecological, social, and economic systems, monitoring their development, identifying development trends, and, most importantly, developing a methodology based on which recommendations can be expanded on the correction of the development trajectory of the considered ecological and economic systems towards sustainable development are becoming increasingly important. At the same time, it becomes possible to identify tools of influence for use by the relevant governing institutions, assess the expected effects from the implementation of measures to manage the sustainability of development and develop an effective policy that sets coordinated directions for the development of ecological and economic systems of different levels.

A significant contribution to the formation of the economic theory of nature management was made by J. Hartwick (1977), H. Hotelling (1929), T. Tietenberg (2009), and others. The theory of sustainable development was among others developed by D. Pierce and G. Atkinson (1989), K. Hamilton (1995), J. Pezzey (1989), R. Costanza (1997), H. Daley (2015), J. Forrester (1973), Dennis, and Donella Meadows (1982), M. Mesarovic and E. Pestel (1976), Ernst von Weizsaecker, E. B. A. Lovins, L.H. Lovins (2006), and J. Randers (2004).

Nowadays, the issues related to the management of the sustainability of the development of ecological, social, and economic systems of different levels remain insufficiently studied. At the same time, the formation of an integral indicator of sustainable development would make it possible to develop coordinated solutions that contribute to improving the efficiency of management of the objects under consideration in the direction of sustainable development. This thesis aims to fill the research gap in the urban sustainability field by examining a central Asian region, specifically Uzbekistan, which has received very little attention to date.

Considering the immense gender gap in the central Asian region, namely in Uzbekistan, in the research the topic of gender equality and female empowerment is emphasized since women's empowerment leads to the fulfilment of SDG5 while also positively impacting many other sustainable development dimensions.

The current Doctoral Thesis develops a methodology for assessing urban sustainability in Uzbekistan's urban areas. The research also offers a classification of region-specific urban sustainability indicators. Lastly, in order to incorporate it into the evaluation system, the author evaluates the nation's sustainability awareness level via surveys.

Research questions

1. What is urban sustainability?
2. What metrics may be used to assess urban sustainability in Uzbekistan to ensure that the results are reliable and take into account regional peculiarities?
3. How aware are Uzbek citizens of the importance of urban sustainability?

The aim of the study is to fill the gap in scientific understanding of urban sustainability in the Central Asian region, specifically in Uzbekistan. The aim of the research is to develop a new methodological approach to the assessment of urban sustainability in this context, taking into account regional characteristics, the level of awareness of the population, and the importance of gender equality. To achieve this goal, the following tasks are set:

1) to analyze the concepts of urban sustainability and sustainable development;
2) to investigate the approaches to regional development and discuss methodological aspects of such approaches in the context of urban sustainability;
3) to explore the importance of gender equality and female empowerment for the achievement of sustainable development in a regional development context;
4) to discuss the role of sustainability awareness among the country's citizens in addressing global warming, climate change, waste management, promotion of gender equality, and other sustainability-related issues and to evaluate the level of sustainability awareness among the Uzbek population;
5) to develop a formula for assessing the level of urban sustainability in Uzbekistan;
6) to formulate recommendations to Uzbekistan authorities based on the findings on how to improve the currently existing situation to achieve a higher level of sustainable urban development.

The **object of the research** is urban sustainability.

The **subject of the research** is the evaluation of urban sustainability in Uzbekistan.

The Thesis examines the dynamics of regional development primarily within the context of Uzbekistan, a pivotal nation in Central Asia with unique developmental challenges and opportunities.

The research design

The research design addresses the research questions by combining qualitative and quantitative research techniques. The research questions, the purpose of the research, and the research objectives specify the logic of the research design.

Stage 1. Elaboration of research methodology and conceptualization of urban sustainability

Research Question 1 – What is urban sustainability? – was addressed through the evaluation of the scientific literature, bibliometric and content analysis which produced the conceptualization of understanding for the subsequent principles:

- defining urban;
- defining sustainability;
- defining urban sustainability;
- models and approaches to sustainability.

Stage 2. Exploration of metrics that may be used to assess urban sustainability

The main focus of Stage 2 of the research was to investigate various methods of urban sustainability evaluation and detect whether there was a methodology applicable to Uzbekistan. The exploration of Research Question 2 – What metrics may be used to assess urban sustainability in Uzbekistan to ensure that the results are reliable and take into account regional peculiarities? – put forward the following principles:

- Despite the abundance of various sustainability evaluation methodologies, there is not a single one that takes into account the specifics of the region. Most of them were proposed and applied in developed countries and were not tested on developing countries in the researched region.
- Regional development could have great potential in improving the sustainability level of the region, especially when taking into account local shortcomings (lack of female empowerment and sustainability awareness).

Stage 3. Investigation of sustainability awareness among Uzbek citizens via surveys

The goal of Stage 3 goal is to investigate the level of sustainability awareness among the Uzbekistan population. This includes assessing their knowledge of existing problems related to urban sustainability as well as their consciousness when it comes to implementing steps for eradication of harmful impact of their daily activities. The stage is crucial to answering Research Question 3 – How aware are Uzbek citizens of the value of regional urban sustainability?

Stage 4. Elaboration of methodology for urban sustainability assessment in Uzbekistan

The aim of this stage is to develop a formula for the evaluation of urban sustainability in Uzbekistan. The first part of this stage depends heavily on Stage 2 of the research. After analysing numerous indicators of urban sustainability, the author selected the most applicable ones. Then these indicators were approved and ranked by the experts. This ranking was later

used to adjust weights to each indicator. The second part of the stage focuses on elaborating the possible maximum and minimum values resulting from the formula to be used as a reference for the result of Uzbekistan.

Research methods

The author used general methodological approaches – systemic and complex, as well as methods of scientific research – statistical methods, classifications, comparative analysis, and programming tools. The theoretical basis of the research was the studies of scientists in the field of environmental economics, the economics of sustainable development, and regional economics. The research methods include:

1) literature analysis;
2) bibliometric analysis;
3) content analysis;
4) secondary data analysis;
5) survey;
6) expert interviews.

Data analysis methods include:

1) graphical analysis;
2) correlation analysis;
3) factor loading analysis;
4) structural equation modelling;
5) interview transcripts.

Scientific novelty

1. Identification of indicators necessary to assess urban sustainability in Uzbekistan. To the author's knowledge, no recent research has been done in the field of urban sustainability in Uzbekistan. Currently, all the methodologies that are applied to Uzbekistan were developed in Soviet times and were not specific to the studied region. Based on the analysis of the country the author offers a set of indicators of urban sustainability specific to that region.

2. Classification of urban sustainability indicators necessary to assess urban sustainability in Uzbekistan. While most of the research offers three pillars when it comes to sustainability – economic, ecological, and social, this does not always fully correspond to the complex nature of urban sustainability. Thus, the author offers "awareness" as a separate pillar of urban sustainability in Uzbekistan. Increasing sustainability awareness is expected to

positively impact the ecological, social, and environmental situation in the country. Additionally, considering the high level of sexism and misogyny in the country, which has a negative influence on all the pillars, the author proposes to classify gender equality indicators into a separate group to bring more attention to this issue.

3. Development of the methodology for evaluating urban sustainability in Uzbekistan. To the author's knowledge, no such methodology currently exists in Uzbekistan or neighbouring countries. Thus, the only way to assess the level of sustainability in urban areas is through methodologies developed in Europe and North America, which do not take into consideration the social, economic, and environmental peculiarities of the country.

4. Based on the literature analysis, the author proposes a definition of the term "urban". The definition offers a more complex understanding of contemporary urban environments and their socio-economic, cultural, and ecological complexities.

5. The proposition of the definition of "sustainability". The literature review shows that even though many scholars use this term, no specific commonly accepted definition is provided for it in the literature. In the Thesis, the author synthesizes the existing definitions of "sustainability" and provides a new one that addresses the shortcomings of the existing definitions.

6. The proposition of definition of "urban sustainability". Although the term "urban sustainability" became increasingly popular in the last few decades, not many scholars have defined it; thus, providing a comprehensive definition can be considered a scientific novelty that addresses the research gap in this field.

When it comes to the proposed definitions, it is acknowledged that definitions are fundamentally context-dependent. While definitions across academic fields are never universally accepted, reflecting a diversity of perspectives that is both inevitable and valuable in this study, the concepts "urban," "sustainability," and "urban sustainability" function as critical points of analysis. Thus, the rationale behind proposing new definitions for these key terms stems from an identified need within the literature. For example, when discussing sustainability, there is an overall consensus that it touches upon at least the following pillars: society, environment, and economics and their maintenance over time; nevertheless, a term that encompasses all that was not proposed earlier. On the other hand, the term "urban" has a lot of different meanings depending on the context. However, it mostly addresses the physical aspects of it, which makes the use of proposed terms not precisely accurate in interdisciplinary research, especially in social sciences.

Practical application of the research

To the author's knowledge, no such research has been previously conducted, and no other formula for evaluation of Uzbek urban sustainability currently exists. No measuring of the level of sustainability awareness among Uzbek citizens was previously performed. Thus, these findings can be used to improve the current sustainability level of urban areas in the country. Additionally, the author proposes a questionnaire to assess sustainability awareness among the population.

Hypotheses

Hypothesis 1: Increased sustainability awareness among the population has a positive impact on addressing sustainability issues in the region.

Hypothesis 2: Higher gender equality is positively associated with urban sustainability.

Hypothesis 3: Higher environmental awareness is positively associated with a higher level of consumption consciousness.

Theses for defence

The following theses are presented for defence by synthesizing theoretical findings and the outcomes of the empirical research attained during the development of the Doctoral Thesis:

1. Female empowerment is essential to sustainable urban development because it has a profound impact on multiple aspects of society, including economic, social, and environmental aspects. When women have access to education, healthcare, economic opportunities, and political participation, they can contribute to the development of their families, communities, and countries.

2. Sustainability awareness is crucial for sustainable development because it enables people and organizations to comprehend how their actions affect the environment, society, and economy. It is challenging to establish and uphold sustainable practices and policies without awareness and comprehension of sustainability.

3. For effective regional development, it is crucial to integrate a robust methodology for evaluating urban sustainability. This helps in identifying areas of weakness that need to be prioritized. This methodology should be regularly utilized to track progress, adjust strategies, and ensure continuous enhancement of urban sustainability within regional development.

Approbation and practical application of research results

The research results were presented and discussed at international scientific conferences in Latvia, Lithuania, Poland, Sweden, and Ukraine and were further reflected in the corresponding scientific publications. The comments and suggestions received at the conferences and during peer reviews of the articles were taken into account and the appropriate changes in the research were done.

Limitations

This research is limited to Uzbekistan; however, the proposed methodology can be tested on other countries in the Central Asian region. Additionally, one part of the developed methodology is the evaluation of sustainability awareness via surveys. Since people tend to portray themselves better when answering survey questions – another limitation of this research can be not fully reliable survey results.

Scientific publications

The results of the research were reflected in 11 articles, 7 of which are indexed in Scopus and Web of Science:

1. Veckalne, R., Tambovceva, T. (2022). The Role of Digital Transformation in Education in Promoting Sustainable Development. *Virtual economics, 5*(4), 65–86. https://doi.org/10.34021/ve.2022.05.04(4)
2. Veckalne, R., Us, Y., & Gerulaitiene, N. (2022). Evaluation of sustainability awareness in Uzbekistan. *Marketing and management of innovations*, (3), 88–102.
3. Veckalne, R., & Tambovceva, T. (2022). Sustainable regional development planning. *Proceesings of the 12th International Scientific Conference Business and Management 2022*, Vilnius, Lithuania, 315–324.
4. Shvindina, H. O., Veckalne, R., Balahurovska, I., & Khrin, N. (2022). Development Features and Directions of Modern Management: In the Case of Ukrainian Health Care Institutions. *Health Economics and Management Review*, vol. 3, no. 1, 2022, pp. 19–24, https://doi.org/10.21272/hem.2022.1-02.
5. Lyeonov, S., Pimonenko, T., Chygryn, O., Reznik, O., & Gaynulina, R. (2021). Green brand as a marketing instrument: Principle, features and parameters. International *Journal of Global Energy Issues, 43*(2–3), 147–165.
6. Hyrchenko, Y., Skibina, T., Us, Y., & Veckalne, R. (2021). World market of liquid biofuels: trends, policy and challenges. In *E3S Web of Conferences* (Vol. 280, p. 05005). EDP Sciences.
7. Veckalne, R, Tambovceva, T. (2021). Innovations in circular economy for sustainable urban development. *Marketing and management of innovations*.
8. Veckalne, R., & Tambovceva, T. (2021). Waste management within context of urban sustainable development: bibliometric analysis. In *Proceedings of the 20th International Scientific Conference Engineering for Rural Development*, Jelgava, Latvia (pp. 26–28).

9. Veckalne, R., & Tambovceva, T. (2020). Influence of sustainability factors on economic development within the context of globalisation. Innovation, social and economic challenges, 25.

10. Gaynulina, R., Tambovceva, T. (2020) Sustainable Development of Urbanized Territories. In: *Политика развития в условиях цифровизации общества: материалы Всероссийской научной конференции с международным участием = Development Policy in the Conditions of Society Digitalization*: Materials of the All-Russian Scientific Conference with International Participation, Russia, Krasnodar, 22–23 October, 2020. Krasnodar: Kuban State University, 2020, pp. 36–41.

11. Gaynulina, R. (2019). The revival of protectionism in the modern world: Case study of Uzbekistan. In the *Proceedings Scientific Conference on Economics and Entrepreneurship* (pp. 17–23).

The results of the research were presented at the following 7 **conferences**:

1. Veckalne, R., Tambovceva, T. Towards a common understanding of urban sustainability. In International Scientific Conference "BUSINESS AND MANAGEMENT 2023", Vilnius Gediminas Technical University: Lithuania, Vilnius, 11–12 May 2023.

2. Veckalne, R., Tambovceva, T. Evaluation of Urban Sustainability in Uzbekistan. In: Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regional and Territorial Development ICEREE'2022: Latvia, Riga, 29–30 September 2022.

3. Veckalne R., Us Y. & Tambovceva T. Circular Economy on Construction and Demolition Waste; the Case of Latvia. BUP symposium, Sweden, 19–20 October 2021.

4. Veckalne, R., Tambovceva, T. Recycling as an Ecologic-Economic Balancing Mechanism for Regional Development Mechanism. In: 8th International Scientific Conference "New Trends in Management and Production Engineering – Regional, Cross-Border and Global Perspectives", Poland, Brenna, 10–11 June 2021. Poland: WSB University, 2021.

5. Veckalne, R., Tambovceva, T. Sustainable Development Through Circular Economy Practices. In: Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regional and Territorial Development ICEREE'2021: organized within 62nd International Scientific Conference of Riga Technical University, Book of Abstracts, Latvia, Riga, 30–30 September 2021.

6. Gaynulina, R., Tambovceva, T. Review of Approaches to the Analysis of Sustainable Development of Urban Territories. In: Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regions and Territories Development ICEREE'2020", organized within 61st International Scientific Conference of Riga Technical University, Latvia, Riga, 1–3 October 2020.

7. Veckalne, R. The Revival of Protectionism in the Modern World: Causes and Consequences. In: Scientific Conference on Economics and Entrepreneurship SCEE '2019, organized within the 60th International Scientific Conference of Riga Technical University, Latvia, Riga, 11–12 October 2019.

Content and volume of the Doctoral Thesis

Chapter 1 provides a comprehensive review of sustainability and sustainable development-related concepts, explores various models and approaches to sustainability as well as discusses factors related to sustainability and sustainable development. In this chapter, the author conducts a literature review via the PRISMA method as well as bibliometric and content analysis using VOSViewer and RStudio. Additionally, focus group discussions to approve the proposed definitions of "sustainability", "urban" and "urban sustainability" are reported.

Chapter 2 investigates various indicators and indices of sustainability as well as approaches to its evaluation. Additionally, the author discusses strategies and approaches to regional development. In this chapter, the author uses bibliometric analysis to indicate which factors are believed to be related to urban sustainability using VOSViewer.

Chapter 3 presents the results of surveys on sustainability awareness among Uzbek citizens that are analyzed via SPSS and SmartPLS. In addition to that, the author proposes a methodology to evaluate urban sustainability in Uzbekistan. The author also conducts qualitative analysis with experts to select and weigh the indicators for the methodology. The statistical data related to the methodology components is analyzed via Excel and SPSS.

1. CONCEPTUALIZING SUSTAINABLE DEVELOPMENT: DEFINITIONS, MODELS, INFLUENCING FACTORS

1.1. Overview of terms "sustainability", "urban" and "urban sustainability"

Although the idea of sustainability has been around for a while, it wasn't until the 1970s that it began to catch on. An ecosystem must be able to create its own resources and take in waste without deteriorating into other ecosystems or losing its usability to people. It is argued that sustainability encompasses both economic growth and human health and well-being in addition to conserving natural resources. By the end of the 20th century, diverse ideas from various movements, such as social justice, internationalism, and conservationism, have united in the call for "sustainable development." The motivation behind sustainable development is usually complex, personal, and diverse; thus, it is unrealistic to list down the reasons for single individuals, groups, and committees being occupied with reaching this goal. Yet, for many, sustainability comes down to what we, humans, are leaving to future generations. But what exactly does sustainability stand for?

In the Cambridge Dictionary (2019), the term "sustainability" is defined as:

1) the quality of being able to continue over a period of time;
2) the quality of causing little or no damage to the environment and, therefore, able to continue over a period of time.

The Brundtland Commission, in its universally known report "Our Common Future," proposes that sustainability means meeting one's own needs without compromising the ability of the descendants to meet their needs (The Brundtland Report, 1987). Additionally, natural resources and social and economic resources have to be taken into consideration; therefore, not only environmentalism but also economic development and social equity are essential constituents of sustainability.

To clarify the definition of this term the author conducted a bibliometric analysis using R-studio. First, the author searched "sustainability" AND "definition" on the Web of Science and limited the search to documents in English; 5193 results appeared. Then, 500 of the most cited articles were selected and analyzed. Based on the comprehensive analysis of these articles, the author suggests the following definition of this term. **Sustainability is the ability to maintain economic growth over time while promoting social development and preserving the environment.**

To analyze the meaning of the term "urban", 71 of the highly cited articles with "urban" AND "definition" as the keywords were selected. Then the articles were screened with 13 that were published in a language other than English, 45 that did not apply to the current research, and 13 that did not provide the definition of the investigated term excluded. Qualitative content analysis of the selected documents leads to the understanding that the term **"urban" refers to a city or town, particularly in terms of its atmosphere, culture, and way of life, entailing traits such as a diverse population, a high density of buildings and people, and a focus on commerce, entertainment, and other forms of cultural expression.** Urban areas frequently have a reputation for invention, inventiveness, and a fast-paced way of life, but they also struggle with issues like pollution, crime, and social injustice.

Finally, when analyzing the term "urban sustainability", it was searched in Scopus and Web of Science (WOS) databases. When doing so only 90 results appeared on WOS and 133 on Scopus. According to the literature, the concepts of sustainability and sustainable development are frequently related, and both phrases are used interchangeably in academic and scientific contexts (Ruggerio, 2021). Not only does this stance raise problems epistemologically but also in social, political, economic, cultural, and environmental spheres, caused by basing local and international environmental policies and activities on a tangled or vague idea. In light of this, some authors have warned about the need to rethink sustainability as a different term (Hedlund-de Witt, 2014). This situation demonstrates that both ideas are still up for debate and highlights the necessity for a more in-depth scholarly examination of their definitions (Whyte and Lamberton, 2020).

Based on the conducted analysis, the author proposes the following definition of sustainable urban development – "**the method of progress that implies ideas and tools that are implemented by urban planning to improve and/or construct cities without permanently depleting their natural resources while enhancing the standard of living in a city across several dimensions (environmental, cultural, political, institutional, social, and economic) for current and future generations.**"

This definition is derived from a combination of the keywords "urban", "sustainability", and "development". Urban, then, refers to the land immediately next to and including a city. Dense human constructions, including homes, businesses, roads, bridges, and trains, characterize highly developed urban regions. Sustainability is a balance between economic growth, environmental protection, and social well-being so that the demands of both present and future generations are met.

In terms of social, environmental, and economic impact, a sustainable urban environment is one that has been planned and managed to minimize negative effects (Sodiq et al., 2019). The development of environmentally friendly replacements is a key component of many sustainability programs. Therefore, it can be seen that the meaning of sustainable urban development revolves around the balancing of the resources in cities without compromising the needs of future generations.

Meanwhile, **urban sustainability** can be defined as "**a state in which the major subsystems of a city (economic, social, physical, and environmental) work in harmony to ensure the long-term well-being of its inhabitants and the preservation of the natural resources on which the city's growth and prosperity rely."**

To evaluate and refine the proposed definitions of "sustainability", "urban", and "urban sustainability", a focus group discussion was organized, the purpose of which was to ensure that the definitions are academically sound while being easily comprehensible to a diverse audience, including students and professionals in the field. By engaging academics and students in the discussion, the aim was to integrate expert knowledge with practical understanding to achieve a common comprehension of the key concepts.

There were 18 people in the focus group, including 10 students, 5 academics, and 3 professionals in the field of sustainable development. The academics were chosen for their competence in sustainable development research; they all hold or pursue PhDs and have a substantial publication record in the area. The students were pursuing undergraduate degrees and were selected to represent diverse backgrounds, experiences, and perspectives. The participants' opinions on the amount of specificity and detail needed in the definitions varied, however, the proposed definitions were generally accepted.

Theoretical analysis of various sustainability models shows that there is no common ground when it comes to sustainability models. However, since the three-pillar model performs as a basis for many other sustainability models, further in this research the author will be referring mostly to this model.

1.2. Factors influencing sustainability and approaches to sustainable development

Women and girls, who are usually the ones that suffer the most from gender inequality, comprise half of the world's population. When their rights, such as political or economic, etc., are taken away from them, the consequences reverberate across societies (Ben-Amar et al.,

2017). On the other hand, access to regular work and decent income leads to poverty reduction whilst supporting health and nutrition outcomes as well as the level of education (Bonewit and Shreeves, 2015). Nevertheless, the progress on gender equality has not been evenly successful in various dimensions of the 2030 Agenda. It is believed that unless the progress on gender equality is accelerated, it is doubtful sustainability will be achieved in the forthcoming future (UN Women, 2018). Gender equality requires the realization of fundamental human rights. Rights that are not real in practice are not enough. To make them applied in real life power and voice are demanded to challenge dominant institutions and forms of knowledge (Fraser, 2013). Gender equality is believed to stimulate economic growth, as higher female inclusion in economic processes dramatically contributes to the rise of economic indicators. UN Women report (2018), for instance, demonstrates that 50 %t of economic growth in OECD countries over the past five decades is attributed to better access to education for girls and women.

As mentioned in General Recommendation No. 37 of the Committee on the Elimination of Discrimination against Women (CEDAW, 2018), gender inequalities often limit the control that girls and women have in the decision-making that governs their lives and their access to education, health services, employment, and social protection as well as resources such as food, housing, water, etc. Due to these inequalities, they are much more likely to be exposed to risks related to natural catastrophes and are less able to adjust to climate changes and their consequences. When it comes to Central Asian countries, such as Uzbekistan, the state studied in the Thesis, due to their underdevelopment, cultural norms, and suppression of female power, women in these countries are often partially or entirely dependent on men of the family – the father or husband, and lack ability to make their own decisions whether it is about their education choices or even age of marriage. Research shows that not only does women's empowerment lead to the fulfilment of SDG5 – ensuring gender equality, but it also positively impacts many other sustainable development dimensions.

Value-belief-norm theorists argue that the intention to perform pro-environmental behaviours is strongly linked to the awareness of adverse environmental consequences (Hansla et al., 2008). From the same point of view, sustainability awareness is key to reaching sustainable development. Environmental Kuznets curve claims that economic development inevitably leads to environmental degradation; nevertheless, some researchers state that the extent to which this happens depends on moral values and laws within the investigated communities (Stern, 2018).

Since the theory of needs is mostly used to predict behaviours, it is only natural to question whether sustainability awareness may be described at the country or town level; for instance,

wealthier countries and cities tend to demonstrate higher awareness levels when it comes to sustainability and sustainable development (Jun et al., 2018). A hierarchy of needs proposed by Maslow suggests that humans need to fulfil their basic needs first before proceeding to higher levels on the pyramid; thus, sustainable development requires meeting all the basic needs, including food, shelter, clothing, and jobs, prior to extending their aspiration for a sustainable life (Clarivate Analytics, 2018). To ensure the implementation of Sustainable Development Goals, societies have to make complex fundamental transformations (The Bertelsmann Stiftung and Sustainable Development Solutions Network, 2018). To achieve such transformations, people need to change their daily behaviour in order to lead more sustainable lifestyles (Rauschmayer et al., 2015). This, however, takes a significant amount of time and is impacted by market, political, and individual factors (Lubowiecki-Vikuk et al., 2021). Pavalache-Ilie and Cazan (2018) argue that the enhancement of responsible environmental behaviour can be achieved by raising awareness. This idea is backed up by Guan et al. (2019), who claim that raising public awareness of sustainability goals is one of the key factors of their successful implementation.

Following this theoretical framework, it can be presumed that compared to developing states, wealthy countries have fewer people with unfulfilled lower-level needs, and therefore, they move up the pyramid, reaching a higher level of sustainability awareness and consequently sustainable development (Li et al., 2021). This, however, does not mean that sustainable development should remain a prerogative of developed nations only.

1.3. Sustainable development in a region-specific context

It is commonly acknowledged that strategic management is a necessary component of the region's sustainable development process. Decision-making requires pertinent information, which is impossible to obtain without it in the case of effective territorial management. To oversee the sustainability of the regional system's development and track changes in the values of the chosen criterion indicator, it is thus required to create an appropriate system of indicators, also known as an integral indicator (Martin & Rice, 2013). In addition, judgments about the necessity of modifying the socioeconomic growth of the region's trajectory in order to get the best indicator values can be made in light of the monitoring data.

According to Pearce et al. (1989) and Pezzey (1989), sustainable development is any measure of human well-being that does not decline over time. The only thing that separates these strategies is the set of prerequisites for achieving sustainable development. Strong

sustainability is fundamentally predicated on environmental imperatives, which also dictate the forms of economic analysis that follow. Conversely, weak sustainability begins with conventional economic presumptions and further establishes the structure in which environmental relations are studied (the relationship between the environment and humans).

It should be noted that the non-fungibility of assets causes aggregation issues in the event of strong stability (Faucheux et al., 1994). Natural capital should be created in incomparable units and quantified independently from human capital. According to Pearce et al. (1990), natural capital has the following characteristics, which call for the application of certain evaluation techniques: irreversibility, uncertainty, and scale. Within the context of both strong and weak resilience, the combination of these characteristics characterizes a "preventive approach" to the problem of natural capital degradation (Dasgupta, 1982). As a result, in order to achieve sustainable development, some actions must be taken. It has been observed that indicators of sustainable development should ideally help decision-makers understand complex processes.

According to the robust resilience paradigm, environmental assets, functions, and processes are the main focus of the indicators. Consequently, these indicators play a more important role in preserving important natural resources by establishing "limits" on the degradation of environmental resources (Swilling et al., 2013).

In many developed countries, the political empowerment of women is increasingly recognized as critical (Sundstrom et al., 2017). Even though women account for over 50 % of the global population, they only make up less than a quarter of the membership of national parliaments worldwide (Iyer & Mani, 2019). In 2019, a global gap in women's political empowerment was over 75 %, while economic participation equalled 42 % (World Economic Forum, 2020). In developing countries, women's political empowerment is far from global goals (Awoa, 2022). Regional performance indicates that central Asia, with 15 %, is one of the worst-performing regions regarding female political empowerment (World Economic Forum, 2022).

Not only is the political empowerment of women a salient measure of social change, but also a priority embedded in SDGs (Miedema et al., 2016). Female empowerment is defined as a process that enables women to make choices that were previously denied. Recent studies show a bidirectional relationship between female empowerment and economic development (Duflo, 2012). Political empowerment of women leads to advancements in institutional quality (Esarey et al., 2018), economic growth, and an increase in human capital (Jayasuriya and Burke, 2013) as well as environmental policy (Mavisakalyan and Tarverdi, 2019).

Simmons (2019) states that sceptics of the natural resource curse, faced with slow progress towards gender equality, warn against patriarchal attitudes, premier institutions, and antisocial policies promoting women's subjugation in resource-rich countries. The natural resource curse is that countries rich in natural resources demonstrate lower development outcomes than their resource-poor counterparts (Atanga Ondoa, 2019). Meanwhile, some studies extend this concept to female political empowerment. Ross (2008) states that the natural resources per capita rate reduces female empowerment in politics in the Arabian Peninsula. This happens mainly through the Dutch Disease; however, abundant natural resources can also impact female political empowerment through the state's characteristics, such as cultural norms and geography, and the quality of public policies and institutions (Simmons, 2019; Rorbaek, 2016). Liou and Musgrave (2016) propose that autocratic governments of resource-rich countries adopt antisocial policies to inflict prejudices on targeted groups, namely women.

Wejnert (2019) claimed that women's participation in the family decision-making process and their political awareness would eventually lead to their political empowerment. Another factor that influences political empowerment is education. Ghosh et al. (2015) empirically proved that the lack of education in India hindered females' political empowerment. Salhi and Golzard (2019) analyzed the role of Internet access in female political empowerment. The Internet helped to bring females together, promoted education, and, perhaps most importantly, allowed women to run online businesses, making them feel more secure and empowered. Al-Mallihan (2019) states that the political empowerment of women positively influences managerial and economic empowerment. It, however, does not affect social empowerment directly but rather through academic empowerment (Al-Qahtani, 2020).

Despite female empowerment being recognized as an essential element of sustainable development, for every 100 men, there are 104 women in poor households (Boudet et al., 2018). It is well known that women are more vulnerable to poverty than men because of cultural norms and values, the gendered division of assets, and the power dynamics between males and females (Atozou et al., 2017). Women tend to bear the burden of household activities that they usually are not paid for.

Empowering women is a pivotal tool in addressing poverty across the globe (Faborode & Alao, 2016). From the short-term perspective, increasing women's productivity (Diiro et al., 2018), employment (Maligalig et al., 2019), and earnings (Rui and Feng-Ying, 2021) can benefit economic growth and poverty reduction. Whereas in the long run, female empowerment and gender equality prevent the intergenerational transmission of poverty (Holland & Rammohan, 2019; Jones et al., 2019). Nevertheless, current poverty reduction policies are

primarily focused on men, which leads to a further increase in the gap in income and productivity between the two genders.

In this chapter, it is discussed that women should be guaranteed not only equal employment opportunities but also ensured protection in the workplace and households. Despite being a critical factor in empowering women, the means of promoting such empowerment are, however, not yet precisely clear. Furthermore, the current literature provides a lot of contradictory findings. Nevertheless, promoting equal rights when it comes to the labour market and participation in politics is a necessary step towards a more sustainable society. In the following chapter, the author offers an analysis of sustainable development in Uzbekistan.

Sustainable development as a new model of domestic policy, which is becoming a part of policymaking topics in an increasing number of countries globally, suggests a number of fundamental principles that reveal features of the new vision of socio-political and socio-economic progress.

Uzbekistan has its peculiarities in choosing a social base of development. The fact is that in Uzbekistan, the leading social base for implementing the Sustainability Program is not a social group but the socio-territorial community known as "mahalla." The mahalla, as a form of territorial-communal settlement of the Uzbek people, has a strong potential for resilience and a socio-psychological framework for families living in it (Sharyi et al., 2019).

The priorities for sustainable development of the country in the long run and the characteristic stages of the republic's entry into sustainable development correspond in many aspects to the priorities of structural changes imposed on market reforms. The similarity of priorities is due to the target landmarks suggesting an increase in the level and quality of life, ensuring conditions for economic growth based on the modernization of the production apparatus and rational use of natural resources (Iymanov, 2020).

The result of the first stage of market transformations in Uzbekistan on the way to sustainable development was the formation of new market institutions that were absent in the pre-reform period: stock and commodity exchanges, real estate exchanges, Chambers of commodity producers and entrepreneurs, new banking system, privatization and investment funds, insurance, and leasing companies (Kobilov, 2020). The organizational and legal basis of a socially-oriented market economy aimed at multiple structures, freedom of private entrepreneurship, and development of market methods of economic management in firm social policy were created.

Meanwhile, ensuring sustainable economic development requires solutions to a number of complex economic, social, and environmental problems. The unstable financial situation of

many enterprises still remains, as well as the balance of payments deficit, the predominance of the raw materials economy, the imperfection of macroeconomic regulation policy, and the low efficiency of institutional transformations (Botirov, 2019). Moreover, the problems of transition economies are compounded by ineffective use of land-water and mineral resources, and the terrible ecological situation in the Aral Sea region is present. The transition to sustainable development is carried out in an environment of an increasing number of problems of social stratification, which require support for socially vulnerable segments of the population and sharing responsibility in social policy between central and local authorities (Kulbekova, 2019).

Uzbekistan is a country with a transitional economy, an economy with material and energy-intensive production, outdated technologies, and an imperfect structure of the economy. The transition from centrally planned to the market economy results in new problems, such as employment problems, state budget deficit, high inflation, and the need to find new foreign trade markets. The country's reform program includes a governance economy at the macro level as well as structural and sectoral restructuring. Ensuring sustainable economic development requires solutions to a number of complex economic, social, and environmental problems. It is vital to develop an appropriate mechanism and necessary conditions and legislation that allow transparency in all aspects of activities to ensure sustainable development. The next chapter offers an exploration of the Thesis research subjects.

2. ASSESSMENT OF URBAN SUSTAINABILITY

2.1. Literature analysis of urban sustainability assessment

The bibliometric analysis, which utilized visualized graphs and maps, has revealed a positive trend in the publications on this topic. The keywords used the most in papers on urban sustainability assessment were "sustainable development," "urban development," "urban area," "environmental impact," etc. Some of the most common methods and approaches were spatiotemporal analysis, fuzzy logic analysis, life cycle assessment, indicator system analysis, and others. This gives us an idea of how scholars tend to evaluate sustainability levels when it comes to urban territories.

The need for the development of sustainable development indicators was highlighted in Agenda 21, which was adopted by the UN Conference on Environment and Development in Rio-de-Janeiro (1992). In the 40th chapter of this report, it was stated that in order to create a foundation for sustainable development decision-making, there is an urge to develop sustainable development indicators (UN Commission on Human Rights, 1993). This is needed for the control and monitoring of the sustainable development goals achievement, managing related processes, and evaluation of the efficiency of the used tools and methods. The development of various sustainable development tools actively takes place worldwide, involving lead researchers from the UN, World Bank, OECD, European mission, SCOPE, and others. Although the development of such indicators is far from being concluded, there are already a number of proposed indicators projects from systems of different volumes: regional, national, local, global, industry-wise, and even neighbourhood (district-wise).

The development of sustainable development indicators is a complex and expensive procedure that requires a lot of data, which is often hard or even impossible to obtain (Kovacic, 2017). Moreover, the variety of indicators that are included in the system makes it harder to be used in many countries due to the absence of necessary statistical data.

The problems of aggregating different indicators into a single index were discussed in the Report on the Aggregation of Indicators for Sustainable Development (CSD, 2001). The key challenge in aggregating the information into indices is identifying the weights of indicators without being subjective. The increase in information aggregation level increases the difficulty of weighing the process of different indicators. To indicate the weights, many suggest the Delfi Method, multi-criteria analysis, and some other methods actively used in social sciences (Sahabuddin, 2021). Generally, equal weights are not recommended for use.

It is clear that there are several key indicators that are commonly used across multiple methods to assess and quantify sustainable development, economic growth, and environmental impacts. Among those are GDP and its adjustments, HDI, as well as indicators of natural resource depletion and environmental impacts such as carbon emissions and water/land use. These are often considered critical components in gauging the sustainable development of a region or country.

2.2. Regional development strategies and approaches

In countries with a market economy, regional development is usually seen as unvital, as it tends to be viewed as a tool to fix market imperfections. Regional development is not analyzed as external to the market; therefore, it is not given enough attention.

Despite significant changes in the main challenges of regional development, the theoretical foundations have not evolved accordingly. Factors influencing regional development include economic events, the socio-economic and political orientation of a country, resource allocation, and the level of development of various industries, among others. The quality of regional development can be understood through the concept of growth stages: pre-industrial, industrial, and post-industrial. Modern regional development should focus on intangible production (e.g., services, science, education, trade finance, insurance, and healthcare) and regional development needs to become a continuous process, responding to rapid changes and the impact of globalization.

One of the key problems of regional development is the identification of developmental goals and the selection of tools for the decomposition of these goals for specific territorially realized programs. One of the reasons for such challenges is due to the incorrect positioning of the region, which can be addressed by putting different regions in groups based on their typology, which unites the socio-ecologic-economic development strategy of selected regions and a country as a whole.

Regions from one and the same group tend to have similar conditions, development trends, and indicators of social, ecological, and economic development. Differentiation of regions allows using similar development models as well as methods and instruments of economic regulations on the macro-management level (Ariaans et al., 2021). Evaluating a region for allocation to one of these groups is crucial for improving regional development, as it helps identify key problems or indicators, enabling the application of the best available techniques used successfully in similar regions.

Urban areas tend to be packed with various business headquarters as most companies prefer either to locate their operations within cities (especially regional capitals) or at least have their branches present there. Despite the fact that women comprise over 35 % of the global workforce, female entrepreneurial activities are still far from being equal to men (World Bank, 2020). Agarwal et al. (2020) argue that women display better capabilities, including creativity and innovative mindset, social awareness, and better abilities to identify opportunities, along with excellent leadership skills. These abilities are vital to achieving sustainability and improving the well-being of societies.

Organizations and programs promoting female economic empowerment, such as self-help groups and cooperatives, offer opportunities for financial growth, education, and community involvement. Therefore, such programs and organizations shall be paid enough attention to when attempting to accelerate regions' development.

3. EVALUATION OF URBAN SUSTAINABILITY IN UZBEKISTAN

3.1. Research methodology

The research methodology of the Thesis employs Saunders' Research Onion Ring model and consists of two stages: a literature review and an empirical data collection. The research uses an epistemological philosophy and critical realism stance. It follows a deductive approach and utilizes selected indicators based on comprehensiveness, representativeness, independence, availability of data, and relevance. These indicators are statistically independent and assessed through a qualitative analysis with experts to ensure their applicability. A step-by-step structure of the research methodology is presented in Fig. 1.
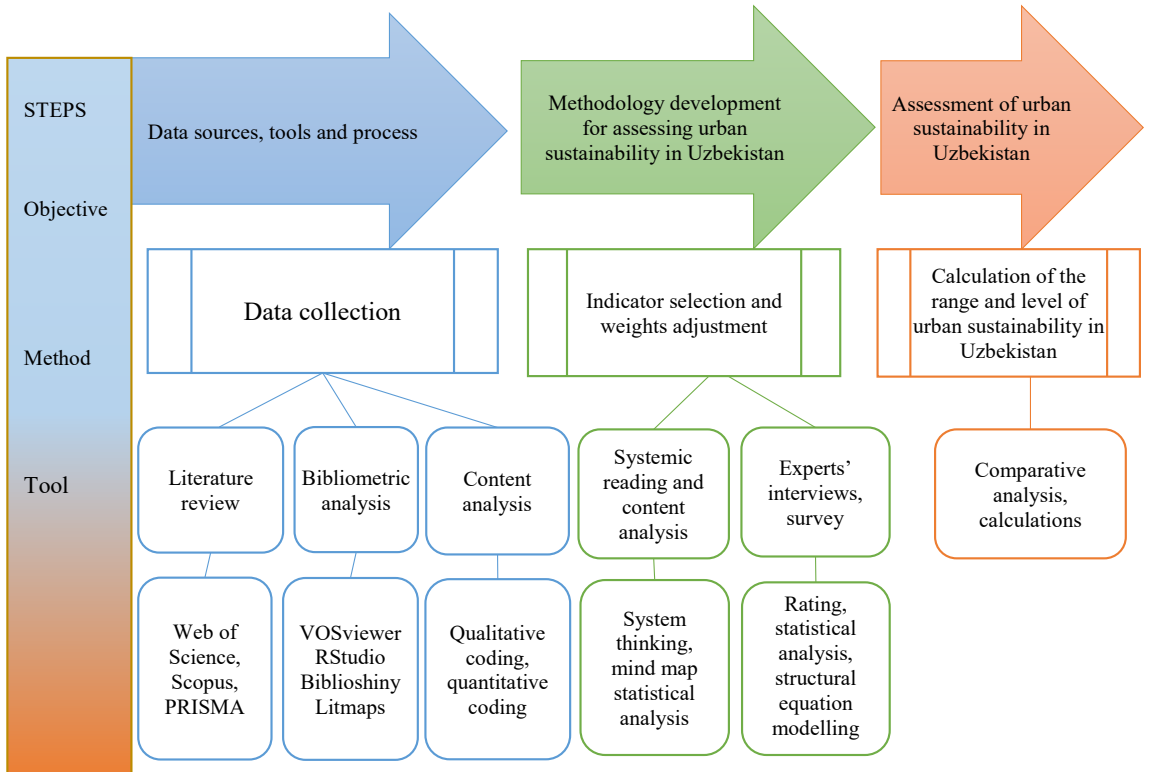
Fig. 1. Step-by-step structure of the research methodology (developed by the author).

This research aims to develop a methodological approach for assessing the sustainability of ecological, social, and economic systems in urban areas of Uzbekistan. The research involves

a literature review and the collection of empirical data. The research methodology relies on indicators to examine data and retrieve necessary information.

3.2. Development of urban sustainability assessment methodology

3.2.1. Formula development and statistical analysis

Based on the analysis in Chapters 1 and 2 and data availability, the author selected 32 indicators to be included in the methodology development; however, upon closer inspection, 3 indicators were eliminated because they did not vary throughout time. The classification of a final set of indicators is presented in Fig. 2. The author proposes "awareness" as a separate group and "gender equality and female empowerment" as a subgroup of social groups (Fig. 2).
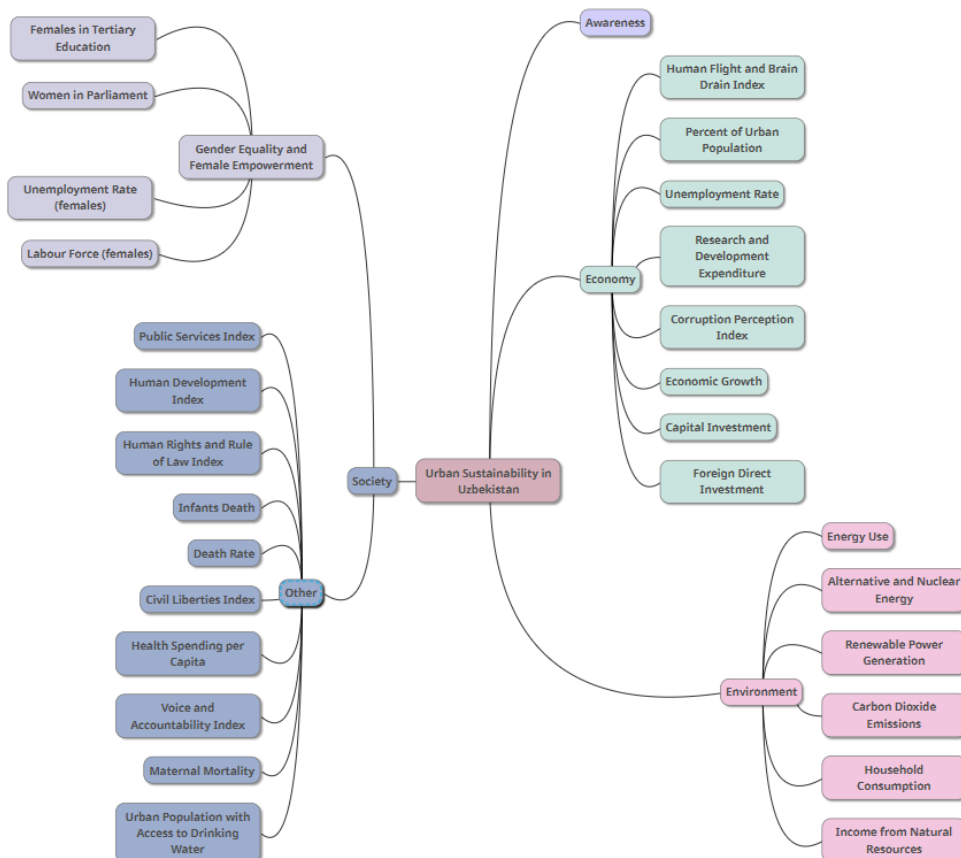
Fig. 2. Classification of urban sustainability indicators in the Uzbekistan context (developed by the author).

The proposed "gender equality and female empowerment group" includes labour force and unemployment among women, women in tertiary education and women in Parliament. While there are lower levels of the country's management, such as city council and other local administrations, there is no data on women's participation in them. Additionally, considering that governance in Uzbekistan is highly centralized, local administrations mostly represent executive and not legislative power, thus making the Parliament the most influential body even when it comes to specific urban areas.

At this stage of the research, the author aims to design an evaluation formula to assess the degree of sustainability of urban development in Uzbekistan. The formula for urban sustainability evaluation is meant to be applied to a country's indicators. However it can be used to analyze territorial regions within the country. Currently, the data for Uzbekistan is only available at the state level, no evaluation of separate regions is possible. Although, most indicators can be related to both urban and rural environments, considering the fact that urban areas have a noticeably higher level of consumption and drive the development of regions it can be said that these indicators are appropriate for evaluating urban sustainability (i.e. household consumption, dioxide emissions, brain drain, etc. are higher in urban areas, while economic growths, capital investment, etc. also tend to initiate in urban areas and only after spread to rural areas). Overall, considering the regional peculiarities of Uzbekistan, urban development has a very strong influence on the development of rural areas; therefore, urban development is seen as a primary step. Additionally, while these indicators can be applied to other countries, especially in the neighbouring region, one of the criteria for selecting them was data availability. Thus, the data for some indicators may not be available in other countries, and on the contrary, there may be a possibility to include other indicators, considering their availability.

Based on these results from theoretical chapters as well as data availability, the author selected 29 indicators to be included in the Uzbekistan urban sustainability evaluation (Fig. 2). Panel data from Uzbekistan for the years 2007 through 2021 is used to build an evaluation formula. Following the indicator selection procedure, the author provided the following function to show how the dependent variable has changed in relation to each of the independent variables, which are listed as follows:

$$S = f\,(HFBD_t,\ PSI_t,\ HRRLI_t,\ HDI_t,\ WP_t,\ RFM_t,\ PUP_t,\ HSpC_t,\ DR_t,\ MM_t, UR_t,\ ID_t,\ PUPADW_t,$$
$$ANE_t,\ RDE_t,\ CPI_t,\ CLI_t,\ EUpC_t,\ CDE_t,\ INR_t,\ RPG_t,\ EG_t,\ CI_t,\ HC_t,\ ERF_t,\ LFF_t,\ FDI_t,\ VAI_{t,}\ A_t),$$

$$(1)$$

where

S – urban sustainability;

HFBD – Human Flight and Brain Drain index, 0 (low) – 10 (high);

PSI – Public Services Index, 0 (high) – 10 (low);

HRRLI – Human Rights and Rule of Law Index, 0 (high) – 10 (low);

HDI – Human Development Index (0–1);

WP – Women in Parliament, %;

RFM – Ratio of Female to Male students in tertiary level education;

PUP – Percentage of Urban Population;

HSpC – Health Spending per Capita;

DR – Death Rate, per 1000 people;

MM – Maternal Mortality per 100,000 live births;

UR – Unemployment Rate, %;

ID – Infant Deaths per 1000 live births;

UPADW – Urban Population with Access to Drinking Water, %;

ANE – Alternative and Nuclear Energy, % of total energy use;

RDE – Research and Development Expenditure, % of GDP;

CPI – Corruption Perceptions Index, 100 = no corruption;

CLI – Civil Liberties Index, 7 (weak) – 1 (strong);

EUpC – Energy Use per Capita;

CDE – Carbon Dioxide Emissions per capita;

INR – Income from Natural Resources, % of GDP;

RPG – Renewable Power Generation, billion kilowatt-hours;

EG – Economic Growth: the rate of change of real GDP;

CI – Capital Investment as % of GDP;

HC – Household Consumption as % of GDP;

ERF – Unemployment Rate for Females;

LFF – Labour Force, % of females;

FDI – Foreign Direct Investment, % of GDP;

VAI – Voice and Accountability Index (–2.5 – weak; 2.5 – strong);

A – awareness;

t – at year t.

Before proceeding to the data normalization step, a correlation analysis is to be performed to determine whether all the selected above indicators have statistical significance in the analysis. It is essential to eliminate variables with a strong positive correlation to avoid multicollinearity. To do so, the author looks for variables with a correlation that equals or exceeds +0.8. No such observations occurred in correlation analysis.

Once the indicators for further analysis had been selected, descriptive analysis via SPSS was performed. The definitions of used variables and descriptive statistics for a 15-year period are presented in Table 1. Each variable has the same number of observations (n = 15), which balances the data.

Table 1

Definitions of Variables and Descriptive Statistics for 15 Years (Developed by the Author)

Variable	Description	Mean	Min > Max	Std. Deviation
HFBDI	Human flight and brain drain index, 0 (low) – 10 (high)	6.200	5.2 > 7.1	0.6199
PSI	Public services index, 0 (high) – 10 (low)	5.487	4.1 > 6.8	0.8806
HRRLI	Human rights and rule of law index, 0 (high) –10 (low)	8.853	7.6 > 9.4	0.6221
HDI	Human Development Index (0–1)	0.68800	0.646 > 0.720	0.024434
WP	Women in Parliament, %	20.800	16.0 > 33.0	5.4766
RWMS	The ratio of female to male students in tertiary-level education	0.6887	0.60 > 0.88	0.08911
UP	Urban population, %	50.5767	49.51 > 51.15	0.42404
HSPC	Health spending per capita	97.7353	46.68 > 131.83	25.48139
DR	The death rate, per 1000 people	4.973	4.6 > 5.8	0.2963
MM	Maternal mortality per 100,000 live births	30.53	28 > 35	2.167
IDR	Infant deaths per 1000 live births	20.907	13.0 > 32.0	5.7930
UPADW	Urban population with access to drinking water, %	85.747	85.1 > 86.1	0.3642
AE	Alternative and nuclear energy, % of total energy use	1.3487	0.79 > 1.77	0.29890
RDE	Research and development expenditure, % of GDP	0.1633	0.12 > 0.22	0.02664
CPR	Corruption perceptions index, 100 = no corruption	20.00	16 > 28	3.928
CLRI	Civil liberties index, 7 (weak) – 1 (strong)	6.80	6 > 7	0.414
EUPC	Energy use per capita	1502.2573	1300.00 > 1823.31	151.83816
CDEPC	Carbon dioxide emissions per capita	3.6113	2.70 > 4.55	0.61599
INR	Income from natural resources, % of GDP	16.8647	6.25 > 34.52	7.97714
RPG	Renewable power generation, billion kilowatt-hours	6.3467	4.44 > 8.35	1.08479
EG	Economic growth: the rate of change of real GDP	6.7113	1.71 > 9.47	1.91453
CII	Capital investment as % of GDP	30.7380	25.76 > 42.07	4.90610
HC	Household consumption as % of GDP	60.2807	49.45 > 66.29	5.03438
URF	Unemployment rate for females	6.0113	4.72 > 13.30	2.11099
LFF	Labour force, % of females	40.4513	39.44 > 41.61	0.65490
FDI	Foreign direct investment, % of GDP	2.2687	0.95 > 3.87	0.96531
VCI	Voice and accountability index (–2.5 – weak; 2.5 – strong)	–1.8993	–2.12 > –1.54	0.20974

The author then performed normality tests to measure the distribution specifics. As Table 2 shows, the data for each indicator chosen for this research is distributed normally.

Table 2

Test of Normality (Developed by the Author)

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Voice and accountability index (–2.5 – weak; 2.5 – strong)	0.152	15	0.200[*]	0.873	15	0.047
Human flight and brain drain index, 0 (low) – 10 (high)	0.107	15	0.200[*]	0.942	15	0.414
Foreign direct investment, % of GDP	0.197	15	0.122	0.906	15	0.117
Labour force, % of females	0.093	15	0.200[*]	0.971	15	0.869
Unemployment rate for females	0.312	15	0.045	0.555	15	0.066
Household consumption as % of GDP	0.242	15	0.076	0.868	15	0.071
Capital investment as % of GDP	0.221	15	0.047	0.848	15	0.068
Economic growth: the rate of change of real GDP	0.200	15	0.110	0.908	15	0.128
Renewable power generation, billion kilowatt-hours	0.145	15	0.200[*]	0.961	15	0.702
Income from natural resources, % of GDP	0.119	15	0.200[*]	0.947	15	0.478
Carbon dioxide emissions per capita	0.143	15	0.200[*]	0.931	15	0.281
Energy use per capita	0.307	15	0.065	0.841	15	0.047
Civil liberties index, 7 (weak) – 1 (strong)	0.485	15	0.073	0.499	15	0.062
Corruption perceptions index, 100 = no corruption	0.228	15	0.055	0.867	15	0.050
Research and development expenditure, % of GDP	0.216	15	0.057	0.939	15	0.373
Alternative and nuclear energy, % of total energy use	0.149	15	0.200[*]	0.944	15	0.430
Urban population with access to drinking water, %	0.196	15	0.124	0.861	15	0.045
Infant deaths per 1000 live births	0.162	15	0.200[*]	0.948	15	0.489
Maternal mortality per 100,000 live births	0.160	15	0.200[*]	0.920	15	0.192
Death rate, per 1000 people	0.264	15	0.076	0.826	15	0.048
Health spending per capita	0.116	15	0.200[*]	0.951	15	0.544
Urban population, %	0.223	15	0.064	0.912	15	0.145
The ratio of female to male students in tertiary-level education	0.249	15	0.073	0.838	15	0.112
Women in Parliament, %	0.280	15	0.082	0.778	15	0.073
Human development index (0–1)	0.115	15	0.200[*]	0.938	15	0.356
Human rights and rule of law index, 0 (high) – 10 (low)	0.327	15	0.073	0.724	15	0.72
Public services index, 0 (high) – 10 (low)	0.139	15	0.200[*]	0.945	15	0.456
* It is a lower bound of the true significance.						
[a] Lilliefors Significance Correction.						

Next, the author produced a multivariate analysis. Multivariate testing is a technique for testing a hypothesis in which multiple variables are modified. The goal of multivariate testing is to determine which combination of variations performs the best out of all of the possible combinations. Pillai's trace is a test statistic produced by a multivariate analysis of variance. It is a value that ranges from 0 to 1. The closer the Pillai's trace is to 1, the more substantial the evidence that the explanatory variables have a statistically significant effect. Pillai's trace test statistic gives more robust results than other tests and is considered the most potent and robust statistic for general use; thus, the author will lean on its values in Table 3. As can be seen, Pillai's trace result in the multivariate analysis equals 0.9, meaning that the variables are statistically significant.

Table 3

Multivariate Tests (Developed by the Author)

Multivariate Tests						
Effect		Value	F	Hypothesis df	Error df	Sig.
Inter-cept	Pillai's trace	0.894	4501747.073[b]	14.000	1.000	< 0.001
	Wilks' lambda	0.671	4501747.058[b]	14.000	1.000	< 0.001
	Hotelling's trace	63024458.818	4501747.058[b]	14.000	1.000	< 0.001
	Roy's largest root	63024458.818	4501747.058[b]	14.000	1.000	< 0.001
[a] Design: Intercept.						
[b] Exact statistic						

3.2.2. Experts' interviews and formula adjustment

According to studies on the techniques for creating composite indices (e.g., Becker et al., 2017; Mazziotta & Pareto, 2013), the author chose to employ uneven weights for each factor based on the data collected from experts in the next stage of this research.

At this stage, the set of indicators was sent out for evaluation by the experts. The author has addressed ten individuals with expertise in the field of sustainable development in Uzbekistan. They have been contacted online, in writing via email or Linkedin. While some experts come from academic backgrounds, others have applied knowledge on the matter. Such selection is based on the desire to collect different prospects that occur due to differences between practitioners' and scientists' experiences. Two of the selected experts were representatives of the city's administration. The total number of female experts is 3. The expert interviews were conducted from the 1st to the 13th of August 2022. The author aimed for at least eight responses and managed to collect ten.
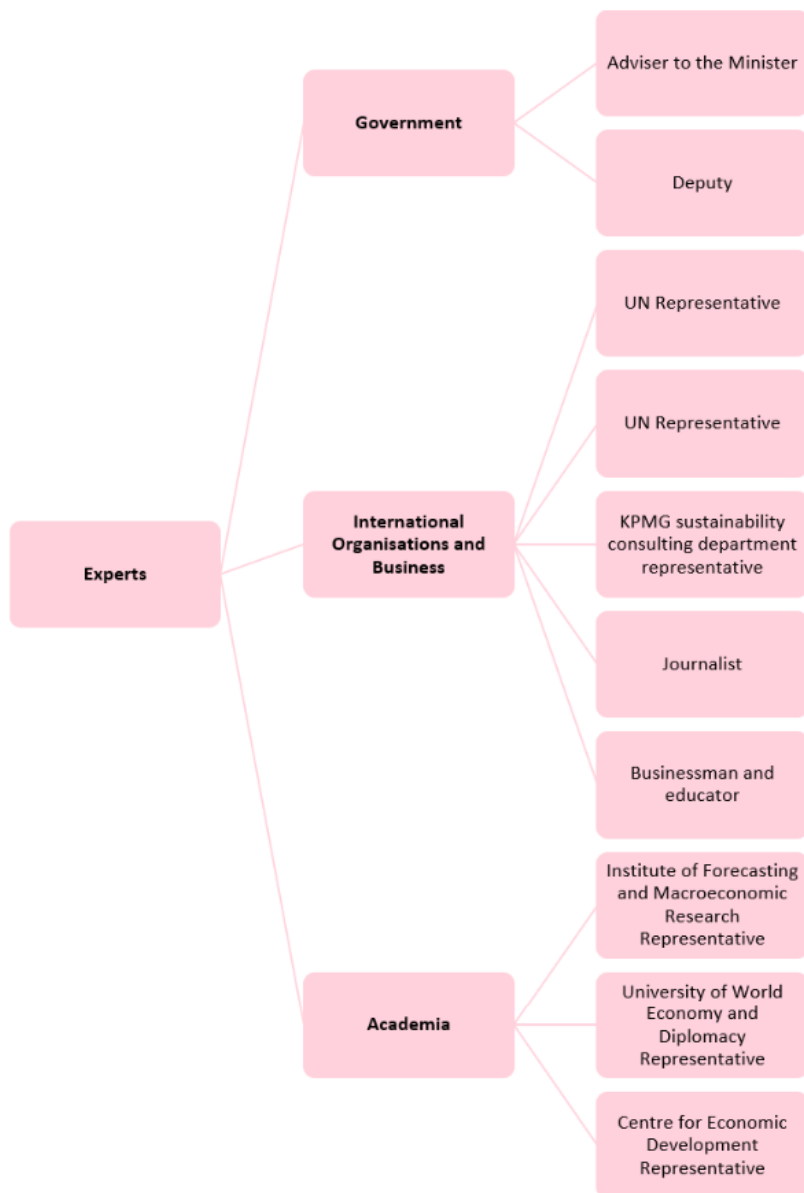
Fig. 3. Experts participating in the interviews (developed by the author).

The experts were asked to rate the importance of each indicator in the Uzbekistan context from 1 to 10, where 1 was the least important and 10 – the most important. After the collection of responses from selected experts, the following evaluation was received.

Table 4

Expert Evaluation of the Selected Indicators (Developed by the Author)

Indicator	Ex1	Ex2	Ex3	Ex4	Ex5	Ex6	Ex7	Ex8	Ex9	Ex10
Human flight and brain drain index	6	7	7	8	10	5	7	6	6	6
Public services index	9	6	6	8	7	9	8	9	6	10
Human rights and the rule of law index	10	9	9	8	10	7	8	9	10	10
Human development index	8	9	7	7	6	8	9	8	8	10
Women in Parliament	5	3	8	8	9	10	9	10	10	8
The ratio of women to men in tertiary education	8	7	6	8	8	9	7	8	8	9
Percentage of urban population	5	2	5	4	1	5	7	6	4	5
Health spending per capita	5	7	6	6	8	7	8	9	9	6
Death rate	1	2	2	1	3	1	1	1	2	1
Urban population with access to drinking water	2	3	3	4	2	2	2	1	2	4
Maternal mortality	5	5	6	7	7	5	4	4	5	5
Infant death	5	2	2	3	5	5	4	3	4	5
Alternative energy	7	8	8	6	10	7	8	7	7	7
Research and development index	6	4	8	8	9	5	6	6	6	7
Corruption perception index	10	4	6	6	8	9	9	9	10	5
Civil liberties rights index	9	8	6	10	6	6	8	8	8	9
Energy use per capita	7	10	10	8	8	7	6	8	6	6
Carbon dioxide per capita	6	8	7	7	5	6	6	6	5	8
Income from natural resources	6	9	6	5	5	9	9	8	5	6
Renewable power generation	8	10	8	8	9	6	7	8	8	7
Economic growth	10	6	8	7	7	9	8	10	9	8
Capital investment index	5	2	5	4	1	5	7	6	4	5
Household consumption	5	8	7	9	9	6	6	7	8	8
Unemployment	10	7	8	8	8	9	7	10	9	8
Employment for females	9	10	8	9	8	8	9	10	10	9
Labour force females	9	9	8	8	9	10	9	9	8	9
Foreign direct investment	10	6	8	8	7	7	9	8	7	6
Voice and accountability index	6	8	8	10	7	9	6	6	5	8
Sustainability awareness	6	8	7	5	10	10	10	9	8	8

When running this data set through SPSS, the statistical outcomes presented in Table 5 were received.

Table 5

Statistical Analysis of Expert Evaluations of Indicators (Developed by the Author)

Descriptive Statistics						
	Min	Max	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Human flight and brain drain index	5.0	10.0	6.8	0.4	1.4	2.0
Public services index	6.0	10.0	7.8	0.5	1.5	2.2
Human rights and rule of law index	7.0	10.0	9.0	0.3	1.1	1.1
Human development index	6.0	10.0	8.0	0.4	1.2	1.3
Women in Parliament	3.0	10.0	8.0	0.7	2.3	5.3
The ratio of women to men in tertiary education	6.0	9.0	7.8	0.3	0.9	0.8
Percentage of urban population	1.0	7.0	4.4	0.6	1.8	3.2
Health spending per capita	5.0	9.0	7.1	0.4	1.4	1.9
Death rate	1.0	3.0	1.5	0.2	0.7	0.5
Urban population with access to drinking water	1.0	4.0	2.5	0.3	1.0	0.9
Maternal mortality	4.0	7.0	5.3	0.3	1.1	1.1
Infant death	2.0	5.0	3.8	0.4	1.2	1.5
Alternative energy	6.0	10.0	7.5	0.3	1.1	1.2
Research and development index	4.0	9.0	6.5	0.5	1.5	2.3
Corruption perception index	4.0	10.0	7.6	0.7	2.2	4.7
Civil liberties rights index	6.0	10.0	7.8	0.4	1.4	2.0
Energy use per capita	6.0	10.0	7.6	0.5	1.5	2.3
Carbon dioxide per capita	5.0	8.0	6.4	0.3	1.1	1.2
Income from natural resources	5.0	9.0	6.8	0.6	1.8	3.1
Renewable power generation	6.0	10.0	7.9	0.3	1.1	1.2
Economic growth	6.0	10.0	8.2	0.4	1.3	1.7
Capital investment index	1.0	7.0	4.4	0.6	1.8	3.2
Household consumption	5.0	9.0	7.3	0.4	1.3	1.8
Unemployment	7.0	10.0	8.4	0.3	1.1	1.2
Employment for females	8.0	10.0	9.0	0.3	0.8	0.7
Labour force females	8.0	10.0	8.8	0.2	0.6	0.4
Foreign direct investment	6.0	10.0	7.6	0.4	1.3	1.6
Voice and accountability index	5.0	10.0	7.3	0.5	1.6	2.5
Sustainability awareness	5.0	10.0	8.1	0.5	1.7	3.0

Additionally, the calculation of the weights based on the experts' interviews produced the following results.

Table 6

Weight Adjustment Based on the Expert Evaluations (Developed by the Author)

	Indicator – sample minimum	Max-Min	I/J*	Weights (I/J)/14.42095**
Human flight and brain drain index	1.8	5	0.36	0.025
Public services index	1.8	4	0.45	0.031
Human rights and rule of law index	2.0	3	0.666667	0.046
Human development index	2.0	4	0.5	0.035
Women in Parliament	5.0	7	0.714286	0.050
The ratio of women to men in tertiary education	1.8	3	0.6	0.042
Percentage of urban population	3.4	6	0.566667	0.039
Health spending per capita	2.1	4	0.525	0.036
Death rate	0.5	2	0.25	0.017
Urban population with access to drinking water	1.5	3	0.5	0.035
Maternal mortality	1.3	3	0.433333	0.030
Infant death	1.8	3	0.6	0.042
Alternative energy	1.5	4	0.375	0.026
Research and development index	2.5	5	0.5	0.035
Corruption perception index	3.6	6	0.6	0.042
Civil liberties rights index	1.8	4	0.45	0.031
Energy use per capita	1.6	4	0.4	0.028
Carbon dioxide per capita	1.4	3	0.466667	0.032
Income from natural resources	1.8	4	0.45	0.031
Renewable power generation	1.9	4	0.475	0.033
Economic growth	2.2	4	0.55	0.038
Capital investment index	3.4	6	0.566667	0.039
Household consumption	2.3	4	0.575	0.040
Unemployment	1.4	3	0.466667	0.032
Employment for females	1.0	2	0.5	0.035
Labour force females	0.8	2	0.4	0.028
Foreign direct investment	1.6	4	0.4	0.028
Voice and accountability index	2.3	5	0.46	0.032
Sustainability awareness	3.1	5	0.62	0.043

* I/J – (indicator – sample minimum)/(sample maximum – sample minimum).

**14.42095 – the sum of all I/J.

When adjusting weights to the indicators based on the expert's evaluation, the individual indicators in each area are normalized on a 1-to-7 scale and aggregated by averaging the normalized scores so that all indicator scores are calculated for each year (De Montis et al.,

2021). In the second step, these scores are normalized again so that the sum of weights equals 1. To achieve this, each weight is divided by the sum of all the weights (Table 6).

$$w = \frac{Indicator - sample\ minimum}{sample\ maximum - sample\ minimum}/14.42095 \qquad (3)$$

Thus, the author has an adjusted formula for the evaluation of urban sustainability in Uzbekistan:

S_t= 0.025 $HFBDI_t$ + 0.031 PSI_t + 0.046 $HRRLI_t$ + 0.035 HDI_t + 0.05 WP_t + 0.042 $RWMTE_t$ + 0.039 PUP_t + 0.036 $HSpC_t$ + 0.017 DR_t + 0.035 $UPDW_t$ + 0.03 MM_t + 0.042 ID_t + 0.026 AE_t + 0.035 RDI_t + 0.042 CPI_t + 0.031 $CLRI_t$ + 0.028 EpC_t +0.032 $CDpC_t$ + 0.031 INR_t + 0.033 RPG_t + 0.038 EG_t + 0.039 CII_t + 0.04 HC_t + 0.032 U_t + 0.035 UF_t + 0.028 LFF_t + 0.028 FDI_t + 0.032 VAI_t + 0.043 A_t \qquad\qquad (4)

3.2.3. Calculation of a range for urban sustainability evaluation formula

For the final results of evaluations via the proposed methodology to make sense, there is a need for the maximum and the minimum possible values in the calculation that would act as reference points. While some indicators already provide possible maximum and minimum values, for instance, human development index, or corruption perception index, others, such as research and development expenditure, economic growth, etc. do not. So, to provide such values, the author had to conduct a comparative analysis.

To obtain minimum values, the author took some data from Afghanistan. It is one of the countries Uzbekistan borders and it is the least developed in that region. The choice of this country can be additionally explained for the following reasons:

1. Historically Afghanistan and Uzbekistan have a lot in common. These two states share a border and have some cultural ties (Weinbaum, 2006).
2. Afghanistan is home to over 3.5 million ethnic Uzbeks, which is the second-largest Uzbek population (Minorityrights.org, 2021). These Uzbeks in Afghanistan have some power to form cultural and social norms there, which are similar to the ones in Uzbekistan.
3. While Uzbekistan was a part of the USSR, for many years, Afghanistan experienced the rise of Communism and was ruled by the Communist Party, which was supported by the USSR (Weinbaum, 2006). This fact brings along similarities in the political

background. Nowadays, with the rise of the Taliban in Afghanistan, the influence of Islam is becoming stronger in Uzbekistan each coming day, which shows the interconnection between these two countries (Schmitz, 2021).

4. These two countries are very similar in terms of nature reserves (Indexmundi, 2019).

Once the necessary data was obtained, the author had to multiply each indicator by the weight previously calculated based on the experts' evaluation. Finally, the data was normalized. Once the normalized values had been obtained, the author summed them up and got the minimum value in the range – 3, meaning that 3 would be the lowest score in this sustainability evaluation methodology. Then the same procedure was followed to calculate the maximum possible values.

The reference for maximum values data on Finland was taken because it was voted the most successful in reaching sustainability goals (Sustainable Development Report, 2021) and the second most sustainably competitive country (The Global Sustainability Competitiveness Index, 2021). The maximum possible value turned out to be 1, which gives us a range from 1 to 3. Now, when there is a scaling range, the level of urban sustainability in Uzbekistan can be assessed.

3.2.4. Evaluation of sustainability awareness in Uzbekistan

Since there is no information on sustainability awareness among Uzbek citizens, the author conducted a survey to access such data. Empirical research requires a detailed analysis of part-taking individuals, as they represent the studied population (Babbie, 2021). The sample of this empirical research represents citizens of Uzbekistan who are allowed to participate in the labour market, thus contributing to the country's budget, which is then used for various sustainability projects. The pension age in Uzbekistan starts at 55 years for women and 60 years for men. 45–55 years was considered as the last age group because it would include both males and females participating in the research.

The survey contained 20 questions, some of which offered a dichotomous scale for an answer, some on a Likert scale, some were presented in the form of a checkbox, and some asked a participant to rank answers. The survey was distributed online via various social media channels: personal accounts on Instagram and Facebook, posts in different groups on Facebook, and direct messaging to potential participants. Surveys were conducted between the 3rd and 24th of July 2022. The participation rate equalled 100 %, which can be explained by the fact

that only people interested in participating followed the survey link. Some participants, however, refused to answer some questions within the survey.

Reinartz et al. (2009) state that 100 responses tend to be sufficient for statistical analysis. However, the author used a sample calculating Formula (5) to determine the adequate size of the sample.

$$Sample\ size = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + (\frac{z^2 \times p(1-p)}{e^2 N})}, \qquad (5)$$

where *n* is the population size, *e* is the margin of error, and *z* is the z-score.

Random sampling was used, meaning that respondents were chosen entirely by chance from the population at large. The sample size was calculated at 385 desired respondents. After the distribution of surveys, 440 responses were received that can be considered sufficient for this research.

In the survey, the major group of participants consists of people 25–34 years of age (53.41 %). This fully corresponds with the actual population metrics, as the average age of Uzbek citizens equals 29.1 (UZStat, 2022). It is followed by the age group of 35–44 years with 21.59 %, 18–24 with 13.64 %, and finally, 11.36 % of participants aged between 45 and 55. There were 67.27 % of female respondents and 32.73 % of male respondents. None of the respondents identify as the other gender.   Only 7.95 % of people taking part in the survey lived outside of the city, while 92.05 % lived in cities. Although, in reality, the urban population in Uzbekistan slightly exceeds 50 %, it was essential for this research to gather the majority of responses from urban dwellers, since this research aimed to evaluate the sustainability of urban areas.

The survey results indicate that while the respondents showed some understanding of sustainability concepts, there were areas that required improvement. The majority associated sustainability with social aspects over environmental and economic ones. Most respondents practised sustainable actions such as turning off lights but had limited participation in proactive actions like contacting officials on sustainability matters. Social media was identified as the most effective method for sustainability education in Uzbekistan. Almost 87 % believed they had personal responsibility for environmental issues, yet awareness of gender equality as a sustainability factor was lacking, with 20 % deeming it unessential. Despite Uzbekistan's patriarchal societal norms and limited female rights, almost half of the respondents believed women there had equal rights. These insights highlight the need to enhance sustainability

awareness, especially considering the possible discrepancy between survey results and reality due to respondents' tendency to project a better image.

Table 7

Descriptive Statistics of Variables (Developed by the Author)

Construct	N	Mean	Std. Deviation
Environmental awareness	440	2.880	0.935
Consumption consciousness (energy conservation)	440	3.273	1.069
Outreach method	440	3.373	1.095
Environmental issues	440	2.626	1.177
Awareness	440	3.153	1.155
Sustainability issues	440	3.196	1.136

The author then conducted an analysis of SmartPLS software. For the analysis of the survey, the author first divided the questions into 6 groups, creating study variables. These variables are environmental awareness, consumption consciousness, outreach methods, knowledge of environmental issues, knowledge of sustainability issues, and overall sustainability awareness. The outcomes of the descriptive statistics are presented in Table 7. The variables and their dimensions are in the range from 2.6 to 3.4. The standard deviations of all dimensions are from 0.9 to 1.2, which is considered acceptable in statistical analysis. Therefore, based on this, it is established that the views of the respondents are at a satisfactory level.

Further in this research, the author applied structural equation modelling (SEM) to test the hypotheses developed from the theoretical analysis. This analysis, based on PCA methodology and factor loading, was created for all indicators. To verify the validity of the constructs of an external model that seeks to ensure that irrelevant actions are not found to be relevant, after analysis, the author performed a discriminatory validity analysis (see Table 8).

Table 8

Discriminant Validity Analysis (Developed by the Author)

Variable	A	EA	CC	EI	OM	SI
A	**0.667**					
EA	0.751	**0.613**				
CC	0.917	0.730	**0.654**			
EI	0.247	0.338	0.228	**0.636**		
OM	0.653	0.701	0.580	0.294	**0.692**	
SI	0.858	0.825	0.837	0.287	0.670	**0.719**

It is expected that 50 or more variations of the indicators are calculated, which means that the square root of AVE must be greater than 0.50. In this research, Table 3 shows that the diagonal values (the square root of the AVE of the corresponding constructs) are higher than the other values of the column and row in which they are located, confirming the discriminant validity of the outer model. Thus, the construct validity of the outer model is confirmed, and it is further speculated that the results are accurate and reliable.

Table 9

Heterotrait-Monotrait Ratio (Developed by the Author)

Variable	A	EA	CC	EI	OM
EA	**0.808**				
CC	0.514	**0.850**			
EI	0.304	0.572	**0.689**		
OM	0.762	0.948	0.650	**0.940**	
SI	0.966	1.028	0.897	0.364	**0.773**

The author had to look at heterotrait-monotrait ratio (Table 9). HTMT values are to be lower than 0.90, which shows that the relationship between the two constructs has been established.

Table 10

Standardized Root Mean Square Residual (Developed by the Author)

	Saturated Model	Estimated Model
SRMR	0.071	0.080

The standardized root mean square residual (SRMR) indicates that the model is a good fit with a value of less than 0.10. Table 10 demonstrates that the SRMR value is 0.071 used for the saturated model and 0.080 used for the estimated model, showing that the model is a good fit.
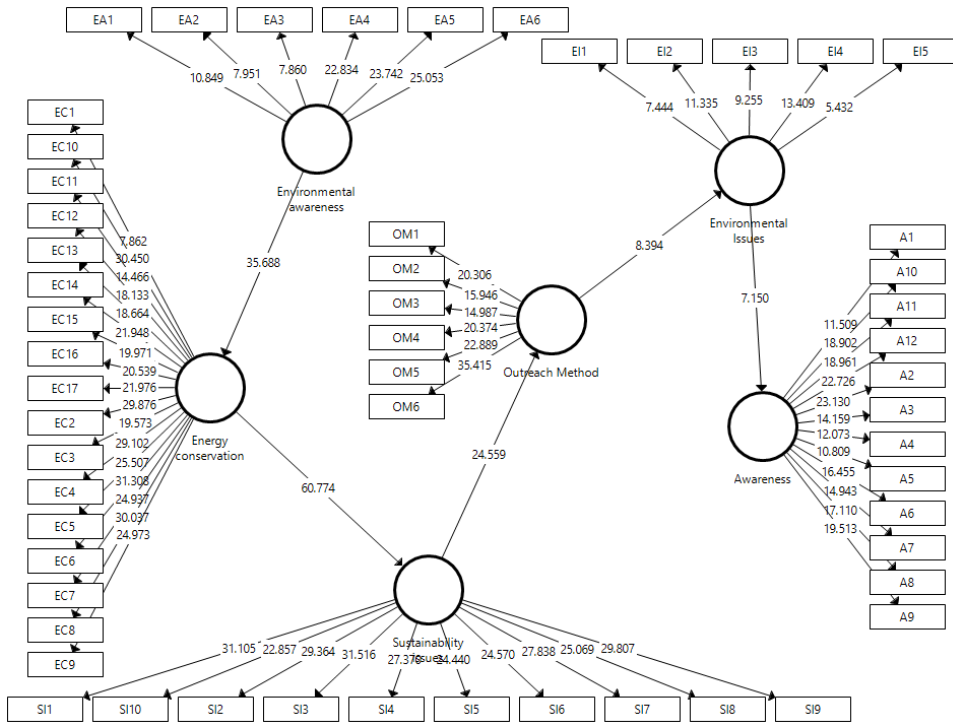
Fig. 4. Bootstrapping of structural model (developed by the author).

Additionally, the author employed the bootstrapping technique to measure the structural model based on 5,000 samples with a 95 % reliability level. The bootstrapping technique uses many samples to replace the original sample data (440). A structural model is used to work out the collinearity assessment, coefficient of determination, and cross-validated redundancy of endogenous variables. Variable inflation factors (VIFs) values are used to observe Collinearity issues. In this research, the values of endogenous variants of VIFs ranged from 1.257 to 2.75, which ensured that relevant issues were not found in the relevant results as they are all less than 0.5 (Hair Junior et al., 2017).

The R^2 value is utilized to evaluate the structural model and model prediction correctness. The R^2 range of all endogenous variables refers to the degree defined in all endogenous variables. The R^2 ranges of 0.75, 0.50, and 0.25 that is sufficient, moderate, and weak, respectively (Sarstedt et al., 2014). Table 11 presents the R^2 or the adjusted R square of the dependent variables.

Table 11

R^2 value of Model (Developed by the Author)

Variable	R Square	R Square Adjusted
A	0.061	0.059
CC	0.532	0.531
EI	0.086	0.084
OM	0.448	0.447
SI	0.701	0.700

Effect size f^2 estimates all independent variables. The change in the value of R^2 when the independent variables are excluded from the model can be a measure of whether the excluded independent variables have a significant effect on the constructs. This refers to how much f^2 contributes to the R^2 value of f^2 created on the value of R^2. The effect size f^2, the value of 0.02, offers a small effect, 0.15 medium, and 0.35 significant effect. The value of f^2 soft tan 0.02 indicates no effect between the variables (Hair Jr et al., 2017).

Table 12

The Effect Size of f^2 (Developed by the Author)

Variable	A	CC	EI	OM	SI
EA		1.138			
CC					2.342
EI	0.065				
OM			0.094		
SI				0.813	

The bootstrap technique for testing the proposed hypotheses was applied. First, the author reviewed the hypothetical direct relationship. Table 13 displays the direct relationship between key variables: environmental awareness, consumption consciousness, outreach method, knowledge of environmental issues, and awareness, and clarifies the direct association between independent and dependent variables.

Table 13

Path Model Results: Direct Hypotheses (Developed by the Author)

Structural paths	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P vlues
EA → CC	0.730	0.733	0.020	36.699	0.000
CC → SI	0.837	0.838	0.013	64.022	0.000
EI → A	0.247	0.265	0.035	7.082	0.000
OM → EI	0.294	0.299	0.037	8.029	0.000
SI → OM	0.670	0.671	0.029	23.377	0.000

Hypothesis 1: The findings indicate that environmental awareness (EI) is positively and significantly connected with consumption consciousness (CC). This can mean that people with higher environmental awareness chose to use resources more wisely. P value in this case is lower than 0.05, which makes the hypothesis acceptable.

Hypothesis 2: The findings indicate that consumption consciousness (CC) is positively and significantly connected with sustainability issues (SI), with p value < 0.05. This hypothesis is also acceptable.

Hypothesis 3: The findings indicate that the sustainability issues (SI) are positively and significantly connected with awareness (A) (p-value < 0.05). Again, this means that raising awareness among the population can have a positive effect on the number of sustainability issues in the region.

The results presented above demonstrate the statistical significance of the conducted survey. From the results, it can be observed that there is a strong connection between environmental and overall sustainability awareness and energy conservation practices and sustainability issues. These results correspond with the findings from theoretical analysis and prove the importance of considering sustainability awareness as an important factor of sustainable development.

3.2.5. Results of evaluation of urban sustainability in Uzbekistan

Using the formula developed earlier, the author can now measure the level of urban sustainability in Uzbekistan. As mentioned earlier, some of the proposed indicators are not specific to the urban area; however, the strong impact of the urban areas on the country's development and the proportion of urban influence in the mentioned indicators must be considered. Additionally, the data for one of the indicators – sustainability awareness, which was ranked among the highest by experts, was collected among the urban population.

Following the process of calculation described earlier, the following results were received.

Table 14

Evaluation of Urban Sustainability in Uzbekistan (Developed by the Author)

Indicator	Value	Weights	Value*Weight	Normalized
Human flight and brain drain index	5.2	0.025	4.91	0.0048202
Public services index	4.6	0.031	4.34	0.00439364
Human rights and rule of law index	7.6	0.046	7.17	0.00652647
Human development index	0.72	0.035	0.68	0.00163517
Women in Parliament	33	0.050	31.15	0.02458445
The ratio of female to male students in tertiary-level education	0.83	0.042	0.78	0.00171338
Percentage of urban population	50.44	0.039	47.62	0.03698332
Health spending per capita	101.2	0.036	95.53	0.07307085
Death rate, per 1000 people	5.4	0.017	5.10	0.00496239
Maternal mortality per 100,000 live births	28	0.035	26.43	0.02102973
Infant deaths per 1000 live births	19.6	0.030	18.50	0.0150578
Percentage of urban population with access to drinking water	86.1	0.042	81.28	0.06233559
Alternative and nuclear energy, % of total energy use	1.6	0.026	1.51	0.0022608
Research and development expenditure, % of GDP	0.12	0.035	0.11	0.00120861
Corruption perceptions index	28	0.042	26.43	0.02102973
Civil liberties index	6	0.031	5.66	0.00538896
Energy use per capita	1405	0.028	1326.32	1
Carbon dioxide emissions per capita	2.7	0.032	2.55	0.00304284
Income from natural resources, % of GDP	13.5	0.031	12.74	0.01072104
Renewable power generation, billion kilowatt-hours	6.4	0.033	6.04	0.00567334
Economic growth: the rate of change of real GDP	7.4	0.038	6.99	0.00638428
Capital investment as % of GDP	32.4	0.039	30.59	0.02415789
Household consumption as % of GDP	62.4	0.040	58.91	0.04548621
Unemployment rate	13.3	0.032	12.56	0.01057885
Unemployment rate for females	39.44	0.035	37.23	0.02916293
Labour force, % of females	2.9	0.028	2.74	0.00318503
Foreign direct investment, % of GDP	–1.58	0.028	–1.49	0
Voice and accountability index	27.2	0.032	25.68	0.02046098
Sustainability awareness	7.16	0.043	6.76	0.00621365

When summing up the normalized values presented in Table 14, the author obtained 1.45206814, which can be rounded up to 1.45. On a scale from 1 to 3, where 1 is the highest level of sustainability, and 3 is the lowest level of sustainability, Uzbekistan is located in the middle. It means that despite making some substantial progress towards achieving sustainable development, Uzbekistan has yet plenty to do to improve its score. To compare, Uzbekistan scored 69.93, on the 100-point scale in Sustainable Development Report Calculations (SDRC, 2021) and 45.2 in Global Sustainability Competitiveness Index (GSCI, 2021). Of course, these indices focus on not simply urban but rather the overall sustainability of the country; however, it can be said that the findings roughly correspond to those of the most established sustainability indices.

CONCLUSIONS AND PROPOSALS

The key **conclusions** that can be drawn from the conducted research are as follows.

1. A comprehensive literature analysis demonstrated that there was no commonly accepted definition of "sustainability", therefore the author proposed a newly developed definition of this term that was accepted by academics, professionals in the field of sustainability, and students.

2. A thorough review of the literature revealed that there was also no generally accepted meaning of "urban," so the author suggested a comprehensive definition of this word that addressed the shortcomings of the existing definitions.

3. The author also proposed a thorough definition of the term "urban sustainability" that synthesized the existing definition, thus taking into account all the complex aspects of it.

4. Gender equality and female empowerment are important factors aiding in the achievement of higher levels of urban sustainability, nevertheless, they are often overlooked, especially in developing countries.

5. Sustainability awareness is a crucial factor in reaching sustainability goals, however, people in developing countries tend to demonstrate lower levels of awareness, thus to improve urban sustainability, it is essential to promote its importance to the general public.

6. The best ways to promote sustainability awareness in Uzbekistan, according to the surveyed individuals, are through social networks, educational institutions, and TV. Radio and newspapers were voted the least promising tools.

7. The conducted theoretical analysis of the existing techniques of evaluation of urban sustainable development enabled us to identify that there was no methodology developed specifically for the Central Asian region. The use of methodologies proposed by scholars in developed countries is not always possible due to the absence of necessary data. On top of that, such methodologies do not address the specific needs of the region.

8. The investigation of various approaches to regional development and analysis of related methodological aspects in the context of sustainability demonstrated that more attention should be allocated to the issues of social development. These findings from theoretical analysis correspond to the empirical findings from experts' interviews, in which indicators of social development were given, on average, higher importance grades than those of ecological and economic nature.

9. Spreading awareness of the importance of gender equality and female empowerment is also crucial for the achievement of sustainability, especially in Uzbekistan, where cultural norms advocate female discrimination, which not only causes drawbacks in social injustice but brings a significant negative impact on the economic development of the country.

10. Encouraging female entrepreneurship and empowerment is crucial for fostering equitable and prosperous societies, as it leads to financial security, improved decision-making, and better living conditions for families.

11. Organizations and programs that promote female economic empowerment, such as self-help groups and cooperatives, can provide essential resources, training, and support for women to establish and grow their businesses. However, they tend to be discriminatory toward less wealthy women.

12. By integrating female entrepreneurship promotion and sustainable urban development practices, cities can become more sustainable, economically vibrant, and inclusive for all members of society. This can be achieved through adequate regional development planning, that accounts for women's empowerment needs.

13. Taking into consideration regional specificities and the lack of accessible data in Uzbekistan, the developed research formula allows us to assess the actual level of sustainability in Uzbek cities while giving us insights into what aspects seek immediate attention for improving sustainability progress in the country.

14. Hypothesis 1 – Sustainability issues are positively and significantly connected with sustainability awareness – was proven by the results of the survey.

15. Hypothesis 2 – Gender equality is positively associated with urban sustainability – was proven by the interviews with experts.

16. Hypothesis 3 – Higher environmental awareness is positively associated with a higher level of consumption consciousness – was proven by the survey analysis.

Based on the findings from this research the following **recommendations** are proposed. **To Government and Policymakers** (Ministry of preschool and school education of the Republic of Uzbekistan, Ministry of Higher Education, Science and Innovations of the Republic of Uzbekistan, Ministry of Poverty Reduction and Employment)

1. More actions should be undertaken in order to promote sustainability awareness among Uzbek citizens. Education for Sustainable Development should be introduced in all

educational institutions and offered as compulsory training at work. For such training, it is advised to use the Atkisson Sustainability Pyramid, as it was specifically designed for learning purposes. Additionally, launching an online sustainability awareness campaign as the most effective outreach method through social networks can be suggested.

2. Uzbek citizens of all ages should be educated on the importance of gender equality and female empowerment. More actions should be undertaken at the higher state and regional management level to demote gender discrimination on societal and legal levels.

3. Female empowerment should be emphasized at the regional development level through introducing special education institutions for women that allow them to acquire education despite marital status and the presence of kids. More community-based productive associations for females should be established in urban and rural areas to help women support each other in their personal and professional lives. Such associations, as well as cooperatives with no entry criteria, should be promoted and supported by "mahallas", as the literature suggests that it is more effective to introduce interventions for urban sustainability transition at a neighbourhood level.

4. Collaborate with the private sector and civil society organizations to create a supportive environment for women entrepreneurs, including fostering partnerships, sharing best practices, and providing funding.

To Private Sector Organizations and Businesses

1. Encourage diversity and inclusion within the workplace, ensuring equal opportunities for women in leadership positions and promoting gender-sensitive policies.

2. Support female entrepreneurs by investing in their businesses, providing mentorship and offering resources to help them succeed.

To Non-governmental Organizations and Civil Society

1. Advocate for gender equality and women's empowerment in entrepreneurship, raising awareness about the importance of female-led businesses in achieving sustainable development.

2. Develop and implement programs that provide training, resources, and support to women entrepreneurs, helping them overcome barriers to entry and success and to raise sustainability awareness among the population.

For further research, it is suggested to apply the developed formula to separate regions of Uzbekistan (if the data is available) and adjust the formula to the needs of such regions, as a

proper, reliable evaluation will consider the specificities of a researched location and the needs of various stakeholders. This can be achieved through the adaptation of the proposed methodology.

Summarizing the results of the Doctoral Thesis, the author concluded that the research goal has been achieved, the research hypotheses have been proven, and the theses supported.

IMPLICATIONS FOR FURTHER RESEARCH

This research provides a foundation for future research in urban sustainability in Central Asian regions, particularly Uzbekistan. It underscores the need for a context-specific approach to sustainability and contributes to an ongoing conversation about how local peculiarities shape sustainability practices and awareness.

Firstly, while this research introduced a unique set of indicators for assessing urban sustainability in Uzbekistan, there is still a need to refine, test, and validate these indicators in a variety of contexts across the country. This involves conducting longitudinal studies to measure their efficacy and applicability over time, thereby allowing for continuous refinement and adjustment.

Secondly, the novel methodology developed for evaluating urban sustainability requires further testing and validation in other urban settings within Central Asia, and potentially in similar developmental contexts outside of the region. This would involve replicating the method with different demographic groups and in different urban environments to ensure its robustness and generalizability.

Thirdly, this research reveals a link between sustainability awareness among citizens and the successful implementation of sustainable practices. Future research should delve deeper into this association, examining the factors that influence public awareness and understanding of sustainability, and how this can be enhanced to achieve better urban sustainability outcomes.

It can be achieved through the adaptation of the proposed methodology.

Overall, the research provides a valuable stepping stone for further investigations into the dynamics of urban sustainability, particularly in Central Asia. It encourages scholars to continue this line of inquiry, emphasizing the need for context-sensitive, inclusive, and multidisciplinary approaches to sustainability research.

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Regina Veckalne was born in Samarkand, Uzbekistan, in 1996. She obtained a Bachelor's degree in Business Studies and Management (2016) from Cardiff Metropolitan University and a Master's degree in Economics (2018) from Riga Technical University. She has been a lecturer at Riga Technical University since 2020. Her research interests are related to sustainability, gender equality, female empowerment, and green economy.