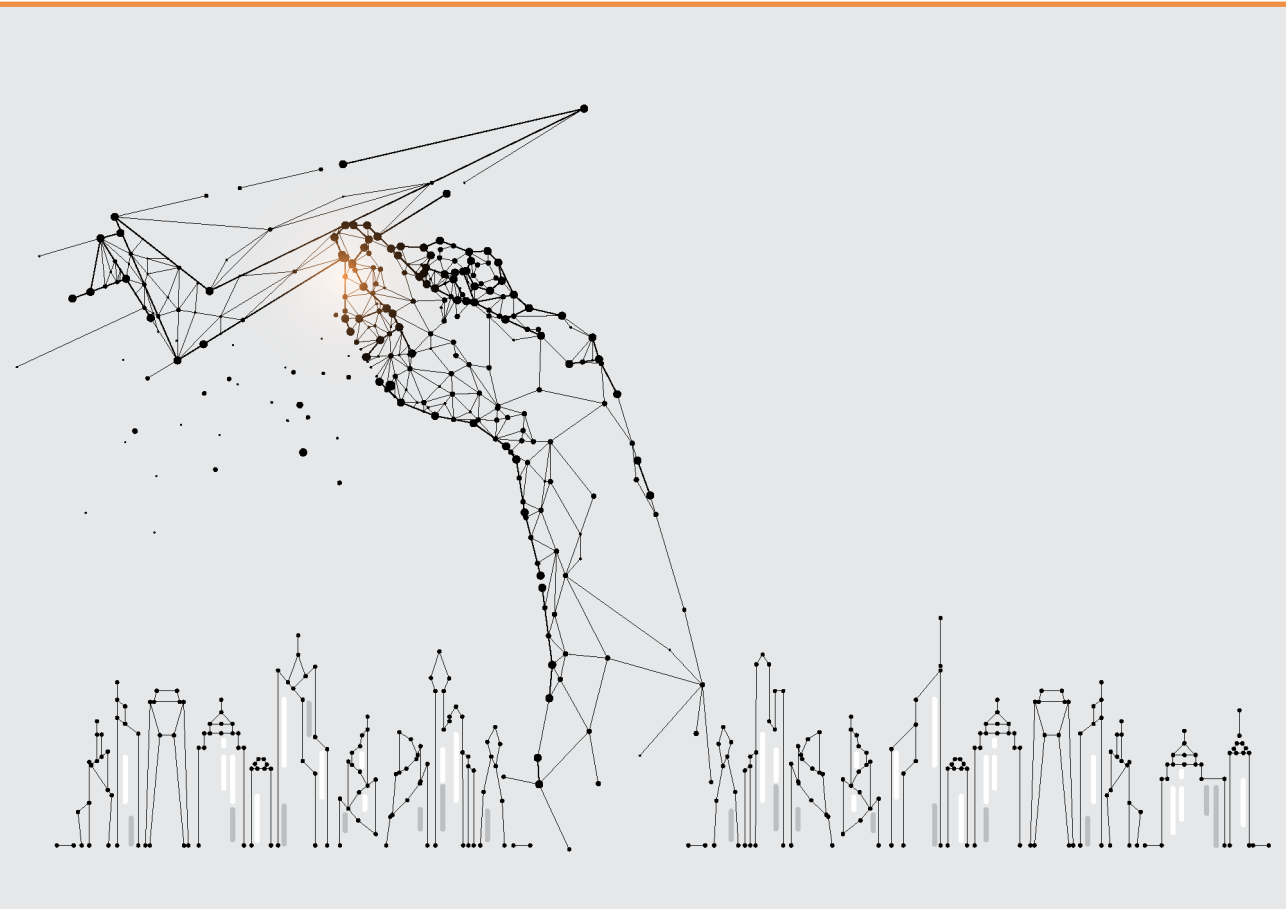


**Kaspars Plotka**

**IMPACT OF THE SYNERGY EFFECT  
OF THE INTELLIGENT URBAN ENVIRONMENT  
ON THE SUSTAINABILITY OF THE CITY**

Summary of the Doctoral Thesis



**RIGA TECHNICAL UNIVERSITY**  
Faculty of Engineering Economics and Management  
Institute of Civil Engineering and Real Estate Economics

**Kaspars Plotka**

Doctoral Student of the Study Programme “Management Science and Economics”

**IMPACT OF THE SYNERGY EFFECT  
OF THE INTELLIGENT URBAN  
ENVIRONMENT ON THE SUSTAINABILITY  
OF THE CITY**

**Summary of the Doctoral Thesis**

Scientific supervisors:

Professor Dr. oec.  
MAIJA ŠENFELDE

Assoc. Professor Dr. oec.  
ARMANDS AUZIŅŠ

RTU Press  
Riga 2023

Plotka, K. Impact of the Synergy Effect  
of the Intelligent Urban Environment  
on the Sustainability of the City. Summary  
of the Doctoral Thesis. – Riga: RTU Press, 2023. –  
44 p.

Published in accordance with the decision of the  
Promotion Council “P-09” of 21 December 2022,  
Minutes No. 04030-9.9.1/9

NACIONĀLAIS  
ATTĪSTĪBAS  
PLĀNS 2020



EIROPAS SAVIENĪBA  
Eiropas Sociālais  
fonds

---

IEGULDĪJUMS TAVĀ NĀKOTNĒ

The Doctoral Thesis has been developed within the European Social Fund project “Strengthening of the Academic Staff Members of Riga Technical University in Strategic Specialisation Areas” No. 8.2.2.0/18/A/017 (SAM 8.2.2.).

<https://doi.org/10.7250/9789934228827>

ISBN 978-9934-22-882-7 (pdf)

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

To be granted the scientific degree of Doctor of Science (Ph. D.), the present Doctoral Thesis has been submitted for the defence at the open meeting of RTU Promotion Council on 14 April 2023 at 10.00 in the Zoom online platform.

## **OFFICIAL REVIEWERS**

Professor Dr. oec. Inga Lapiņa  
Riga Technical University

Professor Dr. oec. Vytautas Juščius  
Klaipeda University, Lithuania

Professor Dr. oec. Agita Līviņa  
Vidzeme University of Applied Sciences, Latvia

## **DECLARATION OF ACADEMIC INTEGRITY**

I hereby declare that the Doctoral Thesis submitted for the review to Riga Technical University for the promotion to the scientific degree of Doctor of Science (Ph. D.) is my own. I confirm that this Doctoral Thesis had not been submitted to any other university for the promotion to a scientific degree.

Kaspars Plotka ..... (signature)

Date: .....

The Doctoral Thesis has been written in Latvian. It consists of Introduction, 3 parts, 10 chapters, Conclusions, 42 figures, 15 tables, 7 appendices; the total number of pages is 146, not including appendices. The Bibliography contains 184 titles.

## TABLE OF CONTENTS

INTRODUCTION.....	5
1. URBAN DEVELOPMENT AND SUSTAINABILITY CHALLENGES.....	14
1.1. THE SYNERGY IMPACT ON URBAN ENVIRONMENT .....	15
1.2. THE IMPORTANCE OF HUMAN CAPITAL AND CREATIVITY IN URBAN ENVIRONMENT .....	17
2. THEORETICAL MEASUREMENTS OF THE CITY AND URBAN ENVIRONMENT	22
2.1. CONCEPTUAL BASIS FOR URBAN DEVELOPMENT .....	22
2.2. BIBLIOMETRIC ANALYSIS OF SMART URBANISM AND SYNERGY .....	24
3. INTELLIGENT ASSESSMENT METHODOLOGY OF THE URBAN ENVIRONMENT FOR ITS SUSTAINABLE DEVELOPMENT.....	30
CONCLUSIONS AND RECOMMENDATIONS.....	40
LIST OF REFERENCES .....	44

# INTRODUCTION

## Topicality of the Research

The multifaceted changes in the world economics and the uneven and unbalanced growth of the world regions, as well as the rapid increase of technological progress have determined the importance of the sustainability of human habitable space, its impact on the city and significance of urban environment change in the circumstances of the development of regions both national and continental and a global scale. The urgent need of every city is to determine and clarify the sustainability of the existing urban environment, identify the intellectual potential of the urban environment, the dimensions and possibilities of using the spaces included in them, as well as determine the value of the elements of these spaces and monitor their potential, respecting the interests of the individual and society and the basic principles of sustainable development, thereby enhancing the urban environment and the value of its associated resources. The urban environment has always been and still remains the object of study of the variety of branches of science because it is a space where all spheres of human activity are concentrated. Here an individual lives and works, developing as a personality psychologically, socially and intellectually. In the specialized literature, the urban environment is considered from different aspects – ecological, economics, mundane and macrosocial processes, as well as of many other activities that are part of a holistic (an individual is considered as a whole unit) understanding of the modern urban environment. In the present Doctoral Thesis, the author draws special attention to the intellectual urban environment – it means a certain set of basic conditions created by the intellectual capital of people and the environment that affect the standard of living of people and its quality within the boundaries of a particular inhabited locality.

In fact, there is a biggest concentration of the population in cities around the world. According to forecasts, in 2050, 80 % of the estimated nine billion people are projected to live in urban areas.<sup>1</sup> Nowadays the cities are facing the social and as environmental challenges caused by negative factors such as poverty, technological and mental pollution, which hinder development, growth and generally affect the sustainability of cities.

The urban environment has become a special object of study. The experience of the historical development of the city convincingly indicates that the intellectual growth of the individual and society and the rational use of the resources associated with it constitute the socio-economic and environmental basis for the prosperity and stability of the state and society. So far, the mutual cooperation of the factors that form the intelligent urban environment and their influence on the sustainable development of cities have not been properly studied yet.

Actually, the necessity for such scientific and methodological support in matters of the intellectual urban environment is closely related to the relevance of the theme of research. Facing changes in economics, some new methods became necessary in the management and planning of the urban environment, as well as the introduction of innovative solutions to improve the infrastructure of the urban environment. As crisis periods are cyclically repeated in the economics, this, in its turn, at the global level, gives an impulse to the necessity of searching for some new or innovative solutions and, by their means, in creation of a synergistic

---

<sup>1</sup> Hoornweg, D., & Pope, K. (2017). Population predictions for the world's largest cities in the 21st century. *Environment and Urbanization*, 29 (1), 195–216.

effect to achieve the sustainability of an intelligent urban environment. Synergy is the interaction of two or more elements of a system in which the combined effect exceeds the sum of their individual effects. The additional effect or difference resulting from such an interaction is called a synergistic effect or synergy effect. The synergy effect can be both positive and negative. For example, the synergy effect on intellectual capital and the sustainable potential of the urban environment with financial instruments creates conceptually new opportunities and new vectors of development. As a result, absolutely new and never existed before professions appear. In its turn, the meaning of public space and the identity of society changes. The sustainability and intellectual growth of society are important components of the development of modern urban environment, and a necessary condition for this is a qualitative and deep understanding of the theory of economic science. As the habits, culture and customs of society change, so does the concept of intellectual development. The demand for intellectual potential is especially growing in the conditions of the "new economics", which is formed by four "pillars" – the economic and institutional base of the state, the education system, information and communication technologies, as well as the national innovation system. The basis of the "new economics" is people, their ability to create high-tech and competitive products in purpose to enrich their home space. Consequently, the importance of human capital and intellectual capital, which has a great potential for social and economic activity, is increasing, which can help increase the competitiveness of cities, regions and countries. The urban environment is the place where the intellectual life of society and the individual is formed.

### **Research Questions**

1. What parameters influence the development of the urban environment?
2. What is the role of human capital and creativity in the urban environment?
3. Does the intellectual capital of a person affect the development of the urban environment?
4. How to improve the positive impact of the synergy effect of the smart urban environment on the sustainability of the city?

### **The Goal of the Research**

To develop methodological solutions for the sustainable development of an intelligent urban environment that can be used at different levels of urban environment management, taking into account the impact of the synergy effect.

### **The Objectives**

1. To learn and analytically assess the role of the elements of urban environment, human capital and creativity in the development of the urban environment.
2. To analyse ongoing studies of the development of the urban environment and synergy since the second half of the 20th century and to identify already proposed concepts of the urban environment.
3. To analyse the definitions of the urban environment proposed in the scientific literature.
4. To identify and analyse the factors that affect the size of the smart urban environment and the sustainable development of the city.
5. To find the best methodological solutions for the development and management of the sustainability of the intelligent urban environment in the city.

**The Object of research** is the urban environment.

**The subject of the research** is the synergy of measurements of the intelligent urban environment and its impact on sustainability.

### **Limitation of the Research**

The study has been conducted using publicly available data from the Sustainable Urban Development Index for the period 2015–2018.

In accordance with the Article 32.33 of Regulation (EU) 2016/679 of the European Parliament and of the Council as well as with the Article 5.20 of Regulation (EU) 2018/1725 of the European Parliament and of the Council, the consent of all experts regarding publication of their personal data has not been collected.

The impact of synergy on the environment (environmental factors, their mutual influence on the climate) has not been studied in details. Elements of the environment are studied narrowly, evaluating the elements of the urban environment, studying the impact of projects that are one of the essential factors in improving the urban environment.

The limited access to statistical data has determined the elements selected for analysis, their characteristic technical, intellectual and economic indicators.

### **Hypothesis**

As the influence of human capital and intellectual capital on the size of the urban environment increases, a positive synergistic effect arises.

### **Theses for Defence**

1. As the impact of intellectual capital on each individual dimension of the urban environment increases, a positive synergy effect originates.
2. The creation of synergistic mechanisms for management and development makes it possible to understand the meaning and essence of the phenomena and processes taking place in the city.

### **Theoretical and Methodological Foundation of the Thesis**

The theoretical and methodological basis of the Thesis is based on the works of urban theorists and researchers G. W. F. Hegel; urban planning theorists R. Florida and J. Zimmerman; human capital theorists E. Glaser and A. Navarro; urban planners J. Kotkin, D. Farr, A. Marcusen, R. P. Damari, R. Berger, M. Castell, J. Robinson, and A. Roy; urban sociologists R. E. Park, L. Wirth, H. V. Zorbo, and others; as well as the works of classical economic theorists and researchers A. R. Smith, D. Ricardo, W. Petty, K. H. Marx, J. M. Clark, L. Walras, J. McCulloch, J. F. Thünen, T. Winstein, W. Farr, I. Fischer, R. Dornbusch, S. Fischer, K. Schmanlesi, T. Schultz, G. Becker, M. Fujita, V. Alonso, V. Kristaller, I. Ansoff, and others; scientific publications in foreign countries and in Latvia, monographs, the latest scientific and methodological solutions, materials of international scientific conferences and seminars, educational and scientific literature available in Ebrary, Scopus, Web of Science, Google Scholar, Ngram Viewer, e - library of scientific libraries and other electronic databases, publications in the media and specialized publications, scientific publications by the author, presentations of research results at lectures and seminars for students of the Riga Technical University, as well as information and experience gained through participation in local international scientific conferences and seminars.

### **Research Methods**

The systematic literature review approach was combined with bibliometric analysis, literary and content analysis, sociological research methods (Delphi method, focus groups). The following quantitative research methods were used: questionnaires, the method of collecting



and analysing descriptive statistical data, and the method of analysing hierarchies – Analytic Hierarchy Process (AHP). In order to promote and confirm the hypothesis, a qualitative method was used – a focus group; and for its implementation, industry experts were selected whose level of competence corresponded to the conditions specified by the author.

### **Scientific Novelties**

1. The aspects of the creative city ecosystem, layers and characteristics of the intellectual urban environment were determined.
2. As the lack of a single definition of the urban environment is stated, an interdisciplinary definition of the concept is proposed.
3. For the first time, the analytical hierarchy process was used to assess the importance of urban environmental factors in Latvia.
4. Matrices of the intelligent urban environment have been developed that can be used in the development of urban planning strategies to determine the synergistic potential of investments and intellectual capital.
5. The postulates of an intelligent urban environment have been developed, as well as algorithms for assessing the impact of the strategic potential of creative and cultural industries on a smart urban environment.

### **Scientific Publications**

1. Zvirgzdiņš, J., Plotka, K., Geipele, I. The Usage of Circular Economics Strategies to Mitigate the Impacts of Climate Change in Northern Europe. From: *Climate Change, Hazards and Adaptation Options: Handling the Impacts of a Changing Climate*. W. Leal Filho, G. Nagy, M. Borga, P. Chávez Muñoz, A. Magnuszewski eds. Cham: Springer, 2020. pp. 853–873. ISBN 978-3-030-37424-2. e-ISBN 978-3-030-37425-9. ISSN 1610-2002. e-ISSN 1610-2010. doi: 10.1007/978-3-030-37425-943 (Scopus, Web of Science).
2. Plotka, K., Viržbickis, J., Zvirgzdiņš, J., Zariņš, G., Geipele (Lapuķe), S. The Impact of Culture and Creativity on the Economics of the City. *Baltic Journal of Real Estate Economics and Construction Management*, 2019, Vol. 7, No. 1, pp. 272–289. e-ISSN 2255-9671. doi: 10.2478/bjreecm-2019-0017; (EBSCO).
3. Plotka, K., Viržbickis, J. The influence of culture and creativity on the urban economics. From: *Real estate and economic development: Synergy of science and practice*. S. Geipele, R. Kochanova ed. Riga: RTU Publishing House, 2019. pp. 114–135. ISBN 978-9934-22-230-6. e-ISBN978-9934-22-231-3. doi: 10.7250/9789934222313.06. (In Latvian).
4. Zvirgzdiņš, J., Plotka, K., Geipele (Lapuķe), S. Circular Economics in BuiltEnvironment and Real Estate Industry. From: *The 13th International Conference "Modern Building Materials, Structures and Techniques MBMST 2019": Selected Papers, Lithuania, Vilnius, 16–17 May 2019*. Vilnius: VGTU Press "Technika", 2019, pp. 704–713. e-ISBN 978-609-476-197-3. e-ISSN 2029-9915. doi: 10.3846/mbmst.2019.046 (Web of Science).
5. Geipele (Lapuķe), S., Plotka, K., Viržbitskis, J. The Evaluation of Synergy. No: *Proceedings of VIII International Scientific and Practical Conference, Russia, Moscow, (April 11–15, 2018) Moscow: Plekhanov Russian University of Economics*, 2018, pp. 37–40. ISBN 9785730713444.
6. Plotka, K., Zvirgzdiņš, J., Šenfelde, M. Intellectual Urban Environment. In: *International Scientific Conference "New Challenges of Economic and Business Development – 2018: Productivity and Economic Growth"*: Proceedings, Latvia, Riga, May 10–12, 2018. Riga: University of Latvia, 2018, pp. 815–824. ISBN 978-9934-18-344-7. (Web of Science).

7. Plotka, K., Zvirgzdiņš, J., Šenfelde, M. Nuclear Energy and Renewable Energy in Urban Environment. In: International Scientific Conference “New Challenges of Economic and Business Development – 2018: Productivity and Economic Growth”: Proceedings, Latvia, Riga, May 10–12, 2018. Riga: University of Latvia, 2018, pp. 825–835. ISBN 978-9934-18-344-7. (Web of Science).
8. Zvirgzdiņš, J., Plotka, K., Geipele, S. Eco-Economics in Cities and Rural Areas. *Baltic Journal of Real Estate Economics and Construction Management*. No. 6, 2018, pp. 88–99. e-ISSN 2255-9671. doi: 10.2478/bjreecm-2018-0007 (Web of Science).
9. Geipele, I., Plotka, K., Wirzbitskis, Y., Zvirgzdiņš, J. The Synergy in Circular Economics. No: *Advances in Economics, Business and Management Research: Proceedings of the Third International Conference on Economic and Business Management (FEBM 2018)*, China Hohhot, 20–22 October 2018. [Amsterdam]: Atlantis Press, 2018, pp. 65–68. ISBN 978-94-6252-623-5. ISSN 2352-5428. doi: 10.2991/feb-18.2018.15 (Web of Science).
10. Viržbickis, J., Plotka, K., Kamols, K. Smart and creative opportunities for the development of cities in the Baltic region. From: *Theory for practice in the education of modern society*, (April 6–7, 2017), 2017, pp. 112–120. Riga Academy of Teacher Training and Education Management, ISBN 978-9934-503-45-0. (in Latvian).
11. Viržbickis, J., Semjonova, N., Plotka, K. Problems of development of creative economics. From: *Theory for Practice in the Modern Society of Education*, Latvia, From: *Proceedings of the 10th International Scientific Conference of the Riga Academy of Teacher Training and Education Management "Theory for Practice in the Education of Modern Society"* Riga, (April 6–7, 2017), Riga: Riga Academy of Pedagogy and Education Management, 2017, pp. 104–111. ISBN 978-9934-503-45-0. (in Latvian)

#### **Presentations at Conferences**

1. Viržbickis, J., Plotka, K., Semjonova, N. Problems of Creative Economic Development, 10th International Scientific Conference of the Riga Academy of Pedagogy and Education Management *Theory for practice in the education of modern society* Latvia, Riga: Riga, 6–7 April 2017.
2. Viržbickis, J., Plotka, K., Kamols, U. Smart and creative opportunities for the development of cities in the Baltic region. 10th International Scientific Conference of the Riga Academy of Pedagogy and Education Management *Theory for the practice of education in modern society* Latvia, Riga, 6–7 April 2017.
3. Plotka, K., Šenfelde, M., Viržbickis, J. Intellectual Urban Environment. In: *Riga Technical University 58th International Scientific Conference “Scientific Conference on Economics and Entrepreneurship” (SCEE’2017)*: Latvia, Riga, 13–14 October 2017. Riga: Riga Technical University.
4. Plotka, K., Zvirgzdiņš, J., Šenfelde, M. Nuclear Energy and Renewable Energy in Urban Environment. *New Challenges of Economic and Business Development – 2018: Productivity and Economic Growth*, Latvia, Riga, 10–12 May 2018. Riga: University of Latvia.
5. Zvirgzdiņš, J., Šenfelde, M., Plotka, K. Intellectual Urban Environment. In: *International Scientific Conference “New Challenges of Economic and Business Development – 2018: Productivity and Economic Growth”* Latvia, Riga, 10–12 May 2018. Riga: University of Latvia.

6. Plotka, K., Šenfelde, M., Zvirgzdiņš, J., Zariņš, G. Smart City and Cyber City Performance. In: Scientific Conference on Economics and Entrepreneurship (SCEE'2018)" organized within 59th International Scientific Conference of Riga Technical University, Latvia, Riga, 18–19 October 2018.
7. Zvirgzdiņš, J., Plotka, K. Changing the Paradigm: Circular Economics and Related Concepts. In: "Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regions and Territories Development ICEREE'2019" organized within 60th International Scientific Conference of Riga Technical University, Latvia, Riga, 27–28 September 2019.
8. Zariņš, G., Plotka, K., Viržbickis, J., Zvirgzdiņš, J., Geipele, S. The Impact of Culture and Creativity Cluster to the Economics of the City. In: "Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regions and Territories Development ICEREE'2019" organized within 60th International Scientific Conference of Riga Technical University, Latvia, Riga, 27–28 September 2019.
9. Plotka, K., Zvirgzdiņš, J. The Concepts of Green City and Sustainable City. 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.
10. Plotka, K., Zvirgzdiņš, J. Sustainability in Urban Environment. 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.
11. Plotka, K., Udris, O., Jirgena, B., Viržbickis, J. Waste Management in a Sustainable Urban Environment in Latvia and the European Union. 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, Latvia, Riga, 30–30 September 2021.
12. Plotka, K., Vaica, A., Varfolomejeva, R., Jirgena, B. Local Environmental Policy for Sustainable Development of Urban Environment. 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, Latvia, Riga, 30–30 September 2021.
13. Plotka, K., Ūdris, O., Jirgena, B., Zvirgzdiņš, J., Viržbickis, J. Sustainable Urban Environment and the Concept of Waste Management in Latvia. In: Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regional and Territorial Development (ICEREE'2021), Latvia, Riga, 30–30 September 2021.
14. Plotka, K., Vaica, A., Varfolomejeva, R., Jirgena, B., Zvirgzdiņš, J. The Role of Synergy in Sustainable Development of Municipalities in Northern Europe. In: Scientific Problems of Engineering Economics of Construction and Real Estate Management, Regional and Territorial Development (ICEREE'2021), Latvia, Riga, 30–30 September 2021.
15. Plotka, K., Jirgena, B. The Concept of Waste Management in Sustainable Environment, 17th annual International Scientific Conference. "Social Innovations for Sustainable Regional Development". 28–29 April 2021, Klaipeda, Lithuania.

16. Plotka, K., Jirgena, B. Micro-Mobility in the Urban Environment. 17<sup>th</sup> annual International Scientific Conference “Social Innovations for Sustainable Regional Development”. 28–29 April 2021, Klaipeda, Lithuania.

## Participation in Projects

The last part of the Thesis was elaborated within the European Social Fund project SAM 8.2.2. “Strengthening the academic staff of Riga Technical University in the fields of strategic specialization”.

## Logic of the Research

The logical structure of the research (see Fig.1) is determined by the aim of the research and the logical sequence of research objects.



Fig. 1. Logic of the research (created by the author).

### **Phase 1. Identification of factors influencing the development of the city and the urban environment**

Being based on the results of this *Phase*, answers were given to the research questions: what measurements affect the development of the urban environment; what is the role of human capital and creativity in the urban environment? Considering the studies documented in the existing scientific literature, as well as the elucidated features of the intelligent urban environment in the development of the urban environment and the importance of the input of human capital and creativity, the following methods were used at this phase of the study: the general survey method (umbrella survey method), monographic or descriptive method, content analysis, logical-constructive (induction and deduction) method, method of analysis and synthesis, graphical method, descriptive method of cross-sectional research.

### **Phase 2. Analysis of theoretical measurements of the city and the urban environment**

As a result, during this phase, schools and concepts of urbanism were collected and definitions of urbanism were defined. A systematic review of the literature has been provided, based on time, terminology, typology, historical and geographical analysis. A monographic or

descriptive method, an expert method, a logical-constructive (induction and deduction) method, as well as a method of analysis and a method of synthesis have been used. In the 21st century, urban concepts have become fragmented and based mainly on the specifics of urban activity, which complicates the process of creating a single definition of the urban environment necessary to continue research and achieve the goals.

### **Phase 3. Transformation of dimensions of the intelligent urban environment and growth opportunities**

Attention is drawn to the discussion questions of researchers analysed in the previous phase in order to identify factors or groups of factors that influenced the urban environment in a limited period of time. For this, additional questions are defined:

- What are the most important scientific publications in the field of smart urbanism, synergy and sustainable development?
- What is the significance of the study of the intelligent urban environment and synergy in the scientific literature?
- What are the most important research topics in this area?

Taking into consideration the analysis provided, the answer was obtained to the research question: to identify and analyse the factors that affect the dimension of the intellectual urban environment and the sustainable development of the city. The author used the method of systematic literature review combined with bibliometric analysis, the VOS viewer program to form a set (clusters) of the most important thematic areas to assess the development of influencing factors in the urban environment and establish links between them.

### **Phase 4. Creation of a sustainable growth model (matrix) of an intelligent urban environment**

At this phase of the study, the main priority is to identify the components of the urban environment growth matrix created by the author of the present Doctoral Thesis, as well as elements of the intelligent urban environment, factors and threats that affect the growth of the urban environment. As a result of this phase, the research question was answered: how can the positive impact of the synergistic effect of the smart urban environment on the sustainability of the city be improved. A projection of the strategic potential of a cluster of creative and cultural industries has been created, which can be used to assess creativity in a smart urban environment. With the help of focus groups (participants are industry experts), the components and indicators of the urban environment were identified and analysed using the analytical hierarchy process (AHP), and the significance of factors affecting the development of the urban environment was assessed. When constructing the matrices, a monographic or descriptive method, a survey and a questionnaire, an expert method, a logical-constructive (induction and deduction) method, an analysis and synthesis method, a graphical method and a Delphi method were used.

#### **Structure and Volume of the Thesis**

The Thesis consists of an introduction, three parts, ten chapters, five subsections, conclusions and proposals, a list of used literature and sources and seven appendices.

In the Introduction of the present Doctoral Thesis, the actuality of the research topic is presented, the research hypothesis is put forward, the purpose and tasks of the work are defined, the subject and object of the research are described, the methodological solution of the research is described, the limitations of the research are determined, the scientific novelty and the approval of the research results are described. More than 200 different sources of information

have been used during the elaboration of the Doctoral Thesis, 184 of which are included in the bibliographic list of the Thesis.

In the first part of the Doctoral Thesis, the author analyses the city and the urban environment as a complex object of study, in the second part – the theoretical dimension and concept of the development of the city and the urban environment. In this part, the author of the Doctoral Thesis analyses the changes in the paradigm discourse in the urban environment, as well as the characteristics of the urban space and its development, guided by the approaches of various concepts and methods. In the third part of this study, the author evaluates the level of competence of city experts and checks their reliability, using methods determined in the decision-making process, through an in-depth study of the analytical hierarchy process (AHP) and conditions or expert laws. The author of the Doctoral Thesis presents the DSCS urban sprawl matrix, 11 postulates of an intelligent urban environment, and analyses the assessments of experts on the problems of the urban environment.

### **Contents of the Doctoral Thesis**

#### INTRODUCTION

#### 1. URBAN DEVELOPMENT AND SUSTAINABILITY CHALLENGES

##### 1.1. Changes in the dimensions of the urban environment

1.1.1. City and urban environment - a complex object of study

1.1.2. Influence of synergy on the urban environment

1.1.3. Analysis of indicators and measurements of sustainable cities

##### 1.2. The importance of human capital and creativity in the urban environment

##### 1.3. Transformation of an intelligent urban environment into a smart urban environment

#### 2. THEORETICAL MEASUREMENTS OF THE CITY AND THE URBAN ENVIRONMENT

##### 2.1. Conceptual foundations of urban development

##### 2.2. Characteristics of the development of urban space and the economic environment

##### 2.3. Bibliometric analysis of smart urbanism and synergy

#### 3. METHODOLOGY FOR ASSESSING THE SMART URBAN ENVIRONMENT FOR ITS SUSTAINABLE DEVELOPMENT

##### 3.1. Methods for assessing the sustainability of an intelligent urban environment

##### 3.2. The concept of model of the sustainable growth of the intelligent urban environment

##### 3.3. Assessing the influence of smart urbanism on sustainable development

3.3.1. Factors influencing the sprawl of the intelligent urban environment

3.3.2. Influence of implemented projects in the urban environment on the formation of a sustainable and smart urban environment

##### 3.4. Quantitative approach and algorithm for assessing the impact of creativity in a smart urban environment

#### CONCLUSIONS AND RECOMENDATIONS

#### LIST OF REFERENCES

#### APPENDICES

# 1. URBAN DEVELOPMENT AND SUSTAINABILITY CHALLENGES

The city has always been considered as the object of research in a variety of scientific disciplines; all spheres of human life are concentrated in it – as in it an individual lives, works and develops as a personality. At the beginning of the 21st century, important changes took place in scientific and theoretical discussions about cities and the urban environment, and some of them are important for creating components of modern urban development. The author of the Doctoral Thesis analysed the theoretical debates of the city and the urban environment and concluded that the characteristic feature of urban studies is the multidimensionality of cities.

Due to its inherent complexity, as well as the lack of a single conceptual scheme, the city and the urban environment were analysed and studied through a narrow disciplinary or interdisciplinary prism. In the scientific community of the 20th and 21st centuries, there were discussions conducted regarding the essence of urban theory and the necessary range of objects to be defined. These scientific debates have highlighted the different characterization requirements for cities and urban environments and, in general, their importance in the global environment of economic change. There is no unified consistent concept applicable to the city and the urban environment; however, all existing concepts have common features. For example, the urban environment as the space and place of activity of society, providing the necessary conditions for existence for a certain individual who fits into a certain society, forms it and accepts its rules.

However, it should be concluded that interdisciplinary scientific discussions of the 21st century are of great importance, since the city is considered from the aspects of the environment, politics, legal framework, economics and other points of view. As a result, the diversity of such discussions in the study of the city and the urban environment, by its very nature, accelerates the solution of various issues and integrates a wider range of knowledge into unified concepts. The basis for the development of such concepts is a person, his intellectual abilities and the possibility of their inclusion in various social and economic processes in the urban environment. It should also be noted that interdisciplinary research is complex, which can be justified by the diversity of cities and the changing structure of their constituent urban dimensions. In this case, not only new studies appear, but also new research insights, and the regeneration of old ideas is also possible. More than half of the world's population now lives in urban areas, increasingly in very dense urban areas. The United Nations and the World Bank predict that the proportion of cities around the world will increase in the coming decades, albeit at different rates. By 2050, 68 % of the world's population is projected to live in cities (up from 54 % in 2016).<sup>2</sup>

Therefore, it is important to identify the common features of the dimensions that make up the urban environment without exaggerating the influence of scientific theories on a particular city, since each city and its urban environment is unique in its own way.

---

<sup>2</sup> Ritchie, H., & Roser, M. (2018). Urbanization. Our world in data.

## 1.1. The Synergy Impact on Urban Environment

Each city is unique in its historical and territorial aspects. The urban locus (location) is a theoretical intersection of the territorial settlement (place of residence), socio-communicative (place of interaction) and mental (place of existence) structures. The author of the present Doctoral Thesis considers it necessary to synthesize those problems, as well as those solutions in creating measurements of the urban environment, which were formulated and discussed as the main objectives of the given investigation. Continuing the research, the author of the Thesis touches upon the theme of the synergy and synergy effect as a specific research group that characterizes the changing nature of the urban environment and the city itself.

The management mechanisms of each urban environment require a differentiated approach, which is associated with the peculiarities of their formation and development under the influence of various conditions and factors. Urban sustainability differentiation shows how functional zones or spaces are created. They specialize in certain types of human activity – administrative, financial, cultural, industrial, residential, recreational, agricultural, etc. Currently, for all urban environments, there is a common problem associated with the effective search for innovative products, territorial management and spatial development, as well as the implementation of hidden competitive advantages, which, in turn, would increase the efficiency and profitability of various urban organizations.<sup>3, 4</sup>

Examining this problem, it can be concluded that an approach that takes into account the benefits of synergy can be used in the mechanism for the development of territorial administration and the urban dimension. These benefits are related to economic processes and opportunities for cooperation in the urban environment between society and the public sector.

**Synergy is the interaction of two or more elements of a system that produces a joint effect that is greater than the sum of their individual effects. The additional effect or difference resulting from such an interaction is called synergy or synergistic effect.**

The system may be economical, technical or other. The synergy effect can be both positive and negative. The effect of negative synergy is called dyssynergy, the effect of zero synergy is called asynergy.<sup>5</sup> The search data obtained from the Google Books public bibliographic data service (Ngram Viewer tool) can be seen in Fig. 1.1.

The data show the proportion of occurrences of the term "synergy" in English-language publications, stored worldwide from as early as the 18th century, which have been entered into public electronic databases. The search results include peer-reviewed journal articles, book chapters, and monographs devoted to explaining smart urbanism. Research methods include careful critical reading of texts and structures and comparison of text, images, and diagrams.

---

<sup>3</sup> von Schönfeld, K. C., & Ferreira, A. (2021). Urban planning and european innovation policy: Achieving sustainability, social inclusion, and economic growth? *Sustainability*, 13 (3), 1137.

<sup>4</sup> Kourtit, K. (2021). City intelligence for enhancing urban performance value: a conceptual study on data decomposition in smart cities. *Asia-Pacific Journal of Regional Science*, 5 (1), 191–222.

<sup>5</sup> Plotka, K., Zvirgzdiņš, J., & Geipele, S. (2018). Eco-economics in cities and rural areas. *Baltic Journal of Real Estate Economics and Construction Management*, 6 (1), 88–99.



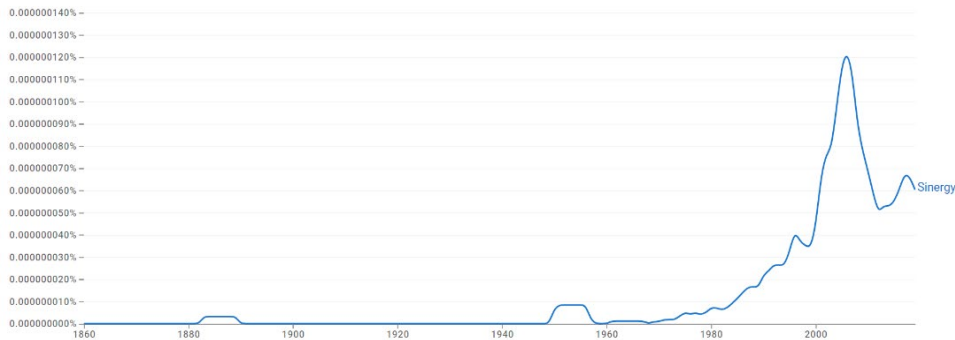


Fig. 1.1. Synergy – number of mentions of the term in literary sources of the 18th–21st centuries (screenshot from "Google Books Ngram Viewer" 21.06.2021).

The synergy allows to achieve a greater effect without using additional resources. It can be concluded that the main feature of the synergetic approach, unlike other methodological approaches, is that such a solution is based on quantitative indicators and assessments and includes an analysis of the dimensions of the urban environment and the already existing characteristics of the urban environment. Elements included in it, in order to obtain a synergistic effect of additional development of the urban environment are based on existing innovations and sources of growth. Sustainable cities and urban sustainability are defined in different ways and are characterized by criteria applicable to many areas according to the specific conditions and needs of cities.

The sustainable urban development is most often defined as a balance between the three main dimensions of sustainability, for example, ICLEI (Local Governments for Sustainability) states that "sustainable cities work to create ecologically, socially and economically healthy and sustainable habitats for existing populations without compromising the ability to future generations to experience the same."<sup>6, 7, 8</sup>

Therefore, it is necessary to include the fourth dimension – the institutional dimension. Such sustainable urban development can be understood as a synergistic relationship between environmental, social, economic and institutional factors in each respective city.<sup>9, 10</sup> In addition to these dimensions, there is also a "cultural dimension" to sustainability in the literature.<sup>11, 12, 13</sup>

<sup>6</sup>Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental impact assessment review*, 32 (1), 94–106.

<sup>7</sup>Tanguay, G. A., Rajaonson, J., Lefebvre, J. F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. *Ecological indicators*, 10 (2), 407–418.

<sup>8</sup>Michalina, D., Mederly, P., Diefenbacher, H., & Held, B. (2021). Sustainable urban development: A review of urban sustainability indicator frameworks. *Sustainability*, 13 (16), 9348

<sup>9</sup>Nováček, P., & Mederly, P. (2015). How to Measure Progress Towards Quality and Sustainability of Life? *Ekologia*, 34 (1), 7.

<sup>10</sup>Dahl, A. L. (2018). Contributions to the evolving theory and practice of indicators of sustainability. In *Routledge handbook of sustainability indicators* (pp. 42–58). Routledge

<sup>11</sup>Angel, H. F., & Zimmermann, F. M. (2016). Nachhaltigkeit–(fast) reine Glaubenssache. In *Nachhaltigkeit wofür?* (pp. 257–283). Springer Spektrum, Berlin, Heidelberg.

<sup>12</sup>Tanguay, G. A., Rajaonson, J., Lefebvre, J. F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. *Ecological indicators*, 10 (2), 407–418.

<sup>13</sup>Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental impact assessment review*, 32 (1), 94–106.

The author of the Doctoral Thesis considers the usage of the advantages of synergy and the investigation of the synergistic properties of the urban environment, as well as the search for mechanisms for sustainable territorial management and the development of the urban environment as the most important tasks of modern scientific research.

## **1.2. The Importance of Human Capital and Creativity in Urban Environment**

The founder of the modern theory of human capital, the 1979 Nobel Prize winner T. Schultz, stated: "The concept of capital is based on something that really exists, that has the economic property of providing future services of a certain value. Understanding the capital as something that provides future services allows us to further divide the whole into two parts". T. Schultz integrates the concept of human capital into several issues:

- "Human capital" – a source of additional income, which is created with the help of knowledge, skills, and abilities of a person.
- Education is one of the types of capital, which is an important factor that ensures economic growth and the availability of certain sources of growth.
- Educational capital is human capital because it cannot be separated from a person.
- To improve the quality of the workforce, it is necessary to increase the investment in education.
- Education as capital is a source of future satisfaction and/or income.
- Education is one of the value-added investments in production factors.<sup>14</sup>

To determine a broader definition of human capital, given by the famous American economist T. Schultz, it is proposed to include in human capital the totality of all the most valuable and useful human qualities. From this interpretation of human capital, several principles follow, highlighted by the author of the Doctoral Thesis:

- Human capital can be considered a determining factor in the growth of economic efficiency and growth of the national economics, in terms of gross macroeconomic indicators of national accounts.
- Human capital can be considered as a determining factor in the growth of economic efficiency and growth of the national economics, in terms of gross macroeconomic indicators of national accounts.
- The question of the nature of the value and usefulness of the quality of human capital is still relevant.

T. Schultz wrote: "All human abilities are innate or acquired. Each person is born with an individual set of genes that determine his innate abilities. Valuable qualities acquired by a person, which can be strengthened by appropriate investments, we call human capital. It should be noted that the owners who have acquired and strengthened valuable human qualities can be used not only in business, but also in other areas. In this case, the question arises about the relationship between the value characteristics of the individual and human capital. From the

---

<sup>14</sup> Schultz, T. W. (1993). The economic importance of human capital in modernization. *Education economics*, 1 (1), 13–19.

point of view of economic theory, capital as a whole has long been understood as value that creates added value as a result of the use of production factors.”<sup>15</sup>

In accordance with the scientific opinions collected by the author of the dissertation, several components of intellectual capital can be distinguished (Fig. 1.2), which play a decisive role in the life of modern urban society. This is due to the fact that the cities of the world are entering a new stage of development<sup>16</sup>, which is based on a knowledge-intensive economics, under the influence of which innovations are formed. The innovative urban economics is based on the use of exchanges of intellectual capital, which is a resource for its development.

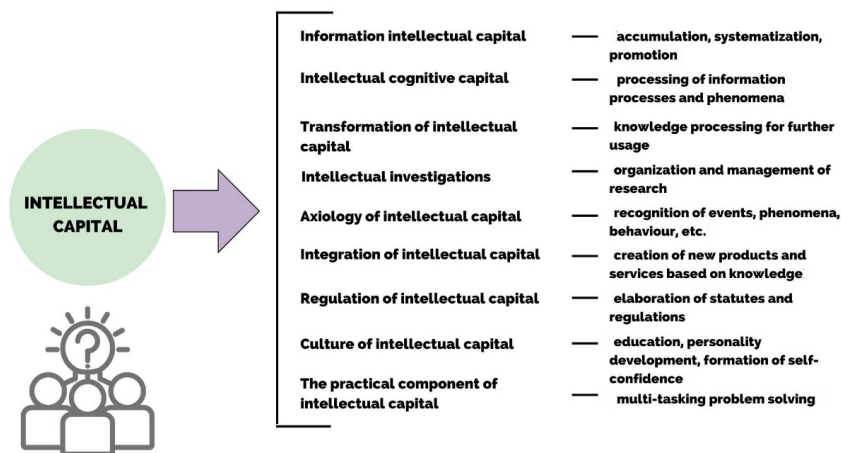


Fig. 1.2. Components of human intellectual capital (compiled by the author based on<sup>17, 18, 19</sup>).

On the one hand, intellectual capital is an important factor of production and a significant resource of economic activity, on the other hand, it acts as an independent object of economic and managerial relations. At the level of the urban environment, the ability to create and effectively use intellectual capital is becoming one of the main factors determining the economic potential and competitive advantages of the urban environment, as well as competitiveness in the rapidly changing market for goods and services in the city. This way, the development of theoretical and methodological tools in an intelligent urban environment and their application in the activities of business entities is an effective way to improve management mechanisms in the process of transition to a sustainable urban economics. Considering the results of analysis, nine components and their functions were formulated, which relate to the intellectual capital of a person (Fig. 1.2). According to the author of the

<sup>15</sup> Schultz, T. W. (1980). *Investment in People. The Economics of population Quality/Theodore William Shultz*. –Berkeley.

<sup>16</sup> Lombardi, P., Giordano, P., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, 25 (2), 137–149.

<sup>17</sup> Luthy, D. H. (1998, August). Intellectual capital and its measurement. In *Proceedings of the Asian Pacific Interdisciplinary Research in Accounting Conference (APIRA), Osaka, Japan* (pp. 16–17).

<sup>18</sup> Мельников, О. Н. (2002). Анализ современной трактовки и использования понятия «интеллектуальный капитал организации». *Российское предпринимательство*, (4), 107–112.

<sup>19</sup> Тесленко, И. Б., Коваленко, С. Ю., & Савельев, И. И. (2014). *Интеллектуальный капитал и инновационное развитие региона: монография*. “Scientific magazine” Kontsep.

Doctoral Thesis, the development of the components of an individual's intellectual capital depends on the desire of each individual to grow intellectually as personality.

It is necessary to conclude that in an urban environment, human abilities can be defined as a set of realized and unrealized abilities of members of society for higher, creative activity at the place of residence or in the adjacent space. The need to transform labour resources stems from the post-industrial features of the socio-economic development of the information industry into management systems at all levels, the creativity of business processes. Intellectual capital, as a philosophical and economic category, includes the absolute nature of the property rights of individuals or legal entities, which are reflected in the results of intellectual activity. Intellectual capital, as a philosophical and economic category, includes the absolute nature of the property rights of individuals or legal entities, which are reflected in the results of intellectual activity. In the future, this can be expressed as long-term relationships based on the restriction of the rights of individuals or legal entities, which are facilitated by the results of human intellectual activity and have intellectual presence, innovation, originality, industrial applicability, and efficiency, allowing to carry out revolutionary scientific and technical activities. They must be connected with the principles of the creative product of labour and universality, which are intertwined in an organic connection with all the branches of production involved.

The growing interest in smart city programs in recent years is also reflected in the scientific literature and investigations on the smart cities. It should be concluded that a smart city is an innovative urban ecosystem characterized by the widespread use of technology in the management of its resources. It is an urban model in which human-AI communication is the source of sustainable development of the system, and the ICT network infrastructure is used to improve the efficiency of economic and political processes, as well as to promote social, cultural and urban development. Technological solutions are just one of several urban resources aimed at improving the economic, social, human and environmental sustainability of the city. This way, the cities that are better equipped with ICT systems do not necessarily represent the urban environment in which people want to live in. The urban environment should be a place where people can enjoy life and everyday work using their full potential and creativity. So, smart cities are the product of a new generation intellectual mind peculiarities, according to those there are a balance of technological infrastructure with factors such as social engagement, citizen empowerment, and human interaction in physical and virtual environments.

The author of the Doctoral Thesis has analysed the opinions of experts and offers the characteristics of an intelligent city, dividing them into three layers: the physical space of the city; innovation and technology; digital space (Fig. 1.4).

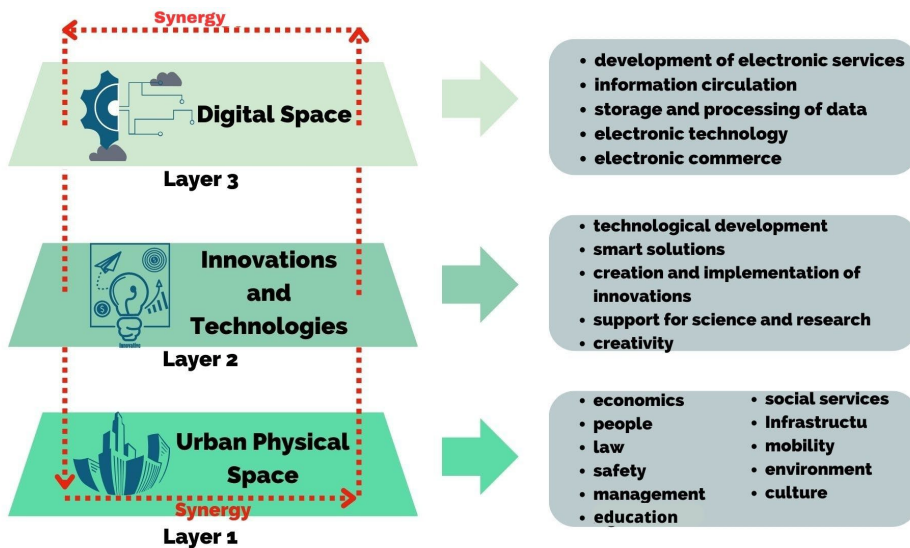


Fig. 1.4. Layers and features of the intelligent urban environment (created by the author – novelty).

The proportionality of the physical space of the city and the individual is its correspondence with the city and the correspondence of the city with the individual, a type of relationship where its proportionality acts as an integrating factor that unites the city and the person into a kind of integrity. Urban space gives every individual the direction of his existence, closely related to the economics, justice, security, education, governance, social services, infrastructure, mobility, environment and culture of this space. Urban space is a measure of the development of the essential forces of a person – activity, sociability, subjectivity and patience – which determines the basis or the first layer of an intellectual city. An individual as an active being in the city finds a sphere of expression of his activity, but in the intellectual urban environment it is associated with innovation and technology, or the second layer, where technological development, smart decisions, adoption and implementation of innovations, support for science and research, and promotion of creativity are formed.

This way, an individual is forced to adapt to the city according to its meaning or leave it. An integral part of the smart urban environment is also the digital space in which there is artificial intelligence embedded in the physical environment of the city in the form of a public broadband infrastructure, wired or wireless, as well as digital technologies and applications that provide electronic services in the urban environment. This is the third layer of an intelligent urban environment, characterized by the following features: data storage and processing; information exchange and speed; development of electronic services; electronic technologies and e-commerce. An individual as a social being acquires a social circle and, accordingly, the opportunity to partially comprehend his life through the lives of others and accept the synergy that can arise between the layers of the intellectual urban environment and affect its features. In the 2nd part of the Doctoral Thesis, an analysis of theoretical measurements and concepts of the development of the city and the urban environment are provided, which determines the limitations of the research: the analysed timeline is from the 50s of the 20th century until the

beginning of the 21st century. The author of the Thesis analyses the changes in the paradigm discourse in the urban environment, as well as the characteristics of the urban space and its development, guided by the approaches of various concepts and methods. In the given research the author uses a systematic literature review method combined with bibliometric analysis to identify relevant articles and key research areas on the topics of smart urbanism, synergy and sustainability, as well as the *VOS viewer* software.

## 2. THEORETICAL MEASUREMENTS OF THE CITY AND URBAN ENVIRONMENT

### 2.1. Conceptual Basis for Urban Development

During the industrial revolution of the 19th century the most advanced countries developed on the basis of the growth of intellectual capital. They were also followed by the expansion of cities and the boom in their sprawl. It culminated in the industrialization of the conveyor belt industry, which influenced the urban sprawl in the United States and Western Europe. The 19th century faced the development of business, administrative and resource functions in the countries of Asia, Latin America and Africa, which were often the basis of the actions of colonial administrators in thinking about economic, geographical and other types of growth.

Later, especially in the 20th to the mid-19th century, some cities in developing countries expanded due to the development of industrialization promoted by the government. Consequently, the importance of cities in the capitalist countries continued to grow on the basis of the growth of production. In the 20th century, at the beginning and in the middle, urban analysis was dominated by a certain ideology of American urban sociologists, which was based on the theories of scientists from the Chicago School of Sociology, such as Robert Ezra Park,<sup>20</sup> Louis Wirth<sup>21</sup> and Harvey Warren Zorbaugh,<sup>22</sup> who presented an analysis of the environmental impact and variability of cities and socially differentiated neighbourhoods in their study.

However, in the late 1950s and early 1960s, the ideas of the Chicago School began to be sharply criticized. This was especially addressed by the Spanish sociologist Manuel Castells and Francis Godard,<sup>23, 24</sup> who argued in his works that the conceptual ideas considered by the urbanists of the Chicago School of Sociology are related to questions about society as a whole but are not sufficient to describe the components and dimensions that make up the city. He later retracted his deep criticism of the Chicago School of Sociology, stating that there was no ideology in these theories.

In the period from 1960 to 1970, the main orientations of the ideas of the Chicago School of Sociology were blurred in the discussions of subsequent researchers, which allowed the approach of Marxist ideas to appear in them. French sociologist, Marxist philosopher Henri Lefebvre<sup>25</sup> and British researcher David W. Harvey<sup>26</sup> championed the theoretical concept of the city as a site of class struggle centred on the distribution of land, labour, production and capital expressed in terms of the political issues involved. It can be concluded that, according to the typical city dweller of the time, the lower class should be granted greater civil rights to urban space and resources than the upper class.

---

<sup>20</sup> Park, R. E., Burgess E. W., and McKenzie R D. (1925) "The city."

<sup>21</sup> Wirth, L. (1938) Urbanism as a way of life. *American Journal of Sociology* 44.1, 1–24.

<sup>22</sup> Zorbaugh, H. W. (1983). *The gold coast and the slum: A sociological study of Chicago's near north side*. University of Chicago Press.

<sup>23</sup> Castells, M., & Godard, F. (2017). *Monopolville: Analyse des rapports entre l'entreprise, l'État et l'urbain à partir d'une enquête sur la croissance industrielle et urbaine de la région de Dunkerque (Vol. 6)*. Walter de Gruyter GmbH & Co KG.

<sup>24</sup> Castells, M. (1968). Y at-il une sociologie urbaine. *Sociologie du travail*, 10 (1), 72–90.

<sup>25</sup> Lefebvre, H. (1970) *La révolution urbaine*. Gallimard, Paris. 248 p.

<sup>26</sup> Harvey, D. (1973) *Social justice and the city*. Edward Arnold, London.

Since the 1970s, many cities have developed in such a way that job distribution and low wages have affected cities, urban areas, regions and countries around the world, often causing major socioeconomic crises. Slow growth began in the 1970s when the urban environment of metropolitan areas was once again subjected to massive reconstruction and restructuring.

The intensification of international integration since the late 1970s has also contributed to a significant wave of urbanization in developing countries, where many cities continue to function as important producers of export goods and services to this day. Cities were at the centre of "post-Fordist" economic ideas, characterized by a decisive shift from material-intensive production to the use of various types of high technology in the fields of production, management, logistics, services, design and culture, which developed a new perspective on the possible formation of an intelligent urban environment.

At the end of the last century, digitization gradually increased its influence, and the dynamic development of information technology could not ignore the daily needs of society. As a result, the number of "connected" devices was increasing worldwide, as well as examples of Internet of Things (IoT) applications in economic environments, including energy, industry, housing, agriculture, transportation, healthcare, and more.

The author of the Thesis concludes that in the 21st century, compared to the 20th century, cities are undergoing rapid changes. The practice and research of urban policy makers show that there is some justification for this, given the diverse nature of cities. Its perception changes with each new generation of urbanists. Fragmentation manifests itself in the ever-changing concepts of cities that are widely used in scientific literature and further used in discussions. This indicates consistent attempts to fix the development of a specific spatial or temporal conjuncture in the urban space. There are such urban concepts as "illegal", "monopolistic", "postmodern", "rebellious", "consumer", "entertainment", "classic", "neoliberal", "fragmented", "dual", "digital", "green", "global", "creative" and "SMART cities" (Fig. 2.1).

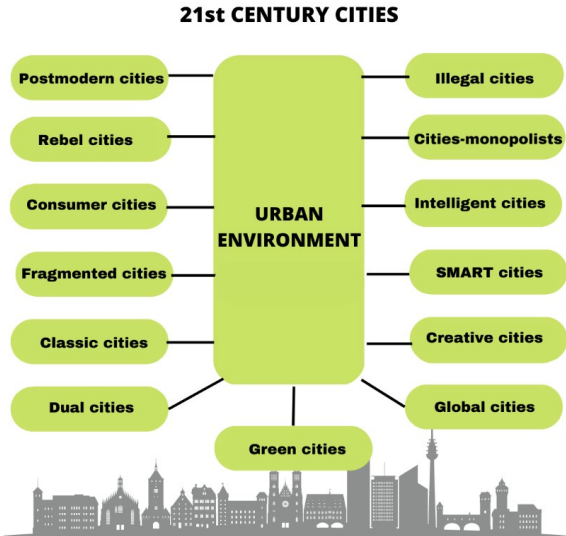


Fig. 2.1. The concepts of cities in the 21st century (created by the author).



Each of the historical concepts contributed to the development of methods of urban analysis, showing that the integration of processes in the urban environment draws a special attention to the discussion and representation of public interests. The author of the Thesis comes to the conclusion that the diversity of urban concepts and paradigms, as well as discussions, is due to the fact that theoretical approaches really help to illuminate and not complicate the study of the characteristics of individual cities or their groups in order to form a diversity of opinions. In the 21st century, the concepts of cities are scattered and based mainly on the specifics of urban activities, which complicates the process of creating a single definition of the city.

## **2.2. Bibliometric Analysis of Smart Urbanism and Synergy**

The author's study of synergy and sustainability in the circumstances of intelligent urban environment has been elaborated on the basis of analysis of the special literature that includes several interdisciplinary areas of the present research from urban planning and regional planning to urban planning theory. These research vectors are based on quantitative and qualitative data that need to be generalized to assess the directions and results of urban research, but they do not allow determining the perception and value attitudes of an individual towards public space in a smart city. At the global level, the city management may require "smart thinking", the essence of which is the sustainability of decisions made and the effectiveness of cooperation between people living in the city.

The effective usage of positive synergies strengthens the existing components of the urban environment or creates new components that improve the quality processes in the existing urban environment, developing the economic potential of cities and territories. Smart city management is built on the basis of various city management models. The scientific approach to research analysis is based on multidisciplinary studies of the impact of urban development on the structure of this environment. The impact of the urban environment is manifested through intellectual creativity, since the main aspect of the impact is the development of the existing social space. At the same time, changing economic, political, technological, security and other aspects requires innovation. During elaboration of the present Doctoral Thesis, the *VOSviewer* software has been used to create collaborative networks. This program has become one of the most reliable and widely used bibliometric tools for measuring and analysing the scientific literature.

To this end, three research questions were identified.

1. What are the most important publications in the scientific literature related to the field of smart urban environment, synergy and sustainability?
2. What is the role of smart urbanism and synergy research in the scientific literature?
3. What are the most important research topics in this area?

To answer these questions, a systematic review was conducted in mid-2022 using the interdisciplinary research database Scopus and Web of Science (WoS).

There are also several other databases that index and archive scientific publications, but the Thesis author chose Scopus and WoS, firstly, because of their reputation for indexing high-quality and peer-reviewed research, and secondly, these two databases provide detailed bibliometric data, information that allows the researcher to obtain more accurate results using bibliometric analysis software. In order to obtain documentary sources and include all research

in the field of smart urbanism, synergy and sustainability, the following search string was created and entered into the above databases:

- TITLE-ABS – KEY ( ( urban AND environment ) AND
- ( intellectual OR ( resilience OR sustainable AND urban ) ) AND synergy ) )

The keyword combinations – "urban" with "environment", "smart" with "synergy", "sustainable" and "urban" with "synergy" or "resilience" and "urban" along with "synergy". It should be noted that the terms "sustainability" and "resilience" are commonly used in documents on environmental and global warming issues. The initial search was carried out without restrictions, i.e. the entire document was considered for terms, not just headings, abstracts, and keywords. A term compatibility analysis was also provided, which showed frequently occurring terms and how they are related to each other. This was used to highlight clusters of the most important subject areas. Each term can have different variations, so before analysis, a keyword variation file was developed and added to the *VOSviewer* database to avoid counting individual synonyms. During the study, it was decided to use only one of the two databases analysed; as a result of which *Scopus* was chosen. The initial search compiled 977 results (Fig. 2.2).

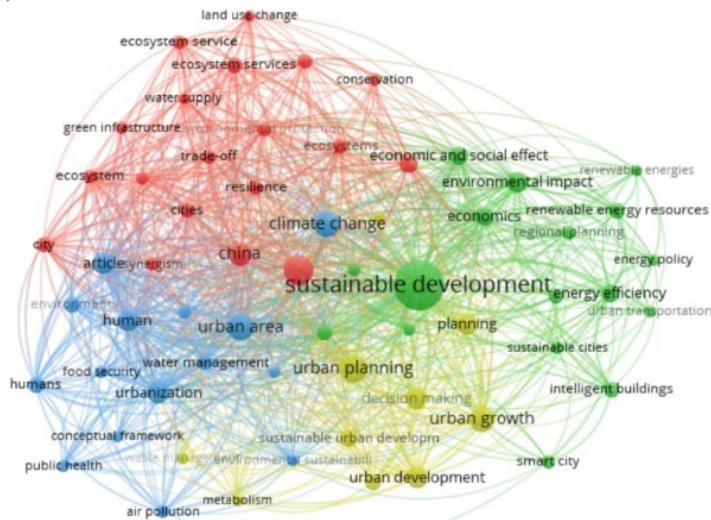


Fig. 2.2. Keyword matching bibliometric map (image created by the author using the *VOSviewer* program based on *Scopus* analytics data).

The present selection was further filtered using exclusion factors and criteria, resulting in 370 papers in social sciences, 112 in arts and humanitarian sciences, 93 in business administration and accounting, 90 in environmental sciences, 54 in engineering sciences, 38 in natural sciences, 30 in computer science, 19 in management science, and 19 in energy science. So, during the work the published peer-reviewed journal articles were considered; books, conference proceedings, working papers, and other irrelevant papers were excluded from the given research. In addition, no time limits were applied and only articles published in English were included. According to these criteria, 179 articles were filtered as a result of demarcation;

after the removal of duplicates, 131 potentially relevant articles were identified. The titles and abstracts of all 131 articles were analysed. By the decision of the author of the Thesis, those that corresponded to the questions posed in the study were determined – 86 documents. The database search was further snowballed (reverse snowballed) for more results.<sup>27</sup> This was followed by an in-depth analysis of the full text of each identified article. After reading the remaining articles, a new area of study has been discovered, namely, articles analysing intelligence, urban environment, synergy and sustainability were identified. As a result, 52 articles were identified that were not within the scope of this study and were therefore excluded from the final selection. The goal of the snowball combination within the database source analysis is to achieve greater accuracy by identifying relevant documents that were not visible in the initial search. And the reasons behind it were either because these documents were not indexed in the database or because the search string did not reach these results.<sup>28</sup> Consequently, the number of articles published between 2008 and 2022 was reduced to 27, which fully answered the research questions, based on the value of the size of the circles, as well as the strength represented by the ratio of the lines. In recent years, the ideas of a safe and sustainable environment have been increasingly included in urban planning and design practices, as well as in national security and energy policy. This has happened especially in light of the threat of climate change and the security concerns that many cities are currently facing. Coaffee explored how synergy is possible between safety, environmental and policy issues related to building planning, design and environmental impact, so that further integration between these areas is possible.<sup>29</sup> In bibliometric references, there is no direct coincidence of the research topic with the research topic of the author of the present Doctoral Thesis. It should be concluded that changes in the urban environment are one of the most pressing problems in the 21st century. An adaptive urban governance is a continuous problem-solving process that explores and revisits the dynamics of institutional and environmental change relevant to the dissertation research. A bibliometric map of the match of all keywords and their increase in popularity over time can be seen in Fig. 2.3, where it can be seen that the most popular keywords in recent years are "smart city", "water supply", "human", "ecosystem", "urban sprawl".

---

<sup>27</sup> Wohlin, C. (2014, May). Guidelines for snowballing in systematic literature studies and a replication in software engineering. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering* (pp. 1–10).

<sup>28</sup> Andrade, A. D. N., Nepomuceno, B., Xavier, D. S., Lima, E., Gonzalez, I., Santos, J. C., ... & Gomes Neto, M. (2020). Evidence-based Physiotherapy and Functionality in Adult and Pediatric patients with COVID-19. *Journal of Human Growth and Development*, 30 (1), 148–155

<sup>29</sup> Coaffee, J. (2008). Risk, resilience, and environmentally sustainable cities. *Energy Policy*, 36(12), 4633–4638

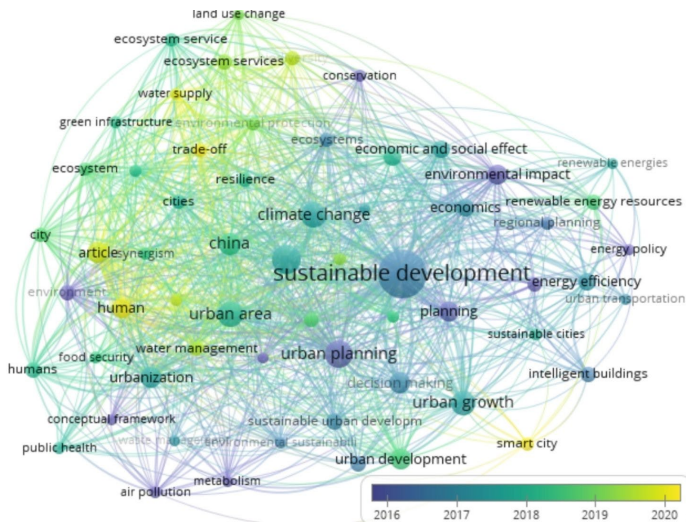


Fig. 2.3. Bibliometric map of all keyword matches and growth over time (image created by the author using *VOSviewer* based on Scopus analytics data).

At this phase it is necessary to conclude that there is bibliometric data showing keywords that are relevant to PhD research, but there is no direct correspondence between them because they are all also found in other research, for example, sustainability, energy, environment, but the measurement of synergy effect depends on the area of study. The Doctoral Thesis research includes keywords taken from several interdisciplinary branches of science. The usage of the advantages of synergy and studying the synergistic properties of the urban environment, in search of mechanisms for sustainable territorial management and the development of the urban environment, are mandatory for the elaboration of the Doctoral Thesis.

This way, the traditional reviews are necessary for a detailed understanding of research areas, they are not always useful for clarifying changes in the rapid pace of scientific publications, especially in popular areas such as sustainability, synergy or urban development. Such a problem can be partially solved by means of scientific mapping and bibliometric analysis methods, which allow to gather together the necessary characteristic of the general structure of knowledge and trends using advanced text analysis methods.<sup>30</sup> So, this why it can be stated that the investigation of bibliometric analysis can complement systematic literature reviews.

In the 21st century, by combining several concepts of the city, the concept of an intelligent urban environment has been created. It is based on public security and stability, which, in their turn, are based on the growth of economics. The intelligent urban environment is based on the dialogue and cooperation of government authorities by means of modern technologies. Intelligent city management is the division of multi-level functions into a single strategic network that combines various development factors into a single system controlled by smart intelligence. The author of the present Doctoral Thesis presents an image of the intelligent urban environment and its various dimensions (Fig. 2.4). It includes four dimensions and six interconnected environments.

<sup>30</sup> Sharifi, A. (2021). Urban sustainability assessment: An overview and bibliometric analysis. *Ecological Indicators*, 121, 107102.

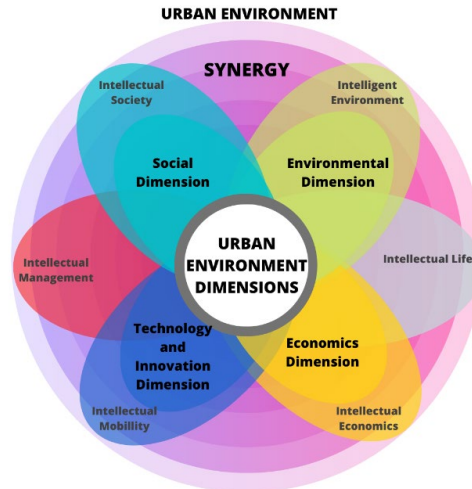


Fig. 2.4. Urban environment and its dimensions (created by the author).

The author of the Thesis draws a conclusion that the foundation of the intellectual urban environment is mainly influenced by historical conditions and economic activities in the urban space. Historical events create a situation where a particular region or country possess the necessary skills, conditions and means to create and develop the overall dimensions of the city (environmental, economic, technological and innovative, social).

The formation of cooperation of measurement data in a certain space can also be caused by a change in the demand of the region, the emergence of certain types of activities, as well as the formation of cooperation groups of new companies and other participants based on the elements of an intelligent urban environment, such as education, culture, health, safety, etc. The process of forming an intelligent urban environment cannot be created in a short time. Historical factors can influence the formation of a new urban space; the availability of labour resources and proximity to other spaces are also the main historical conditions that can contribute to urban change. In addition, third parties can act as initiators, such as universities, companies and other organizations that have the ability to attract investment to develop the formation of new companies.

The given research concluded that the processes taking place in the urban environment are developing; there are open discussions, and over time, there is a need to make appropriate additions or corrections to the terminology, which would facilitate practical work, implementation of the concepts and definitions proposed in this study in assessing the urban environment at different levels of city management. This may serve as the basis for a new interdisciplinary study. Urban planning is the design and regulation of the use of urban space, which is based on the physical image of the urban environment (architecture and construction), economic and social functions, as well as the placement of several objects in urban space. Urban planning includes the development of unused lands (spaces), as well as the revitalization and restoration of existing parts and factors of the urban environment. Any object, especially one as complex as a city, cannot be described from one point of view. The author of the Thesis comes to the conclusion that when creating a definition of an intelligent urban environment, different points of view should be taken into account in order to avoid a single vision; each representation must go through a process of generalization and conceptualization. As a result,

different perspectives and conceptual representations of a smart urban environment can be obtained, which are necessary for the formation of a system concept. This method ended when all involved specialists were satisfied with the achieved result. Experts knew the thoughts of other participants on topical issues to lead a discussion. As part of the Delphi method, the Hegelian principle of idea generation "thesis – antithesis – synthesis" is followed, as specialists reflect in their forecasts, ideas or solutions and create new, more complete conclusions. The author offers an updated definition of the concept of urban environment: "Urban environment is the environment of the existence of subjects, natural objects and anthropogenic factors in a certain space, which as a result of synergy creates an innovative system with initial properties that the subject or object does not possess separately".

In the 3rd part of the present Doctoral Thesis, the author assesses the level of competence of urban environment experts and checks their reliability, using the methods used in the decision-making process, through an in-depth study of the Analytical Hierarchical Process (AIP) and conditions or expert assessments and the laws. The author will present the DSCS urban sprawl matrix, 11 postulates of an intelligent urban environment, and analyse the assessments of experts on the problems of the urban environment.

### 3. INTELLIGENT ASSESSMENT METHODOLOGY OF THE URBAN ENVIRONMENT FOR ITS SUSTAINABLE DEVELOPMENT

The Author of the Thesis has elaborated the urban sprawl matrix DSCS, deciphering its abbreviation as follows: Degrading, Stagnant, Creative and Sustainable, or the urban sprawl matrix.

The Smart City Matrix is a tool that can be used in urban planning strategies to determine the synergistic potential of sustainability and intellectual capital, to analyse the urban environment based on two variables: the relative share of urban intellectual capital and the growth rate of financial investments (Fig. 3.1)

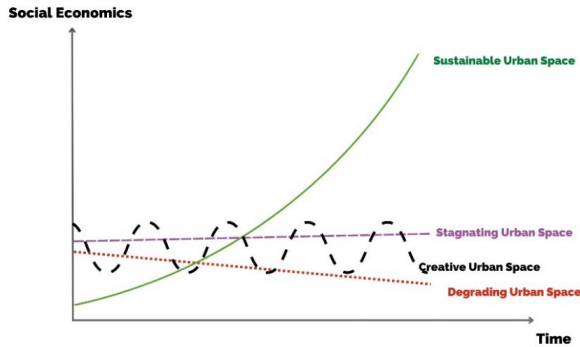


Fig. 3.1. Synergetic process of sustainability and capital in urban space models (created by the author).

By means of combining the relative share of urban intellectual capital and the growth rate of sustainable development in the matrix, stakeholders can properly represent their urban spaces, which will require an increase in the capacity of intellectual capital or the development of impactful innovations, allocating additional (financial) resources, to which environment to provide additional funding and where to give up because it has reached a steady growth rate (Fig. 3.2).

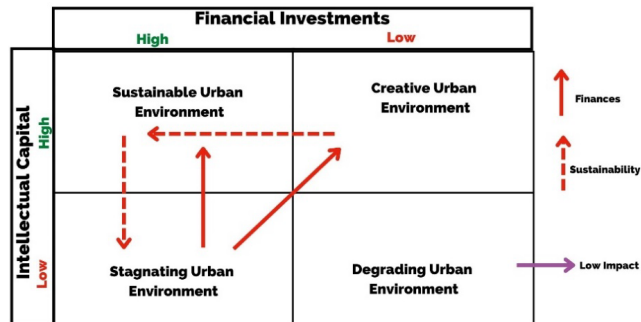


Fig 3.2. Functional representation of DSCS or urban sprawl matrix (created by the author).

The urban social economics can be described as a paradigm in which economic analysis is provided, including elements such as community and values. The main purpose of the urban sprawl matrix is to make decisions about the possibilities of supporting intellectual capital, stimulating them with additional financial investments. Depending on how important sustainability is, each urban space can be included in one of the following categories:

- degrading;
- stagnating;
- creative;
- sustainable.

Further, the author analyses each of the four categories of the intellectual urban environment.

**The “Degrading urban environment” category.** The share of intellectual capital is small; the architecture of the urban environment is a legacy of previous generations, the cultural environment is formed through the experience of previous generations, which is adopted by the new generation; there is practically no interest in sustainable development; lack of social initiatives; the volume of private financial investments is not more than 10 %, the rest of the investments are formed at the expense of tax revenues from the state and local governments, which is affected by the share of employees. The capital is used to maintain the existing urban environment at the current level. The borders of the urban ecosystem are not taken into consideration. It is characterized by a constant decrease in the population, there is a high level of committed suicides.

**The “Stagnating urban environment” category.** Broad leadership penetrating the private and public sectors; social initiatives are capitalized; intellectual capital is not developed; sustainable development is based on the principle of capitalization (sustainable development is planned as a source of acquiring and attracting capital); the volume of private financial investments exceeds 50 %. Capital is used for the needs of the interests of certain social groups. The positive experience of other cities in creating a sustainable development policy is borrowed, the level of implementation is stagnating. The boundaries of the urban ecosystem are set in proportion to financial goals. Characteristic signs of stratification of the population and conservative snobbery.

**The “Creative urban environment” category.** Bright, creative and thinking individuals; clearly articulated political and social goals; broad leadership and public-private cooperation; broad social initiatives; private investments with a high degree of risk for third parties; creative intellectual potential is supported by grants and philanthropy. Capital is used for creative purposes determined by society. The integration of creative thinking is used in planning the processes of analysis and development. This approach contributes to the transition of the urban environment from standard solutions to creative solutions that are able to diversify the sustainable activities of the urban environment in order to attract financial investment. The share of creative capital exceeds financial capital. Sustainable development occurs with the integration and popularization of creative thinking in society, the education and improvement of the creative perception of individuals so that they can take leadership initiative in solving managerial issues. The boundaries of the urban ecosystem are determined by the availability of capital. Characterized by a stable proportion of the population in the urban space.



**The “Sustainable urban environment” category.** High availability of resources in the urban space, which contributes to entrepreneurship, the formation of clusters, the availability of skilled labour, which reduces the time of labour integration into the urban environment. The basic principles of sustainable development are respected, smart and sustainable urban development are intertwined so that future generations can provide for their needs in a fair and equitable manner, without violating the boundaries of the urban ecosystem. There is an equal distribution of intellectual and financial capital. Capital investments are distributed equally among the interests of a sustainable society.

Further, each of these urban measurements will be considered in detail and information provided on how to use the DSCS matrix. It is necessary to conclude that in the matrix system it is assumed that as a result of the relative sprawl of intellectual capital, the capacity of the intellectual environment of space increases and a synergy effect is formed between dimensions, which can be both positive and negative. Each of the dimensional spaces gains sustainability advantages over other urban environments, or there is a possibility of losing these sustainability advantages over adjacent urban dimensions (Fig. 3.3).

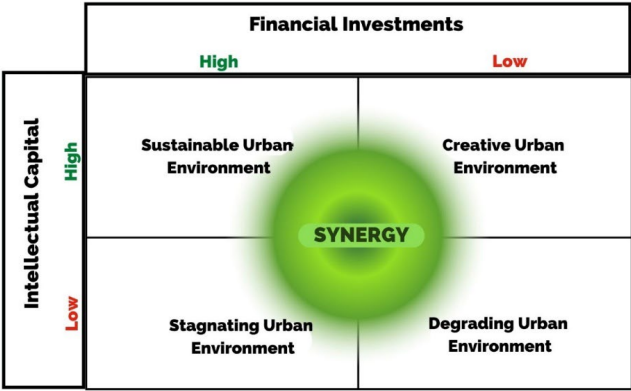


Fig. 3.3. DSCS urban sprawl matrix under the influence of synergy (created by the author, novelty).

Intellectual capital is used to increase the attractiveness of the urban environment. Cities are looking forward to achieve sustainability quickly in order to develop effective innovations, as they promise long-term returns on investment. However, the drawback is that the dimensions with fast growing properties will require additional investments to ensure sustainable urban sprawl.

Creative urban environments are associated with growth opportunities for intellectual capital, or have the potential to acquire and move into the sustainability phase. Providing the effective management of intellectual capital, financial investments will increase, which will allow the development of new solutions and make it possible to move to the next phase of the development of the urban environment.

If a stagnating urban environment fails to attract new intellectual capital, it can achieve maximum return on financial investment and existing sustainability, and a situation may arise where the urban environment falls into the category of long-term stagnation, which can lead to its measurement to go into a degrading phase, since financial resources invested in the long

term were used inefficiently, not contributing to capital appreciation and sustainability. In the case of a stagnant urban environment, through the investment of financial resources, synergy can create both a creative and degrading urban environment.

The spheres of influence of intellectual capital and investments are associated with the cultural and historical identity of each urban environment, which, in turn, is associated with aspects of the cultural perception of the individual and third parties. The sustainability of financial investments depends on the level of human perception of the urban environment. In each of these environments, a person has his own inner beliefs, worldview and view of the world. There are people for whom they are limited, and for others they are wide.

Any urban policy depends on creative thinking, which in the context of urban planning means studying, analysing and solving urban problems in a given space. Intellectual capital is able to create social initiatives and attract private investment, creating close links between economic and socially beneficial urban projects. By selecting and integrating intellectual capital (its representatives) into each of the four urban environments, new ways of thinking can be achieved.

The development of such an urban environment means not only the creation of a sustainable system for managing the urban environment, but also the education, improvement and development of society in this urban space, striving for sustainability. Conditions are being created for people with creative thinking and perception who are able to take the lead in managing this urban environment. Intellectual capital creates a platform for possible sustainable growth and development without breaking the ties with previous generations living in cities whose experience can contribute to the degradation of the urban environment. AHP-analysis was performed on the matrix of city categories created by the author of the present Doctoral Thesis in order to assess the adequacy of the theoretical model for categorizing the urban environment by the share of intellectual capital investment in real conditions that in every city and society can have the potential to make it sustainable. Analysing the factors of financial and intellectual capital, the author comes to the conclusion that they are arranged in an expert assessment similar to the DSCS matrix developed during the research (Fig. 3.5).

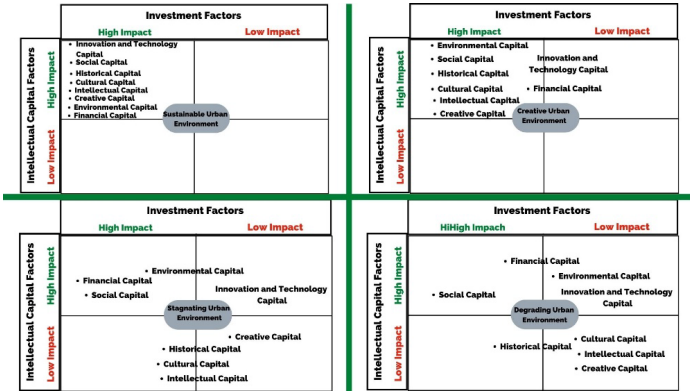


Fig. 3.5. Compilation of indicators of financial and intellectual capital in the categories of the urban environment (compiled by the author, novelty).

The stagnant urban environment has sufficient financial but low intellectual capital. According to the assessment of experts, four factors in a stagnant urban environment had a

medium impact (two related to investment capital, two to intellectual capital factors); one intellectual capital factor and one financial capital factor had a low effect, one investment capital factor had a high effect.

**The creative urban environment** has insufficient financial, but sufficient intellectual capital. According to the assessment of experts, two factors in a stagnant urban environment received a medium impact (by law, both are considered investment capital factors); two factors of investment capital received a high influence, three of the four factors of intellectual capital received a very high influence.

**A sustainable urban environment** has sufficient financial and intellectual capital. According to the assessment of experts, all factors of investment capital and two factors of intellectual capital will have a very high impact in such an urban environment, while the other two factors of intellectual capital were rated as high.

**In a degrading urban environment**, according to the matrix created by the author of the dissertation, there is low financial and low intellectual capital. According to the assessment of experts on the matrix of T. Saaty, five factors of the degrading urban environment had a low impact (two related to investment capital, three to the factors of intellectual capital); two factors had a medium influence (one – investment capital, one – an intellectual capital factor); one factor of investment capital had a high influence.

It is necessary to conclude that the creation of management and development mechanisms based on a synergistic approach will make it possible to understand the role and essence of the phenomena and processes taking place in the city. By creating possible new components for the development of the urban environment, as well as optimizing and rationalizing the system for their implementation, it is possible to improve the infrastructure to ensure economic growth and create a sustainable urban environment. As a result of the joint impact of synergy sources, it is possible to increase the efficiency of the socio-economic development of the urban environment through the implementation of sustainable development politics.

The city of the 21st century is a multifunctional system with various subsystems: trade, transport, communications and information technology, water supply, energy supply, education and culture, healthcare, etc. As the urban dimensions increase, so does the load on these subsystems. As a result of the analysis of the urban environment, the Author of the present Doctoral Thesis proposes 11 postulates of the intelligent urban environment (basic principle, basic assumption, which is usually determined in the field of practice), which are essential components in the process of forming the synergy effect in the intelligent urban environment (Fig. 3.5). The research shows that the need for safety and comfort in the urban environment is increasing.<sup>31, 32, 33, 34</sup> There are new technologies and knowledge to reduce, neutralize, prevent or eliminate potential threats, as well as the necessary competencies in the field of new and innovative urban planning.

---

<sup>31</sup> Wijekoon, N. (2020). Assessing visual impacts of roadscape installations on urban safety and comfort in Galle Road, Colombo (Doctoral dissertation).

<sup>32</sup> Sarkar, S. (2003). Qualitative evaluation of comfort needs in urban walkways in major activity centers. *Transportation Quarterly*, 57 (4), 39–59.

<sup>33</sup> Kübler, D., & de Maillard, J. (2022). Why European mayors emphasize urban security: Evidence from a survey in 28 European countries. *European Journal of Criminology*, 19 (4), 712–729.

<sup>34</sup> Virta, S. (2013). Governing urban security in Finland: Towards the ‘European model’. *European journal of criminology*, 10 (3), 341–353.



Fig. 3.5. Postulates of the intellectual urban environment (created by the author, novelty).

**Postulate 1.** Balancing the human and urban environment with nature, where the focus is on using the new resources as little as it is possible in the environment, encouraging the usage of more of the recycled resources, because once the point of no return is reached, the use of natural resources will exceed the natural capacity of the ecosystem to regenerate. This postulate provides for the creation and analysis of environmental assessments to identify vulnerable areas, endangered ecosystems and habitats that can be preserved through operational monitoring of environmental impacts, land use planning and design of open spaces in the urban environment. This postulate leads to the development of a way of life in which consumed resources will be replaced by renewable or reusable resources, creating a balance between the environment and human activities. The author comes to the conclusion that such a balance can be achieved if people and society are informed about global environmental problems and their impact on the urban environment and the ecosystem of the planet as a whole.

**Postulate 2.** Balance of the urban environment with the cultural environment and traditions. It is implemented with the aim of integrating different urban environments, both belonging to different social strata of society and cultural values present in different urban spaces, while respecting the traditions and stylistic precedents of a given space and group. Urban planning decisions must be rooted in tradition and balanced with future possibilities, for example by protecting, promoting and preserving the components and elements of urban space that bear witness to unique inherited knowledge, culture, signs and symbols expressed through art, space and urban architecture. The author comes to the conclusion that this urban planning principle requires respect for the historical and cultural heritage of the place

**Postulate 3.** Urban environment of technology and innovation. The presence of appropriate innovative technologies highlights and demonstrates the use of building materials, construction methods, architectural and infrastructure systems and design solutions that are appropriate for a specific urban context. The intellectual and physical capabilities of people, climatic conditions, local resources and capital investments – all are also a component of technology.

Places with a large number of employed professionals have a high potential for urban innovation. Urban change offers a range of potential technological and innovative solutions that can be successfully exploited. To prevent this, funds are invested in an information space that encourages public participation and creates discussion among stakeholders. City managers would benefit from conducting a survey to get the opinion of citizens before introducing innovations that affect society.

**Postulate 4.** Collaboration, interaction and community. It promotes social interaction both at the macro level (which will be the urban space and the community living in it) and at the level of households and individuals. Collaborative communities are interactive, socially engaging and offer many opportunities for their members to gather and meet, which is typical of socially active urban spaces. They provide a place for individuals, friendships, social and interest groups, neighbourhoods and city branding. The sense of community includes spirit, character, image and pride and is an essential element of a healthy urban environment. Collaboration and interaction create positive synergies based on open connection to new opportunities that build valuable relationships and give the city dweller a heightened sense of belonging as a result of positive synergy.

**Postulate 5.** Efficiency. This promotes a balance between the consumption of resources (such as energy, time, and finances) and advances in comfort, safety, property, productivity, and hygiene. It promotes optimal sharing of roads, facilities, services and infrastructure networks, reducing the cost of each household while increasing the affordability of their products and services. The main problem with this postulate is related to the transport sector. Good urban planning practices encourage the development of alternative modes of transport, rather than dependence on personal vehicles, and promote an efficient urban infrastructure system that provides services at an affordable price for every citizen. The author of the Thesis concludes that an efficient urban environment is aimed at multifunctional development, reducing the need for people to move long distances. This environment has increased the importance of the availability of mobility options in the urban environment. Mobility incorporated into an efficient transport system can optimize travel time and reduce pressure on the urban environment. The opportunity for micromobility participants to choose different modes of transport is an additional comfort that the urban environment offers.

**Postulate 6.** Human – space. It promotes human-centered urban spatial development.

The human-space principle supports direct human interaction with urban space, providing for green spaces, walking and cycling paths, and freely accessible spaces where people can meet and socialize. The planning and management of urban green spaces is an important factor influencing urban space, as it brings significant benefits to people. The author of the study concludes that the importance of diversity in the choice of green areas in the urban environment for human health and well-being is undeniable, but it is difficult to ensure it. Given the rapid urbanization that can cause environmental problems, sustainable urban development is needed. One solution is to create compact green corridors or lanes, then such urban greening is possible to some extent, but requires careful planning and a well thought out knowledge base on how a limited green space can provide basic ecosystem services. It is difficult to prevent the formation of unsustainable urban areas devoid of green spaces. Therefore, highly qualified urban planners should be involved in the sustainable development of the urban environment, taking into account both environmental characteristics and the vision of development.

**Postulate 7.** Urban environment as an opportunity for personal growth. City as an engine of the growth of economics, city as an effective collection of knowledge, skills and competencies. This principle considers the city as a means of personal, social and economic development providing access to various organizations, services, facilities and information, which, in turn, provides various opportunities for a more efficient labour market, economy, education and recreation. This guiding principle aims to increase access to housing, health care and human resource development, as well as to improve safety and hygiene conditions. The city is seen as a system of processes and opportunities. However, they are unevenly distributed. Security, health care, education, housing, hygiene, employment are not equally accessible to all social groups of the population. The author of the present Doctoral Thesis comes to the conclusion that the basis of such an urban environment is a person whose development is closely related to the opportunities provided by the environment. Such competition is facilitated by the general desires of society and the understanding of growth.

**Postulate 8.** Regional integration. It portrays the city as an organic part of a larger ecological, socio-economic, cultural, and geographical system. Regional integration is based on the possibilities of mergers and exchanges. The economic essence of such integration is to enable the territories adjacent to the city to achieve competitiveness at the regional level. Each city should use its advantages to export goods and introduce advanced technologies, which are the basis for increasing market competition. Regional integration can also take place between environments within a city. The author of the Doctoral Thesis concludes that regional integration appears in the 21st century as an alternative that will allow the cities and urban areas of the region to overcome the resource crisis by creating dynamic economic relations, cooperation, and respect for solidarity. Such an integration process should be seen as part of the transition to a reasonable and sustainable alternative model of production and consumption, transforming the existing boundaries of integration and the boundaries of the development model in the urban environment.

**Postulate 9.** Balanced traffic. An integrated transport system is supported in the urban environment, including a balanced distribution of modes of transport. This principle accepts the private car system, but it should not be made an integral part of the city. A well-planned urban environment should be dense and intense along public transport corridors and around major city transport hubs, while at the same time serving as convenient and accessible access to city services, while remaining as uncluttered as possible in the central part of the city. It should be concluded that the process of measuring and integrating balanced traffic in urban areas is important for understanding the environmental, economic and social processes that stimulate the further development of urban space.

**Postulate 10.** Institutional integrity. This main principle emphasizes that good practice can only be implemented with responsible, transparent, competent and accountable local government based on appropriate rights and obligations, civil liability and appropriate legal and administrative rules. The institutional structure can only work if there is a strategy or equivalent mechanism that acts as a legal instrument for the sprawl, development and improvement of the city. It defines, for example, how urban space will be used and maintained and how access rights to it will be secured. In the urban environment, the strategic goal is to provide owners and investors with predictable scenarios for future development, there should be a system for the participation of stakeholders in the preparation of plans, certain communication guidelines. There must be appropriate legislation establishing legitimate local governments and

empowering them to operate, administer, invest, maintain, protect, promote and promote urban development. It is emphasized that the city's local self-government bodies are professionally managed. In this context, it contributes to the development of institutional frameworks that improve transparency, accountability and sound public decision-making. The author of the present Doctoral Thesis concludes that the institutions of the urban public sector depend on political processes, procedures and guidelines that determine the necessary actions to build integrity. However, organizational and institutional culture can influence and determine process performance and improvement. Such principled leadership includes both formal and informal tools that are developed and implemented through ethical leadership and organizational culture that can directly or indirectly influence people in the urban environment. Some of these ethical principles conflict with others, or the general interest may conflict with the private interests of those who perform public functions (their own interests or those of third parties). People in the urban environment need to be able to explain the impact of institutional integrity on the urban environment and the individual.

**Postulate 11.** Urban synergy. It is based on the idea of the superiority of the overall benefit of the postulates listed above in comparison with the contribution of each individual postulate.

In the economics and sustainability of the urban environment, the intellectual abilities of people are of great importance, which are associated with a creative and important assessment of the potential of a cluster of creative and cultural industries.<sup>35</sup> This can be analysed using the level of employment in the cluster or urban area compared to the overall level in the city, as well as the growth rate of employment in the cluster compared to employment in the urban economics, and the share of the cluster product in the city's total value added generated by the urban economics. To invest in the development of a creative city and a new economic approach, it is necessary to evaluate the usefulness of the economics of clusters in a particular area. All cluster formations benefit from the localization effect – the presence of other formations in the urban environment benefits all organizations when using common or similar intermediate factors of production, as well as when using the creativity of the workforce.

Considering the all mentioned above, it can be concluded that the network of the urban environment, formed on the basis of a cluster of creative and cultural industries, can contribute to the emergence of new factors for the long-term development of the urban environment, since they are places where creative resources are accumulated and capitalized, the attractiveness of which can stop the outflow of young people from the city in the future and facilitate the influx of new specialists from other cities. The intensity of cultural activity contributes to the recognition of the region, the urban environment and its creative resources in foreign markets. It increases competition in domestic markets, attracts tangible and intangible flows (e.g. tourists, capital), and increases the demand for increased economic activity. The growth of activity of economics in the field of creativity and the cultural industry provides a certain structural shift in the economics – the transition to a higher technological level. Various city strategies often become the founding manifesto of social and economic politics and are often not implemented or delayed indefinitely. The strategies perform two important management functions:

---

<sup>35</sup> Plotka, K., Viržbickis, J. Kultūras un kreativitātes ietekme uz pilsētas ekonomiku. No: Nekustamais īpašums un ekonomikas attīstība: zinātnes un prakses sinerģija. S. Geipele, R. Kočanova red. Rīga: RTU Izdevniecība, 2019. 114.–135. lpp. ISBN 978-9934-22-230-6. e-ISBN 978-9934-22-231-3. Pieejams: doi:10.7250/9789934222313.06.

1. By means of them, one city development scenario is selected that is optimal from the point of view of urban society and is taking into account the available resources and capabilities of a particular city.
2. The development of the guidelines contained and described in the action plan should serve as a description of the actions to be taken, which enable the city to implement the chosen scenario for the development and management of the urban environment.

The presence of a strategy serves as a factor in the investment attractiveness of the city. The presence of an urban environment development plan favourably influences the choice of investors and thus increases the assessment of the investment climate. The strategy gives the city community the opportunity to consolidate in solving the most important city problems. Each of the social forces of the city occupies a certain place in the performance of tasks:

- Executive bodies of local self-government create the existence of a regulatory and legal framework that ensures the implementation of strategies (planning processes related to the socio-economic development of the city) and target programs of the city.
- Entrepreneurship supports the development of local self-government, creation of jobs, implementation of investment projects, participation in urban social programs, etc.
- Residents' active participation in the life of the city, influencing the local territorial structure, law-abidingness, patriotism, raising the personal standard of living.

The author of the present Doctoral Thesis concludes that the presence of a strategy cannot fully cover all areas of development of the urban environment, it indicates the most important or necessary ways to move forward to achieve the strategic goals of the city.



## CONCLUSIONS AND RECOMMENDATIONS

During the elaboration of the present Doctoral Thesis, the theoretical aspects of the processes of urban sprawl and the urban environment were investigated and analysed, the essential problems were identified, and factors affecting the dimensions of the urban environment and their sustainable development were analysed. The present Doctoral Thesis explores the synergy effect and proposes a city sprawl matrix for DSCS. It can be used in urban planning strategies to analyse the urban environment based on two variables: the relative share of urban intellectual capital and the growth rate of financial investment. The Doctoral Thesis assesses the projection of the cluster of creative and cultural industries and its strategic potential. The author of the Doctoral Thesis proposes to use two approaches in assessing the potential of a creative and cultural industrial cluster. The definition and analysis of the cumulative cluster can be used by both cultural policy makers (in policy planning and analysis of the ministry of culture and its subordinate institutions) and consumers of culture. The second approach is related to the assessment of the potential impact of the creative and cultural cluster, which is based on the assessment of the socio-economic effect of the development of the creative and cultural sector of the cluster in a smart urban environment. Its purpose will be to assess the existing cluster or identify the possibility of its formation and to determine the vision of cultural policy while developing a sustainable strategy in the urban environment.

The theoretical conclusions and results of the studies included in the present Doctoral Thesis confirm the fact that the goal of the given Doctoral Thesis is achieved and the hypothesis is confirmed. By studying the scientific literature and analysing the data obtained during surveys and focus groups, it is proved that with an increase in the influence of human intelligence on the urban environment dimensions a positive synergy effect arises.

The author of the Thesis has summed up the results of the study and formulated the main conclusions and the proposals arising from them.

1. Interdisciplinary scientific discussions of the 21st century are of great importance, since the city is analysed and considered interdisciplinary – from environmental, political, legal foundations, economics and other aspects. The variety of such discussions in urban studies and the urban environment significantly accelerates the solution of various issues and integrates a wider range of knowledge into general concepts. The basis for the development of such concepts is an individual, his intellectual abilities and the possibility of their inclusion in various social and economic processes in the urban environment. Functions in the urban system are becoming more and more differentiated, processes are becoming more complex and can be interpreted ambiguously, which makes it possible to create the synergy.
2. The processes taking place in the urban environment are developing, open discussions are being established, and over time, there is a need to make appropriate additions or corrections to the terminology that would facilitate the practical implementation of the concepts and definitions proposed in this study and the assessment of the state of the urban environment at different levels of city management. This way, they can serve as a basis for new interdisciplinary research.
3. The mechanisms for managing the urban environment require the use of a differentiated approach related to the peculiarities of their formation and development under the influence of various conditions and factors. An approach that takes into account the benefits of

synergy can be used when developing aspects of territorial governance and the urban environment. They are related to economic processes and opportunities for public sector cooperation in the urban environment.

4. In the urban environment there is an increasing focus on human input, which is interpreted as creative thinking that not only directly provides economic and sustainable benefits, but also creates cooperation and communication between the internal and external governance structures of the city.
5. In an urban organization, the need for human intelligence must be identified and clearly defined in order to create an intelligent urban environment. The higher the level of knowledge, the smarter becomes the urban environment, while in the organization of the city and the urban environment more importance is given to the interactive interaction of human intelligence and technology.
6. Smart city governance is an open and democratic form of ethical space governance that ensures the right to information, fairness, sustainability, safety and accountability in collaborative building using technology and the human mind. Smart cities are based on natural human intelligence, with smart city management partially open as it uses artificial intelligence to engage the population through ICT and the Internet of Things (IoT) for efficient resource and asset management.
7. The development and formation of the urban environment is influenced by the desire of organizations at the national, regional and local levels to integrate into it. In European cities initiatives are being implemented in cooperation with local residents and members of non-governmental organizations.
8. The intellectual capital of the urban environment and its components are the basis of new growth of economics. The intellectual components are difficult to measure, they are related to the quality of the intangible assets of the urban environment and the economics and are also focused on future processes expected in the economics.
9. Urban development means not only the creation of a sustainable urban management system, but also the education, improvement and development of society in the urban space, striving for sustainability. Thus, the necessary prerequisites for the sustainability of the urban environment are created while determining both the required volume of attracting resources and their consumption in order to create conditions for the arrival in the cities of people with creative thinking and perception able to take leadership in a certain urban environment.
10. The creation of synergistic mechanisms for management and development will allow to reach a deeper understanding of the role and nature of the phenomena and processes taking place in the city, to create possible new components for the development of the urban environment, as well as optimize and rationalize them. By implementing the system, infrastructure can be improved. This will ensure economic growth and the creation of a sustainable urban environment. As a result of the joint impact of synergy sources, it is possible to increase the efficiency of the socio-economic development of the urban environment through the implementation of sustainable development policies.
11. Urban space open to technology and innovation is able to transform and adapt to global changes and requirements. Globalization can also create inconsistencies in urban space under the influence of which technologies and innovations may not be accepted and used.

12. Social entrepreneurship plays an important role in solving social, economic and environmental problems in the urban environment, as it simultaneously contributes to the growth of society, shared prosperity and social inclusion.

Taking into consideration all the conclusions made during the elaboration of the present Doctoral Thesis, the author suggests several proposals for assessing the impact of sustainability methods and the synergy effect of the intelligent urban environment. The proposals for responsible ministries, municipalities, non-governmental organizations and other social partners involved in the development of the urban environment and sustainable development, in cooperation with each other, can take into account the conclusions set out in the dissertation and implement the proposed offers for responsible ministries of the industry.

For the **Ministry of Environmental Protection and Regional Development**, which forms the sectoral policy in the field of environmental protection and nature, regional development and digital transformation management:

- To improve and refine the concept of the urban environment and its definition to promote a common understanding among policy makers and implementers.
- To find an opportunity to assess cities and their urban environment, analyse the development of each dimension and its position in the urban environment, identify weaknesses, pursue a balanced investment and development policy in order to create an urban environment in which all dimensions are strong both as individual units and in general, the shared benefit would enable faster growth and development, both economically, intellectually and sustainably.
- Availability and accessibility of data and information and decision-making based on the results of analysis are important for sustainable policy.

Considering the research provided during the Doctoral Thesis elaboration and clarification of concepts, a refined definition of concepts is proposed according to the analysed tasks: “The urban environment is the environment for the existence of subjects, natural objects and anthropogenic factors in a certain space, which, as a result of synergy, creates an innovative system with original properties that the subject or an object in isolation do not poss.”

Sustainable development is increasingly used as a basis for stimulating economic growth while maintaining environmental components, as well as the social and cultural balance of the territory in the urban environment. To maintain a balance, the availability and accessibility of data and information and decision-making based on the results of the analysis are important.

To the **Ministry of Culture** in order to create a cohesive society:

- To find the possibility of using the methods of identification and analysis of cumulative clusters in the formation of sectoral policy in order to assess the potential of existing creative clusters and identify the possibility of new clusters.
- To develop a sustainable strategy for the vision of cultural policy implemented in cooperation with cities and their communities, so that positive synergies are formed in the urban environment.
- To accept the fact that the development of cultural and leisure sectors using urban infrastructure is identified as one of the possible political and economic drivers that should attract smart and sustainable solutions.

To the **Ministry of Education and Science**:

- May the person, responsible for the education policy, be the one who will be promoting cooperation with municipalities, non-governmental organizations and

other social partners in order to determine the policy for the development of human intellectual potential, taking into account the needs of the dimensions of the urban environment (social, economic and innovation and technology, etc.).

- The cities should have a definite and clearly expressed need for the intellectual potential of a person to create an intelligent urban environment. The higher the level of knowledge, the smarter becomes the urban environment.
- Having investigated the theoretical aspects of synergy in relation to the urban environment, it is proposed to evaluate the human influence in the development of an intellectual urban environment. To achieve this, it is necessary to analyse how often innovations are introduced in the urban environment, the creation of which involves a certain urban community. The purpose of this proposal is the growth of intellectual capital and the formation of positive synergies.

Human creativity and evaluation of this creativity can serve as one of the factors of sustainable development attracting investments that can contribute to the formation of a smart urban environment. On the other hand, the transformation of an intelligent urban environment into a smart urban environment means the integration of several parallel socio-technical processes, which are based on scientific and technological progress, the development of technologies and their implementation in various spheres of life, as well as attracting investment.

**Municipalities, non-governmental organizations** and other social partners involved in the development of the urban environment and sustainability can use the methods and approaches developed in this paper to determine the synergistic potential of sustainability, intellectual capital, as well as analyse the urban environment based on two variables: the relative value of shares urban intellectual capital and the growth rate of financial investments. To create an intelligent and smart urban environment, managing organizations should develop the interactive interaction of human intelligence and technologies, giving priority to natural intelligence and determining the limits of artificial intelligence involvement in the processes of management.

To assess the urban environment within a city, the DSCS urban sprawl matrix is used to analyse the urban environment based on two variables: the relative share of the intellectual capital of the city and the growth rate of financial investments.

The results of the study included in the Thesis prove the need for management mechanisms.

## LIST OF REFERENCES

1. Angel, H. F., & Zimmermann, F. M. (2016). Nachhaltigkeit—(fast) reine Glaubenssache. In Nachhaltigkeit wofür? (pp. 257–283). Springer Spektrum, Berlin, Heidelberg.
2. Castells, M. (1968). Y at-il une sociologie urbaine. *Sociologie du travail*, 10 (1), 72–90.
3. Castells, M., & Godard, F. (2017). *Monopolville: Analyse des rapports entre l'entreprise, l'État et l'urbain à partir d'une enquête sur la croissance industrielle et urbaine de la région de Dunkerque* (Vol. 6). Walter de Gruyter GmbH & Co KG.
4. Dahl, A. L. (2018). Contributions to the evolving theory and practice of indicators of sustainability. In *Routledge handbook of sustainability indicators* (pp. 42–58). Routledge
5. Harvey, D. (1973) *Social justice and the city*. Edward Arnold, London.
6. Hoonweg, D., & Pope, K. (2017). Population predictions for the world's largest cities in the 21st century. *Environment and Urbanization*, 29 (1), 195–216.
7. Kourtit, K. (2021). City intelligence for enhancing urban performance value: a conceptual study on data decomposition in smart cities. *Asia-Pacific Journal of Regional Science*, 5 (1), 191–222.
8. Kübler, D., & de Maillard, J. (2022). Why European mayors emphasize urban security: Evidence from a survey in 28 European countries. *European Journal of Criminology*, 19 (4), 712–729.
9. Lefebvre, H. (1970) *La révolution urbaine*. Gallimard, Paris. 248 p.
10. Luthy, D. H. (1998, August). Intellectual capital and its measurement. In *Proceedings of the Asian Pacific Interdisciplinary Research in Accounting Conference (APIRA)*, Osaka, Japan (pp. 16–17).
11. Michalina, D., Mederly, P., Diefenbacher, H., & Held, B. (2021). Sustainable urban development: A review of urban sustainability indicator frameworks. *Sustainability*, 13 (16), 9348.
12. Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental impact assessment review*, 32 (1), 94–106.
13. Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental impact assessment review*, 32 (1), 94–106.
14. Nováček, P., & Mederly, P. (2015). How to Measure Progress Towards Quality and Sustainability of Life? *Ekologia*, 34 (1), 7.
15. P., Lombardi, S., Giordano, H., Farouh, & Yousef, W. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, 25 (2), 137–149.
16. Park, Robert E., Ernest W. Burgess, and Roderick D. McKenzie. "The city." (1925).
17. Plotka, K., Viržbickis, J. *Kultūras un kreativitātes ietekme uz pilsētas ekonomiku. No: Nekustamais īpašums un ekonomikas attīstība: zinātnes un prakses sinerģija*. S. Geipele, R. Kočanova red. Rīga: RTU Izdevniecība, 2019. 114.–135. lpp. ISBN 978-9934-22-230-6. e-ISBN 978-9934-22-231-3. Pieejams: doi:10.7250/9789934222313.06. (in Latvian)
18. Plotka, K., Zvirgzdiņš, J., & Geipele, S. (2018). Eco-economics in cities and rural areas. *Baltic Journal of Real Estate Economics and Construction Management*, 6 (1), 88–99.
19. Ritchie, H., & Roser, M. (2018). *Urbanization*. Our world in data.
20. Sarkar, S. (2003). Qualitative evaluation of comfort needs in urban walkways in major activity centers. *Transportation Quarterly*, 57 (4), 39–59.
21. Schultz, T. W. (1980). *Investing in People*. The Economics of population Quality/Theodore William Shultz. –Berkeley.
22. Schultz, T. W. (1993). The economic importance of human capital in modernization. *Education economics*, 1 (1), 13–19
23. Tanguay, G. A., Rajaonson, J., Lefebvre, J. F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. *Ecological indicators*, 10 (2), 407–418.
24. Tanguay, G. A., Rajaonson, J., Lefebvre, J. F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. *Ecological indicators*, 10 (2), 407–418.
25. Virta, S. (2013). Governing urban security in Finland: Towards the 'European model'. *European journal of criminology*, 10 (3), 341–353.
26. von Schönfeld, K. C., & Ferreira, A. (2021). Urban planning and European innovation policy: Achieving sustainability, social inclusion, and economic growth? *Sustainability*, 13 (3), 1137.
27. Wijekoon, N. (2020). *Assessing visual impacts of roadscape installations on urban safety and comfort in Galle Road, Colombo* (Doctoral dissertation).
28. Wirth, L. (1938) *Urbanism as a way of life*. *American Journal of Sociology* 44.1, 1–24.
29. Zorbaugh, H. W. (1983). *The gold coast and the slum: A sociological study of Chicago's near north side*. University of Chicago Press.
30. Мельников, О. Н. (2002). Анализ современной трактовки и использования понятия «интеллектуальный капитал организации». *Российское предпринимательство*, (4), 107–112.



**Kaspars Plotka** was born in 1979 in Riga. He received a Bachelor's degree (BA) in Management of Institutions and Organizations from Business Institute RIMPAK Livonia in 2005, and a Master's degree in Economics from Riga Technical University in 2017. He has been a Vice-President of UAB "LLA" (Great Britain) in the Baltic States, member of the Board of "Golden Gates Edelmetalle International" Ltd., Executive Director and Member of the Board of "Protected Noble Metals Baltic" Ltd, and also an adviser and consultant in non-governmental projects in Asia and Eastern Europe. Since 2019, he has been a researcher with the Riga Technical University. His scientific interests are related to the economy of the city, eco-economics, sustainable development issues, management and management policy.