Máté Szilárd Csukás

Corvinus University of Budapest
Doctoral School of Business and Management

Supervisor:
Tamás Mészáros, CSc

© Máté Szilárd Csukás, 2026

Corvinus University of Budapest
Doctoral School of Business and Management
Strategic Management Program

Smart City Development in Practice

Governance, Organizational Design and Strategic Trajectories in Medium-Sized and Central European Cities

DOCTORAL DISSERTATION

Máté Szilárd Csukás

Budapest, 2026

Table of Contents

LIST OF TABLES **8**

LIST OF FIGURES **9**

ACKNOWLEDGEMENTS **11**

1. INTRODUCTION **12**

1.1 Research field, problem and relevance 12
1.2 Research gap and justification 17
1.3 Conceptual boundaries and key terms 24
1.4 Integrative conceptual framework of the dissertation 28
1.5 Overarching research question and article-specific sub-questions 33
1.6 Methodological architecture of the five studies 38
1.7 The five studies: coherence, synergies and difference 44
1.8 Structure of the dissertation 49
1.9 Article portfolio matrix 52

2. FACTORS HINDERING SMART CITY DEVELOPMENTS IN MEDIUM-SIZED CITIES **55**

2.1 Chapter preface 55
2.2 Bibliographic record and author contribution 57
2.3 Introduction 58
2.4 Literature review 59
2.5 Methodology 65
2.6 Porter's Five Forces Framework 66
2.6.1 Bargaining Power of Suppliers *67*
2.6.2 Bargaining Power of Buyers *68*
2.6.3 New Entrants *70*
2.6.4 Industry Rivalry *71*
2.6.5 Substitutes *72*
2.7 Conclusions 72
2.8 Chapter takeaway for the dissertation argument 74

3. CHALLENGES AND SOLUTIONS FOR ORGANIZATIONAL DESIGN IN URBAN DIGITALIZATION **78**

3.1 Chapter preface 78
3.2 Bibliographic record and author contribution 80
3.3 Introduction 81
3.4 Methodology 83
3.5 Results 84
3.5.1 Public organizational barriers *84*
3.5.2 Private organizational barriers *87*

3.5.3 Professional organizational barriers ... *88*
3.6 Discussion of a Proposed Model: Urban Planning Platform ... 90
3.6.1 Platform attributes ... *91*
3.6.2 Overcoming organizational barriers ... *93*
3.7 Conclusion ... 96
3.8 Chapter takeaway for the dissertation argument ... 96

4. THE MANY FACES OF THE SMART CITY: DIFFERING VALUE PROPOSITIONS IN THE ACTIVITY PORTFOLIOS OF NINE CITIES ... 101

4.1 Chapter preface ... 101
4.2 Bibliographic record and author contribution ... 102
4.3 Introduction ... 103
4.4 Literature review and research framework ... 105
4.4.1 Efficiency ... *105*
4.4.2 Citizen (stakeholder) engagement ... *107*
4.4.3 Quality of life ... *109*
4.4.4 Inclusion and equality ... *110*
4.4.5 Connectivity ... *111*
4.4.6 Knowledge creation and sharing ... *112*
4.4.7 Scalability and transferability ... *113*
4.4.8 Environmental impact ... *114*
4.5 Methodology ... 115
4.6 Results ... 118
4.6.1 Descriptive statistics of the anticipated benefits of SC activities in the case study cities ... *118*
4.6.2 Clusters analysis of the anticipated benefits of SC activities in the case study cities ... *119*
4.7 Discussion ... 125
4.8 Limitation, validity and future research ... 129
4.9 Chapter takeaway for the dissertation argument ... 136

5. WHAT ARE THE CONDITIONS TO BECOME SMART? A SYSTEMATIC ANALYSIS OF THE SMART CITY STRATEGY AND DEVELOPMENT ACTIVITIES OF BUDAPEST ... 140

5.1 Chapter preface ... 140
5.2 Bibliographic record and author contribution ... 141
5.3 Introduction ... 142
5.4 Methodology ... 145
5.5 Results ... 146
5.5.1 Dichotomy 1: Technology-Led or Holistic Strategies ... *146*
5.5.2 Dichotomy 2: Top-Down or Bottom-Up Approach ... *148*
5.5.3 Dichotomy 3: Double or Quadruple-Helix Model of Collaboration ... *151*
5.5.4 Dichotomy 4: Mono-dimensional or Integrated Intervention Logic ... *153*
5.6 Discussion ... 154

5.7 Conclusions and Future Research Directions 158
5.8 Limitation and Validity 158
5.9 Chapter takeaway for the dissertation argument 159

6. SMART CITY GOVERNANCE IN A MEDIUM-SIZED EUROPEAN CITY: STRATEGIC DICHOTOMIES AND STAKEHOLDER NETWORKS IN DEBRECEN (HUNGARY) 163

6.1 Chapter preface 163
6.2 Bibliographic record and author contribution 164
6.3 Introduction 165
6.4 Materials and Methods 169
6.4.1 Data Collection and Study Context 169
6.4.2 Coding Approach: Dichotomous Strategy Dimensions 170
6.4.3 Network Construction and Analysis 172
6.5 Results 173
6.5.1 Strategic Orientation: Tech-Driven vs. Holistic Balance 173
6.5.2 Governance Mode: Top-Down City Leadership vs. Bottom-Up Initiatives 175
6.5.3 Collaboration Model: Stakeholder Participation and Quadruple-Helix Analysis 177
6.5.4 Multidimensional Project Portfolio: Domains and Integration 181
6.5.5 Application-domain profiles 184
6.5.6 Spatial scale of initiatives (City, District, Building, Home) 186
6.6 Discussion 188
6.7 Limitations and future research directions 192
6.8 Conclusions 192
6.9 Chapter takeaway for the dissertation argument 194

7. INTEGRATIVE CONCLUSION 199

7.1 Synthesis of results across the five studies 199
7.2 Consistency, differences and interpretation of results 206
7.3 Scientific novelty and theoretical contribution 211
7.4 Managerial, policy and urban governance implications 215
7.5 Limitations 222
7.6 Future research directions 226

REFERENCES 230

APPENDICES 253

Appendix B. List of Abbreviations 254
Appendix C. Glossary of Key Terms 255
Appendix D. References of publications of the author 257

List of Tables

Table 1 Article portfolio matrix of the dissertation. 52

Table 2 Existing definition of Smart Cities with the author's interpretation 62

Table 3 Summary of identified barriers 73

Table 4 Public Organizational Barriers 86

Table 5 Private Organizational Barriers 88

Table 6 Professional Organizational Barriers 89

Table 7 Generic Organizational Barriers 90

Table 8 Breakdown of value proposition components of SC solutions, with references 120

Table 9 Demonstrated and emerging excellence of case study cities. 122

Table 10 Descriptive statistics of value proposition components in case study cities. 123

Table 11 Status of the reported SC activities in the case study cities 123

Table 12 Spatial level of the reported SC activities in the case study cities. 123

Table 13 Literature review across anticipated SC benefits 133

Table 14 The four dichotomies of SC research and the divergent strategic principles 144

List of Figures

Figure 1 Integrative conceptual framework of the dissertation..... 33

Figure 2 Search terms are ‘Smart City’ or ‘Smart Cities’ in the keywords of all types of documents. Source: Own edition based on Scopus Database. 58

Figure 3 Main focus areas of Smart City definitions 60

Figure 4 Distribution of publications from different academic fields..... 61

Figure 5 Mapping of existing Smart and Sustainable City frameworks and models..... 64

Figure 6 Overview of sampled cities..... 65

Figure 7 Application of Porter's Five Forces Model on Smart Cities 67

Figure 8 SmartCEPS Platform Layers (Source: own edition) 91

Figure 9 High-level platform architecture with stakeholder relations 92

Figure 10 Design features overcoming public barriers 94

Figure 11 Design features overcoming private barriers 95

Figure 12 Design features overcoming professional barriers..... 95

Figure 13 Design features overcoming generic barriers 96

Figure 14 Case study cities sampled in the analysis. 117

Figure 15 Influence of value proposition components on the clusters (created and exported from IBM SPSS Statistics 25)..... 124

Figure 16 Distribution of clusters across years with most occurrences 128

Figure 17 Distribution of clusters across the case study cities in the dataset..... 129

Figure 18 Principle Component Analysis (PCA) of case study cities and clusters (created and exported from IBM SPSS Statistics 25). 129

Figure 19 Cities across years focusing on environmental sustainability goals 130

Figure 20 Cities across years focusing on QoL applications 131

Figure 21 Cities across years focusing on social impacts. 131

Figure 22 Cities across years focusing on citizen engagement..... 131

Figure 23 Budapest’s SC development strategy: Number of activities by category (own edition) 147

Figure 24 SC development activities of Budapest: Distribution of activities by groups of categories (own edition) 147

Figure 25 Share of public Hungarian organisations, based on their spatial level (own edition) 150

Figure 26 Organisations by quadruple-helix type in Budapest's SC development activities (own edition) 152

Figure 27 The SC development ecosystem of Budapest's strategy (own edition) 153

Figure 28 Budapest's SC development strategy: Activities by application domain (own edition) 154

Figure 29 Debrecen's smart city development strategy: number of initiatives by category (A–D) 174

Figure 30 Collaboration network of Debrecen's smart city actors (nodes coloured by type: red = government, green = industry, blue = research, orange = civil; node size proportional to number of projects; edge thickness proportional to number of shared projects). 177

Figure 31 Debrecen Smart City Ecosystem – Organisations by Helix Category 178

Figure 32 Debrecen smart city initiatives by domain 183

Figure 33 Debrecen Category C ("Services and Applications") initiatives by application domain (C.01–C.12). 185

Figure 34 Debrecen smart city initiatives by spatial level (n = 120). 187

Figure 35 Integrated layers of the dissertation's results 200

Figure 36 Managerial, policy and urban governance implications of the dissertation 218

Acknowledgements

I would like to express my sincere gratitude to all those who supported me throughout my doctoral journey. First and foremost, I am deeply grateful to my previous supervisor and co-author, **Szabó Zsolt Roland**, Ph.D., for the mentorship, guidance, and knowledge he shared with me over the years. His support played a defining role in my academic development.

My sincere thanks go to my current supervisor, **Tamás Mészáros**, CSc, for kindly accepting me as his PhD student and for helping me bring my doctoral studies to completion. I am particularly grateful for his support, professional experience, and the benefit of his longstanding academic network. I am also especially thankful to Lilla Hortoványi, PhD for her support during my studies and for the inspiring research programmes in which I had the opportunity to participate.

I would also like to thank Borbála Szüle, PhD for her quantitative methodological support and György Pataki, PhD for his qualitative methodological support during my studies. I am grateful to Nikolett Deutsch, PhD, Szabó Lajos György, PhD, and György Drótos, PhD for their support in the Strategic Management specialisation. My thanks also go to Gábor Michalkó, DSc and Zsuzsa Krista for their administrative support from the doctoral office, especially during the period when I had to suspend my studies for a year. I am thankful to my fellow doctoral students and to the staff of the doctoral office for their collegiality, encouragement, and support throughout these years.

I would also like to sincerely thank my former employer, DBH Group, and my current employer, FIER Sustainable Mobility, for supporting my academic aspirations throughout my doctoral journey. Their encouragement, flexibility, and understanding helped me balance professional and academic commitments, and their support contributed significantly to the successful completion of my studies and this dissertation.

I owe my deepest gratitude to my parents for their unwavering support, encouragement, and love, which gave me the strength to complete this journey. I am equally grateful to my partner for the patience, care, and support that helped me finish my studies. Finally, I would like to remember with love and gratitude my grandmothers, who strongly wished for me to complete my studies and to see me at the award ceremony. Their faith in me remained a lasting source of motivation.

1. Introduction

1.1 Research field, problem and relevance

The smart city has become one of the most visible and contested paradigms of contemporary urban development. Over the past two decades, it has evolved from a largely technology-oriented discourse into a broader field that connects digitalization, sustainability, urban governance, innovation, and quality of life. Early smart city narratives frequently emphasized information and communication technologies, urban data infrastructures, and the optimization of services and physical systems. At the same time, a growing body of scholarship has criticized narrowly techno-centric interpretations and has argued for more holistic understandings that include institutional capacity, citizen engagement, social inclusion, and the public value of digital transformation (Angelidou, 2016; Bibri and Krogstie, 2020; Hollands, 2008; Kitchin, 2015). In this sense, the smart city is not simply a label for the application of advanced technologies in urban environments. Rather, it is a field of competing visions about how cities should organize innovation, govern transitions, and align digital tools with broader economic, environmental, and social objectives.

The relevance of this field is closely related to wider structural pressures on cities. Urban areas concentrate population, infrastructure, production, environmental burdens, and governance responsibilities at an unprecedented scale. As a result, cities are expected to address multiple, intertwined challenges, including climate transition, mobility, energy efficiency, public service modernization, social cohesion, and economic competitiveness. Smart city agendas emerged partly as a response to these pressures, promising that digital technologies, data-informed decision-making, and integrated urban management could improve the performance of city systems and the everyday lives of residents (Caragliu et al., 2011; Giffinger et al., 2007; Manville et al., 2014). Yet the field has also matured to the point where such promises can no longer be taken at face value. The central question is no longer whether cities should become “smart” in some generic sense, but under what institutional, strategic, and organizational conditions digital urban development can produce meaningful and equitable outcomes.

This dissertation is situated precisely within that shift. It starts from the observation that the smart city field has produced a large amount of conceptual work, policy discourse, benchmarking exercises, and technology-led experimentation, but much less cumulative knowledge about how smart city development is actually organized and governed in

specific urban contexts. The literature has established that smart city strategies may differ along several critical dimensions, including technology-driven versus holistic development, top-down versus bottom-up governance, narrower public-private collaboration versus broader multi-stakeholder cooperation, and fragmented versus integrated implementation logics (Deakin and Reid, 2018; Komninos and Mora, 2018; Mora et al., 2019; Mora and Bolici, 2017). However, the empirical implications of these distinctions are still unevenly understood, especially when one moves away from the most visible and highly resourced metropolitan cases.

This is where the problem context of medium-sized cities becomes especially important. Much of the smart city literature and many of the best-known practical examples have focused on capital cities, global cities, or flagship projects with unusually strong administrative, financial, technological, and branding capacities. These cities have played an important role in shaping the discourse, but they have also skewed it. Their experiences are often implicitly generalized, even though they operate under conditions that are not typical for the wider European urban landscape. By contrast, medium-sized cities form a far more common category of urban settlement in Europe, yet they tend to work with thinner organizational capacity, more limited financial room for experimentation, less in-house technological expertise, and greater dependence on external funding programmes, suppliers, and inter-organizational cooperation (Desdemoustier et al., 2019; Giffinger et al., 2007; Manville et al., 2014). For this reason, medium-sized cities are not a marginal subtopic within smart city research. They represent a crucial setting for understanding how smart urban development functions under more typical, more constrained, and often more transferable conditions.

The medium-sized-city focus is also important because it reveals that the obstacles to becoming smart are not only technological. Earlier smart city research often suggested that the main challenge lay in the adoption of digital infrastructure, data systems, or specific solutions. However, evidence increasingly indicates that the deeper barriers are frequently organizational and governance-related. Medium-sized cities may face shortages of expertise, data limitations, weak standards, path dependencies in procurement, and strong dependence on external vendors. They may also struggle with fragmented internal structures, insufficient coordination mechanisms, limited stakeholder engagement, and the absence of dedicated institutional arrangements capable of translating strategy into coherent implementation. In this respect, smart city development

must be understood not merely as the deployment of technologies, but as a problem of organizing collective action across sectors, departments, and stakeholder groups (Ruhlandt, 2018; Sepasgozar et al., 2019; Sørensen and Torfing, 2018). The governance dimension is therefore central to this dissertation. Smart city development is frequently discussed as if digital tools, platforms, and innovations would automatically produce better cities. Yet in practice, their effects depend on who defines priorities, who controls resources, how collaboration is structured, which actors are included or excluded, and whether city governments are capable of integrating technological initiatives into broader development objectives. Governance matters because digitalization changes not only the instruments of urban management, but also the institutional relationships through which urban change is planned and delivered. Questions of municipal leadership, interdepartmental coordination, public-private partnerships, academic involvement, civic participation, and stakeholder networks are therefore not secondary implementation issues. They are constitutive elements of what smart city development becomes in reality.

A related reason for the dissertation's relevance is the Central and Eastern European context. Although the smart city concept has diffused widely across Europe, its uptake has been uneven, and the empirical literature remains heavily weighted toward Western and Northern European examples, along with a smaller number of globally branded cases. Hungarian and broader Central and Eastern European cities have received much less attention in systematic smart city research, even though they operate in institutional environments that make the conditions of smart transition especially visible. In these settings, smart city development often unfolds under stronger fiscal constraints, more uneven local capacities, layered governance structures, and a more fragile relationship between strategic ambition and implementation capability. The Hungarian cases examined in this dissertation show that the question is not simply whether a city has adopted the smart city label, but whether it has built the strategic, organizational, and governance conditions necessary for meaningful transition.

This regional dimension strengthens both the theoretical and practical relevance of the dissertation. Theoretically, it challenges the tendency to derive general conclusions from exceptional cities. Empirically, it contributes to a still limited body of systematic evidence on smart city development in Central and Eastern Europe. Practically, it offers insights for cities that are unlikely to replicate the institutional density or investment power of major flagship cases, but still face strong expectations to digitalize, decarbonize,

innovate, and modernize urban governance. In this sense, the dissertation speaks not only to debates about what smart cities are, but also to the more consequential question of how cities with constrained capacities can pursue smart development in ways that are coherent, context-sensitive, and publicly valuable.

Finally, the field is relevant because smart city development should not be reduced to a matter of urban branding or technical modernization. As the literature increasingly shows, smartness is inseparable from choices about strategic orientation, anticipated public benefits, institutional design, and the distribution of agency among urban actors. Different cities pursue different value propositions through their smart city portfolios: efficiency, quality of life, stakeholder engagement, inclusion, environmental improvement, knowledge creation, or cost reduction may all be emphasized to varying degrees. Understanding these differences requires looking beyond slogans and indicator rankings to the actual activities, governance patterns, and organizational conditions through which smart city development is enacted. This dissertation therefore approaches the research field as one in which strategy, governance, organization, and context jointly determine whether digital urban development remains fragmented and technology-led, or becomes more integrated, reflexive, and responsive to local needs.

For these reasons, the present research is positioned at the intersection of smart city studies, urban governance, and organizational analysis. It treats medium-sized cities not as scaled-down versions of metropolitan pioneers, but as analytically important settings in their own right. It also treats governance and organizational design not as background conditions, but as core explanatory dimensions of smart city development. By doing so, it seeks to contribute to a more empirically grounded and contextually sensitive understanding of how cities, particularly in Central and Eastern Europe, can move from smart city rhetoric toward more coherent forms of urban digital transition.

The evolving smart city field across the study period. Because this dissertation is article-based and its constituent studies were produced over a period of roughly eight years, the smart city field against which they should be read did not stand still. When the earliest study was designed, smart city scholarship was still strongly shaped by the techno-centric and definitional debates that Hollands (2008) had brought to the surface, and by an optimism about digital infrastructure that later proved too narrow. Over the subsequent years the centre of gravity of the field shifted decisively from technology toward governance, strategy, and the social purposes of urban digitalization. Framing the

publications historically at the outset, rather than only in the concluding synthesis, clarifies why the studies emphasize different questions and why their cumulative trajectory mirrors the maturation of the field itself.

A first and pervasive development concerns the **growing centrality of residents' quality of life and the social dimension of smart urban development**. Early smart city discourse tended to treat citizens as data sources or service recipients, but more recent scholarship has reframed quality of life, inclusion, and citizen experience as the proper ends of smart development rather than its by-products. The systematic review by Chang and Smith (2023), for example, shows that the smart city concept did not focus sufficient attention on citizens' quality of life until relatively recently, and that themes such as smart living, participation, social inclusion, and smart urban governance have only lately moved to the centre of the field. This reorientation is directly relevant to the present dissertation, whose value-proposition and governance perspectives anticipate, and now connect to, this more citizen-centred and public-value-oriented turn.

A second development is the **disruptive influence of the COVID-19 pandemic**, which fell in the middle of the study period and reshaped both practice and scholarship. The pandemic accelerated the deployment of digital urban services, data-driven monitoring, and remote public administration, while simultaneously exposing the unevenness of digital capacity across cities and the risks of surveillance-heavy, top-down responses. Sharifi, Khavarian-Garmsir and Kummitha (2021), reviewing 147 studies, document both the contributions of smart city solutions to urban resilience during the crisis and the governance and equity tensions those solutions raised. For a dissertation centred on governance and organizational design, the pandemic matters less as a technological episode than as a stress test of institutional capacity: it reinforced the dissertation's central claim that the decisive conditions of smart city development are organizational and strategic rather than narrowly technological.

A third development concerns the **shifting international geography of smart city research and practice**. When the field emerged, its reference cases were concentrated in Western and Northern Europe, North America, and a small number of globally branded Asian cities. Over the study period the empirical and conceptual centre of gravity broadened, most visibly through the rapid expansion of Chinese smart city scholarship and policy. Zhen et al. (2025) trace the Chinese trajectory through an information-project-driven phase, a holistic development phase, and a collaborative development phase, and

argue, in striking parallel with the present dissertation, that smart city initiatives must move beyond a purely technology-driven framework toward a more human-centred approach. The Chinese experience also illustrates a strongly state-steered, centrally orchestrated model of smart urbanism that differs markedly from the more market- or community-driven models of the West, and that thereby sharpens, by contrast, the questions this dissertation raises about governance and stakeholder configuration in the Central and Eastern European context.

Taken together, these developments mean that the studies in this dissertation should be read as observations taken at different moments of a moving field rather than as synchronous snapshots. This temporal positioning, developed more fully in the integrative conclusion (Section 7.2), is introduced here deliberately, so that each study can be interpreted against the state of the debate at the time it was conducted. Far from weakening the article-based design, this evolving backdrop is one of its strengths: the portfolio captures the field's own movement from broad techno-centric barriers toward governance architecture, strategic differentiation, and citizen-centred public value, and it does so from within the period in which that movement occurred.

1.2 Research gap and justification

Despite the rapid expansion of smart city scholarship, the field continues to be marked by conceptual fragmentation, uneven empirical coverage, and a persistent gap between strategic discourse and implementation-oriented knowledge. One of the most frequently noted problems in the literature is that smart city research has generated a large number of definitions, models, rankings, and normative visions, yet has not converged on an easily adaptable, widely applicable, and robust framework that cities can use under real governance and organizational constraints (Bibri and Krogstie, 2017; Kitchin, 2015; Komninos, 2011). This fragmentation is not merely terminological. It affects how cities are assessed, how strategies are justified, and how urban actors interpret the concept in practice. The 2018 study included in this dissertation already identified the absence of a strong and adaptable model as a central challenge of the field, and argued that heterogeneous assessment frameworks leave cities exposed to partial, biased, or vendor-driven understandings of smart development.

A first major gap, therefore, concerns the **lingering techno-centric bias of the literature**. Although it is now widely acknowledged that smart city development cannot be reduced

to the deployment of ICT-based solutions, much empirical and policy-oriented work continues to privilege visible technologies, infrastructures, and digital services over the institutional and social conditions that make such interventions effective. The organizational design study in this dissertation formulates this problem very clearly: investments in urban digitalization have been slower than expected to deliver meaningful impacts, and the reason is not simply technological immaturity, but the **inability of prevailing organizational arrangements to address complexity**, scalability, and procedural difficulties. It explicitly argues that these challenges cannot be solved through technological innovation alone and that attention must shift toward organizational structures capable of supporting transition (Barns, 2018; Ruhlandt, 2018; Sørensen and Torfing, 2018). The Debrecen study reaches a similar conclusion from a later empirical angle, showing how technology-led modernization can produce highly visible "smartness" while leaving citizen capabilities, participation, and public value creation comparatively weakly embedded in the governance process.

A second gap concerns the **dominance of flagship-city and capital-city perspectives in smart city research**. Many influential empirical studies, benchmarking systems, and comparative syntheses rely disproportionately on large metropolitan examples, global cities, and cities that already enjoy strong administrative, financial, and innovation capacities. As a result, the strategic patterns derived from such cases are often treated as if they were broadly generalizable. Yet this is methodologically problematic, because these cities operate under atypical institutional and resource conditions. The Debrecen study addresses this issue directly by warning that the empirical base used to theorize smart city governance remains uneven and that flagship-city bias distorts understanding of how smart development unfolds under more ordinary European conditions. It further argues that medium-sized cities constitute a more common, but still under-examined, implementation setting, one in which thinner organizational capacity, limited fiscal space, external funding dependence, and lower in-house analytical capability may systematically shape strategic choices. The 2018 article anticipated the same problem from another angle by emphasizing that the European urban landscape is dominated not by megacities but by medium-sized cities, and that approaches tailored to their specific conditions are still missing.

A third gap lies in the **limited integration of strategic-management and organizational perspectives into smart city research**. The field has produced sophisticated discussions

of smart city domains, indicators, governance ideals, and technological innovation, yet far fewer studies have analysed smart development through lenses that are standard in organizational and strategic research, such as barriers to coordination, resource dependencies, market asymmetries, stakeholder alignment, or organizational capability formation. The 2018 article explicitly positions Porter's Five Forces as a neglected but potentially fruitful framework for examining the enabling and hindering conditions of smart city development in medium-sized cities. It argues that methodological components, reasoning, and concepts from enterprise strategic management could add substantial value to smart city research, precisely because current work rarely accounts sufficiently for the diverse local histories, institutional contexts, and constraints of cities. The 2020 organizational design article deepens this line of argument by moving from barrier diagnosis to the design of an alternative collaborative model, thereby addressing not only what the barriers are, but also how cities and their partners might reorganize around them.

A fourth gap concerns the limited empirical attention paid to what cities actually seek to achieve through smart city activity portfolios. While the literature has discussed smart city strategies extensively, it has much less often examined how anticipated benefits and value propositions are distributed across concrete urban interventions. The 2021 article included in this dissertation addresses exactly this deficiency. It argues that, although the strategic principles of smart city development are relatively well researched, there are still only few publications on what beneficial outcomes cities anticipate from smart city developments and how these are represented in implemented activity portfolios. It therefore connects theory and practice by deconstructing the value proposition components of smart city development and comparing them across nine cities. This contribution is important for the dissertation as a whole because it expands the analytical frame beyond barriers and governance toward the question of what cities believe smart development is for, and how those expected benefits are materially reflected in urban project portfolios.

A fifth gap is geographical. Smart city scholarship has expanded globally, but **empirical research remains unevenly distributed, and Central and Eastern European cases are still much less visible than Western and Northern European exemplars**. This underrepresentation matters because cities in this region often operate under different historical trajectories, governance traditions, and capability constraints. The Budapest

article addresses this directly by stating that relatively few empirical publications are available on Eastern European, and especially Hungarian, smart city development, even though the implementation of smart developments should be realized with strategic methods. It also criticizes a literature that often focuses either on specific technological solutions or on indicator-based rankings, while providing much less systematic and comparable analysis of city-wide smart development activities in this regional context. The same paper makes clear that even in Hungary, where the concept has diffused institutionally, its uptake is uneven and often weakly embedded in local strategy documents.

Taken together, these gaps justify the dissertation's research design. The present dissertation does not begin from the assumption that one article, one city, or one method would be sufficient to address the problem. Instead, it treats smart city development as a **multi-layered phenomenon** that must be approached through complementary studies. The five articles collectively move from barrier diagnosis in medium-sized cities, to organizational design responses, to comparative analysis of city activity portfolios, to the strategic assessment of Budapest, and finally to the governance-network analysis of Debrecen. In this sense, the dissertation is justified as article-based not for formal convenience, but for substantive reasons. The research problem itself is cumulative and multidimensional: it concerns barriers, organizational arrangements, strategic value propositions, city-level implementation logics, and stakeholder governance structures. No single empirical design could adequately capture all of these dimensions without sacrificing either depth or comparability.

This geographical gap, however, requires more than a claim of underrepresentation; it requires an explicit account of **why the Central and Eastern European (CEE) context should be expected to matter analytically**. Geographic location in the region does not, by itself, guarantee distinctive smart city dynamics. Two cities may both lie within CEE and yet differ substantially, as Budapest and Debrecen do in scale, institutional complexity, and resource base. The relevant question is therefore not merely where these cities are, but which regionally patterned conditions plausibly shape how they pursue smart development.

Several such conditions can be specified. CEE cities operate within governance traditions and administrative structures marked by post-socialist institutional path-dependencies, including comparatively centralized authority, fragmented metropolitan coordination,

and a historically weaker tradition of participatory, multi-actor urban governance (Varró and Szalai, 2022). Their smart city financing depends heavily on EU cohesion funding and central-government programmes rather than on autonomous local fiscal capacity, which conditions both the pace and the content of development. And the embedding of the smart city concept in local strategy tends to be more recent, more uneven, and more strongly mediated by national policy framing than in many Western European cases (Varró and Bunders, 2020). These are not simply matters of having fewer resources; they are structural and institutional features that shape the form smart city governance takes.

This distinction, between **regional-institutional explanations and resource-based explanations**, is one the dissertation takes seriously rather than resolves by assumption. Where Hungarian cities display predominantly technology-led, top-down, and selectively collaborative patterns, it is analytically important to ask whether these reflect a regionally specific governance logic or, instead, the more general consequences of constrained financial and human capacity that might appear in similarly resourced cities elsewhere. The dissertation's design, which pairs a capital city (Budapest) with a medium-sized city (Debrecen) within the same national setting and situates both against a broader comparative portfolio, is intended precisely to make this question visible, even though a definitive disentangling would require wider cross-regional comparison (see Section 7.6). Recent work on middle-sized Hungarian cities similarly stresses that place-specific development paths, rather than region alone, condition how cities articulate and pursue smartness (Szalai and Fabula, 2021). Treating the medium-sized CEE city, rather than the CEE city in the abstract, as the unit of analysis thus allows the dissertation to discuss inter-urban variation without overstating regional homogeneity.

Because two of the dissertation's empirical chapters examine Hungarian cities, the specific way in which Hungarian cities are governed warrants brief clarification, since it conditions who the relevant stakeholders are and how authority over smart city development is distributed. Hungarian local government operates within a comparatively centralized national framework in which competences, revenues, and many development funds are strongly shaped at the central level, while municipalities retain responsibility for a broad range of local services. In practice this means that the room for autonomous, locally financed smart city strategy is narrower than the formal list of municipal tasks might suggest, and that national programmes and priorities are frequently decisive for what cities can implement.

The capital presents an additional layer of complexity that bears directly on the Budapest study. Budapest has a **two-tier governance structure**, combining a city-wide municipality led by the Lord Mayor with twenty-three districts, each having its own elected mayor and council and its own competences and budget. Responsibility for urban development, public services, and many smart-city-relevant domains is therefore divided, and at times contested, between the city level and the districts, as well as between the municipality and central-government bodies and their agencies. Strategic coherence across this fragmented structure is difficult to achieve, and apparent city-level smart city activity may coexist with uneven district-level capacity and divergent priorities. This institutional fragmentation forms part of the explanation for the implementation gaps identified in the Budapest analysis, and it illustrates why the dissertation treats governance architecture, rather than technology, as the decisive variable.

Debrecen, by contrast, is a medium-sized city that has in recent years been associated with a particularly strong, centrally supported development orientation, including special economic and investment arrangements that have concentrated resources and decision-making within a relatively tight municipal and public–private constellation. Across both cities, the principal stakeholders of smart city development can be grouped, following the helix logic used in the dissertation, as: municipal governments and their development companies; central-government bodies, agencies, and state-owned enterprises; private technology suppliers, utilities, and investors; the knowledge sector of universities and research institutes; and civil-society and citizen actors. A recurring finding of the Hungarian chapters, consistent with the wider observation that governance aims in CEE smart city strategies often remain instrumental and only vaguely specified (Varró, 2025), is that the first three groups dominate, while knowledge-sector and especially civil-society actors participate more selectively. Making the identity and relative weight of these stakeholders explicit is necessary for interpreting the strategic and network findings that follow, and it is taken up directly in the Budapest and Debrecen chapters.

For this reason, the dissertation's contribution lies not only in the findings of the individual articles, but also in their integration. The gap in the literature is not simply that we know too little about smart cities in general. More specifically, we know too little about how medium-sized and Central and Eastern European cities navigate the tension between technology-led modernization and more holistic development; how governance and organizational design shape the actual implementation of smart city agendas; how

anticipated public benefits are translated into activity portfolios; and how strategic and stakeholder configurations condition the possibilities of becoming smart in practice. The dissertation is designed to address precisely these linked deficiencies, and its article-based structure is therefore methodologically justified by the nature of the research gap itself.

Read together rather than separately, these gaps are not five unrelated deficits but facets of a single underlying problem: the smart city literature has tended to examine context, barriers, strategy, organization, value, and stakeholder relations in isolation, and has rarely integrated them into one explanatory account of how cities actually become smart in practice. The individual articles in this dissertation each engage the relevant debates, including techno-centric versus holistic conceptions of the smart city, ranking-based versus process-based assessment, top-down versus participatory governance, and government–industry versus quadruple-helix collaboration, but they do so within their own empirical frames. Bringing these debates together into a single, explicitly layered account is one of the dissertation-level contributions of the integrative chapters.

These debates also have a temporal structure, which the analytical layers developed in this dissertation (Section 1.4) help to organize. The earliest debates were largely definitional and technological, asking what a smart city is and which technologies make it so. Attention then moved to barriers and organizational conditions, as the gap between digital investment and realized urban benefit became apparent. Subsequent debate shifted toward strategy and value, asking what cities pursue through their portfolios and for whom, and, most recently, toward governance, stakeholder inclusion, and the relational structure of smart city ecosystems. The dissertation's analytical layers, namely urban context, barriers, strategic orientation, organizational and governance design, activity portfolios and stakeholder networks, and development trajectories, thus double as a map of how the field's central questions have evolved. Using these layers as an organizing principle allows the dissertation to position each study both within the literature and within the historical movement of the debate, and it is in this integrated, layered, and historically situated reading that the article portfolio's contribution most clearly exceeds the sum of its parts.

1.3 Conceptual boundaries and key terms

This dissertation operates with a set of deliberately bounded working definitions. Such clarification is necessary because the smart city literature is characterized by conceptual proliferation, competing normative visions, and a large number of overlapping models and indicator systems. Across the five studies included in the dissertation, the recurring starting point is that smart city research has produced multiple definitions and analytical frameworks, but has not converged on a single, universally accepted interpretation. The dissertation therefore does not seek to resolve all definitional controversies. Instead, it establishes a coherent conceptual vocabulary that is sufficiently precise for the integrated reading of the five studies and sufficiently broad to accommodate their different empirical and methodological emphases (Bibri and Krogstie, 2017; Kitchin, 2015; Komninos, 2011; Mora and Bolici, 2017).

First, the term **smart city** is used in this dissertation neither as a celebratory label nor as a purely technological category. It does not simply denote a city that deploys digital infrastructure, sensors, or ICT-enabled services. Nor is it treated as a ranking position or a marketing identity. Rather, the smart city is understood as a mode of urban development in which digital technologies, data, organizational capabilities, and governance arrangements are mobilized to improve urban performance and public value across economic, environmental, social, and administrative dimensions. This understanding builds on the shared literature base of the five articles, in which smart city development is associated with quality of life, efficiency, sustainability, civil participation, innovation, and improved urban management, while also remaining vulnerable to techno-centric reductionism if technology becomes an end in itself rather than a means to broader urban goals (Angelidou, 2015; Caragliu et al., 2011; Hollands, 2008; Komninos, 2011). In this dissertation, therefore, a smart city is best understood as a city pursuing a strategic and organized transition in which technology is embedded within a wider socio-institutional process.

A related distinction is required between **smart city** as a condition and **smart city development** as a process. The dissertation is concerned primarily with the latter. The focus is not on determining whether a city "is" smart in some essential or fixed sense, but on examining how cities **attempt to become** smart through strategies, projects, organizational arrangements, and stakeholder collaboration. This process-oriented understanding is especially important because several of the included studies explicitly

criticize static benchmarking approaches that reduce smartness to indicator-based rankings. Instead, they argue for attention to **what cities actually do**, how they organize implementation, and what kinds of benefits or outcomes they anticipate from specific interventions. In this sense, smart city development refers to the cumulative process through which urban actors define priorities, mobilize resources, create institutions, implement initiatives, and evaluate their effects in pursuit of a smarter form of urban governance and development.

The dissertation uses **governance** as a broader concept than government. Governance refers to the institutionalized processes through which urban priorities are defined, decisions are coordinated, responsibilities are allocated, resources are mobilized, and interventions are legitimized and implemented. In the context of smart city development, governance includes **municipal steering, interdepartmental coordination, public-private partnerships, academic involvement, civil-society participation, and the design of recurring mechanisms** through which these actors interact. Across the article portfolio, governance is repeatedly treated as a decisive explanatory dimension because smart city outcomes depend not only on what technologies are available, but also on who frames problems, who has authority to act, which actors are included, and whether coordination mechanisms allow knowledge, resources, and responsibility to be pooled effectively. For this reason, the dissertation treats governance as the central institutional process through which smart city development is translated from strategic ambition into practical implementation.

Within this broad concept, the dissertation repeatedly refers to **strategic governance dichotomies**. These are not understood as rigid categories into which cities neatly fall, but as analytical axes that capture recurrent tensions in the literature and in practice. Following the framework used in the Budapest and Debrecen studies, four such dichotomies structure the dissertation's comparative language: (i) **technology-led versus holistic development**, (ii) **top-down versus bottom-up governance**, (iii) **double-helix versus quadruple-helix collaboration**, and (iv) **mono-dimensional versus integrated intervention logic**. A technology-led orientation prioritizes deployable ICT solutions and digital infrastructure, while a holistic orientation places greater emphasis on wider socio-technical, institutional, and community conditions. A top-down approach assigns a leading role to municipal or public authorities, whereas a bottom-up approach gives greater formative weight to citizens and non-state actors. Double-helix collaboration

refers mainly to public-private cooperation, while quadruple-helix collaboration expands this to include academia and civil society as systematic co-producers. Finally, mono-dimensional logic denotes a narrower concentration on isolated domains or projects, whereas integrated logic refers to broader cross-domain alignment. These dichotomies function in the dissertation as diagnostic tools for interpreting strategic orientation, not as normative absolutes.

The concept of **organizational design** is used in a similarly substantive sense. It does not refer only to formal organograms or administrative charts. Rather, organizational design denotes the **configuration of roles, authority, coordination mechanisms, routines, interfaces, and collaborative arrangements** through which smart city transition is organized. The organizational design article makes clear that the core barriers of urban digitalization are often not technological but organizational: weak convergence among interventions, insufficient horizontal integration, unclear responsibilities, poor stakeholder engagement, limited collaborative capabilities, and closed organizational structures can all undermine smart city transition. In this dissertation, organizational design therefore refers both to the internal arrangement of public institutions and to the inter-organizational architecture that links municipalities, firms, experts, universities, and citizens in the implementation of smart city initiatives. This is why governance and organizational design are treated as closely related but not identical concepts: governance concerns the broader steering and coordination of collective action, while organizational design concerns the specific institutional configurations through which that steering becomes workable.

The term **medium-sized city** also requires clarification. In the dissertation, this concept is anchored in the definition adopted in the 2018 article, following Giffinger et al. (2007), where **medium-sized cities are understood as cities with approximately 100,000 to 500,000 inhabitants in the European context**. This definition is useful because it corresponds to an established research tradition and highlights the importance of population size as a practical segmentation criterion in both academic and strategic work. At the same time, the dissertation uses the term in a substantively richer sense than population alone. Medium-sized cities are treated as an implementation context typically characterized by more limited administrative and analytical capacity, thinner innovation ecosystems, smaller fiscal room for experimentation, and stronger dependence on external funding, suppliers, and intermediary organizations than flagship metropolitan

cases. In this dissertation, then, medium-sized city denotes both a demographic category and a governance condition. It should also be noted that not all studies in the article portfolio are about medium-sized cities in the strict sense: Budapest is included as a capital-city contrast case, while Debrecen and the 2018 study place the medium-sized-city question at the centre of the analysis.

The dissertation uses **strategy** in an enacted, not merely documentary, sense. A smart city strategy is not reduced here to a published framework document. Instead, **strategy refers to the relatively coherent orientation** through which a **city defines priorities, selects intervention areas, organizes implementation, and signals what kinds of urban change it seeks to produce**. This is important because one of the recurring findings across the article portfolio is that strategy cannot be inferred solely from formal rhetoric. It must also be read through the **city's activity portfolio**, the distribution of project types, the balance between technological and non-technological interventions, and the actor constellations involved in implementation. Thus, strategy in this dissertation means **both declared strategic intent and the pattern of practical choices** through which that intent is enacted, diluted, or contradicted.

Two further concepts are essential for the integrative logic of the dissertation: **activity portfolio** and **value proposition**. The many-faces article argues that smart city research has paid relatively little systematic attention to the beneficial outcomes cities anticipate from smart city developments and to how these are represented across implemented activities. Building on that contribution, the dissertation uses **activity portfolio** to denote the aggr**egate set of smart city initiatives pursued by a city within a given period**. The portfolio is analytically important because it shows what cities actually prioritize across domains, instruments, and time. The notion of value proposition refers to the anticipated benefit or public benefit logic attributed to those activities. These may include, among others, efficiency, stakeholder engagement, quality of life, social inclusion, connectivity, knowledge creation, cost reduction, scalability, and environmental impact. In the dissertation, value proposition does not mean commercial value only; it refers more broadly to the expected urban benefit profile embedded in a city's smart development choices. Together, activity portfolio and value proposition provide a bridge between strategic discourse and implementation practice.

Finally, the dissertation uses **stakeholder network** as a specifically relational concept. A stakeholder network is not simply a list of actors involved in smart city development. It

refers to the structured pattern of relations among organizations participating in smart city initiatives, including public authorities, municipal companies, private firms, universities, development agencies, NGOs, and other civic actors. The Debrecen study extends the dissertation's conceptual language by showing that the network perspective makes visible not only which actor categories are present, but also which organizations occupy central, bridging, or peripheral positions. This matters because the structure of the stakeholder network affects how knowledge circulates, how coordination is achieved, how authority is concentrated or distributed, and how inclusive the governance model is in practice. In this dissertation, stakeholder network therefore denotes the relational architecture of smart city governance rather than merely its actor composition.

Taken together, these conceptual boundaries define the analytical scope of the dissertation. The study is not primarily about smart technologies as engineering artefacts, nor about city rankings as ends in themselves. It is about how cities, especially medium-sized and Central and Eastern European cities, organize and govern smart development; how strategy becomes visible in project portfolios and anticipated benefits; and how stakeholder relations shape the possibilities and limits of urban digital transition. These working definitions now make it possible to move to the dissertation-level synthesis in the next section, where the separate concepts are brought together into one integrative conceptual framework.

1.4 Integrative conceptual framework of the dissertation

The five studies included in this dissertation address different, but closely related, dimensions of smart city development. Taken separately, they examine barriers of implementation, organizational design challenges, the anticipated benefits embedded in smart city activity portfolios, the strategic conditions of becoming smart in Budapest, and the governance structure of smart city development in Debrecen. Taken together, however, they support a broader dissertation-level argument: smart city development should be understood as a context-dependent urban transition process in which strategic orientation, organizational design, and governance arrangements mediate between local conditions and the concrete portfolio of smart city initiatives, ultimately shaping the type of public value that smart city development is able to produce. This integrative framework does not replace the article-specific frameworks used in the individual studies. Rather, it brings them into a single analytical structure that explains how the five papers relate to one another and why their findings are cumulative rather than merely parallel.

At the most general level, the dissertation conceptualizes smart city development as a multi-stage and multi-actor process. It begins not with technology itself, but with the **urban context** in which the smart city agenda is pursued. This context includes the structural characteristics of the city, especially whether it is a medium-sized or capital-city case; the institutional environment in which local governments operate; the local availability of financial, human, and data resources; and the wider regional and national conditions that shape strategic capacity. The 2018 study makes this especially clear by showing that medium-sized cities face specific enabling and constraining conditions, including uneven access to expertise, weak standards, limited data quality, resource concentration in capitals, and vulnerability to vendor lock-in and biased assessment practices. The Budapest and Debrecen studies add that Central and Eastern European cities also operate under uneven strategic uptake, fragmented authority structures, and more limited embeddedness of the smart city concept in local policy practice. In this dissertation, therefore, context is not treated as background scenery, but as the first explanatory layer of smart city development.

The second layer of the integrative framework is **strategic orientation**. Here the dissertation adopts the insight, developed especially in the Budapest, Debrecen, and comparative portfolio studies, that smart city development can be interpreted through recurrent strategic tensions or dichotomies. These are not absolute categories, but analytical dimensions along which cities position themselves in practice: technology-led versus holistic development, top-down versus bottom-up governance, double-helix versus quadruple-helix collaboration, and mono-dimensional versus integrated intervention logic. These dichotomies matter because they reveal how cities understand the purpose and mechanism of smart development. A city that privileges technology-led and top-down solutions may still appear active and innovative, but its development path will differ substantially from that of a city that places stronger emphasis on community-building, institutional learning, and participatory governance. In the dissertation-level framework, these strategic orientations mediate between contextual constraints and practical implementation choices. They translate local conditions into a more or less coherent smart city development logic.

The third layer concerns **barriers and enabling conditions**. This is where the 2018 and 2020 studies provide the first major building blocks of the dissertation. The barriers article identifies structural constraints such as knowledge gaps, poor data availability and

quality, vendor lock-in, biased approaches, and the lack of standards. The organizational design article then deepens this diagnosis by showing that many implementation failures stem not from the absence of technological solutions, but from sociotechnical scalability problems, procedural difficulties, weak integration mechanisms, inadequate collaboration, power asymmetries, and closed organizational structures. Taken together, these two papers support a central proposition of the dissertation: smart city development is constrained or enabled by non-technological conditions to a much greater extent than many technology-centred narratives assume. The integrative framework therefore places barriers and enabling conditions between strategic orientation and organizational response. Cities do not move directly from strategy to implementation; they do so through institutional frictions, capability gaps, and governance challenges that condition what kinds of smart development are realistically possible.

The fourth layer is **organizational design and governance arrangement**, which occupies a central place in the overall framework. This is one of the dissertation's main synthetic contributions. Across the five studies, it becomes increasingly clear that smart city development depends not simply on having a strategy, but on having an organizational and governance architecture capable of carrying that strategy into practice. The 2020 article shows that conventional organizational models in urban digitalization are often ill-suited to manage complexity, cross-sectoral coordination, and multi-actor collaboration, and therefore proposes a more collaborative platform-based model built on open innovation and lean urban planning. The Budapest and Debrecen studies then show how these issues manifest empirically at the city level: who leads, who participates, whether governance is centralized or distributed, whether collaboration remains narrowly public-private, and whether stakeholder relations create a genuinely adaptive ecosystem or merely a formally connected but hierarchical network. In the dissertation's integrative framework, governance and organizational design are the key mediating mechanisms through which barriers are either reproduced or partially overcome.

The fifth layer of the framework is **implementation through smart city activity portfolios**. The dissertation does not assume that strategy can be understood solely from policy documents or rhetorical declarations. Instead, it follows the logic developed especially in *The Many Faces of the Smart City* and in the Budapest and Debrecen studies: strategic orientation becomes visible in the actual portfolio of initiatives that cities implement. Activity portfolios reveal what cities prioritize, how broadly they intervene

across domains, whether their actions are dominated by infrastructure and services or also include strategic and community-building measures, and what forms of anticipated benefit are embedded in these activities. The 2021 comparative study makes a major contribution here by deconstructing smart city developments into value proposition components, including efficiency, citizen engagement, quality of life, inclusion and equality, connectivity, knowledge creation and sharing, cost reduction, scalability and transferability, and environmental impact. This enables the dissertation to treat smart city portfolios not just as collections of projects, but as empirical expressions of what cities believe smart development is meant to achieve.

The sixth layer is **stakeholder network structure**, which is most fully developed in the Debrecen article but is implicit across the dissertation. The stakeholder network perspective adds a relational dimension to the conceptual framework. It shows that it is not enough to know which actor categories are present in smart city development; it also matters how they are connected, which actors occupy central positions, where bridging roles emerge, and whether the resulting structure reinforces top-down control or enables broader knowledge diffusion and collaborative problem-solving. The Debrecen study demonstrates that even where a city's initiative portfolio appears broad and multidimensional, the network can still remain highly centralized, dominated by the municipal government and a narrow set of development actors. This insight complements the organizational design article, because it allows the dissertation to move from abstract governance types to observable relational architectures. In the integrated model, stakeholder networks are therefore treated as both outcomes of governance design and determinants of future implementation capacity.

These six layers culminate in the final element of the framework, namely **smart city development trajectory and public value orientation**. The dissertation does not measure success in a purely ranking-based or output-based way. Instead, it asks what kind of smartness is being produced in practice. Is the city moving toward a technology-led but socially thin model, or toward a more holistic and integrated one? Does the activity portfolio produce mainly efficiency gains and connectivity, or does it also strengthen participation, inclusion, learning, and quality of life? Are stakeholder relations widening the city's intelligence base, or are they reproducing narrow public-private arrangements? In this sense, the outcome dimension of the conceptual framework is not a single performance indicator, but a patterned development trajectory. This trajectory is shaped

by the interaction of context, strategy, barriers, organizational design, implementation portfolio, and stakeholder network structure.

On this basis, the dissertation-level conceptual framework can be summarized as follows: **local urban context** shapes the constraints and opportunities of smart city development; cities respond through a particular **strategic orientation**; this orientation encounters specific **barriers and enabling conditions**; these are mediated by **governance and organizational design**; the resulting logic becomes visible in the **activity portfolio** and the **stakeholder network**; and together these produce a distinct **smart city development trajectory** with particular anticipated and realized public value outcomes. This model integrates the contribution of all five articles into one cumulative explanatory scheme. It also clarifies why the dissertation needs all five studies: none of them alone is sufficient to explain the full process, but together they provide a layered account of how smart city development is framed, constrained, organized, implemented, and relationally structured.

A further advantage of this integrative framework is that it accommodates both similarity and difference across the five studies. The 2018 and 2020 articles concentrate more heavily on barriers and organizational conditions. The 2021 article emphasizes value propositions and activity portfolios. The Budapest and Debrecen studies move the framework to city-level empirical diagnosis through strategic dichotomies, implementation analysis, and stakeholder mapping. Yet all five are positioned on the same analytic continuum. They are not isolated pieces on unrelated aspects of smart cities; they are successive entries into the same underlying research problem: *under what conditions, through what governance and organizational arrangements, and toward what strategic logic do cities become smart in practice*?

The dissertation-level logic that links these layers is summarised in Figure 1.

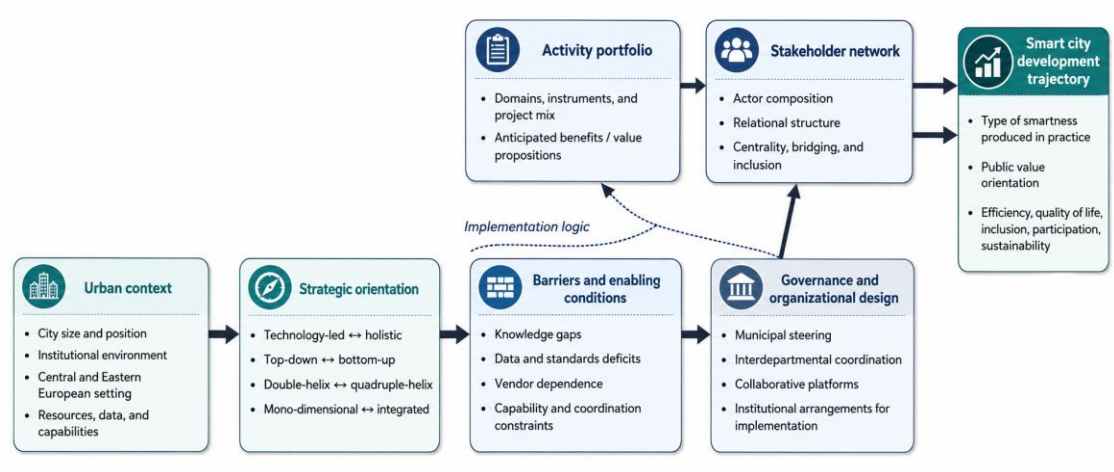


Figure 1 Integrative conceptual framework of the dissertation.

Figure 1 presents the dissertation-level logic linking urban context, strategic orientation, barriers and enabling conditions, governance and organizational design, activity portfolios, stakeholder networks, and the resulting smart city development trajectory and public value orientation.

1.5 Overarching research question and article-specific sub-questions

Building on the integrative conceptual framework outlined above, this dissertation is guided by one overarching research question that brings the five studies into a single analytical programme. The formulation of this question reflects the central premise emerging across the article portfolio: smart city development is not adequately explained by technology adoption alone but must instead be understood through the interaction of local context, strategic orientation, governance arrangements, organizational design, and stakeholder collaboration. This is particularly important in medium-sized and Central and Eastern European cities, where capacity constraints, uneven institutionalization, and selective uptake of the smart city concept make the pathway to "becoming smart" more contingent and more revealing than in flagship metropolitan cases (Angelidou, 2015; Komninos and Mora, 2018; Mora et al., 2019). This cumulative logic is already visible in the individual studies: the first article asks what hinders medium-sized cities; the second examines organizational barriers and alternative models; the third investigates the value propositions embedded in activity portfolios; the fourth assesses Budapest through the

four strategic dichotomies; and the fifth extends that diagnostic to Debrecen while adding stakeholder-network analysis.

The **overarching research question** of the dissertation is therefore formulated as follows:

How do cities, especially medium-sized and Central and Eastern European cities, become smart in practice, and how do strategic orientation, governance arrangements, organizational design, and stakeholder configurations shape the translation of smart city ambitions into concrete development portfolios and public-value outcomes?

This question is intentionally broader than the research question of any individual article. It is not limited to one city, one governance mechanism, or one methodological lens. Instead, it captures the dissertation's full explanatory ambition. First, it foregrounds **becoming smart** as a process rather than treating smartness as a fixed status. Second, it identifies the principal mediating dimensions emphasized throughout the dissertation: strategy, governance, organizational design, and stakeholder structure. Third, it links these mediating dimensions to the empirical manifestations of smart city development, namely activity portfolios and anticipated public-value outcomes. In doing so, it also addresses the key gap identified in the article portfolio, namely the persistent disconnect between abstract smart city discourse and the actual institutional and strategic conditions under which cities implement smart development.

The overarching research question is pursued through five article-specific sub-questions, each corresponding to one of the studies included in the dissertation. These sub-questions are not independent side issues. Each addresses one constitutive layer of the integrative framework, and together they build the cumulative answer to the dissertation-level question.

Sub-question 1 (Article 1: *Factors Hindering Smart City Developments in Medium-Sized Cities*)

What are the principal factors hindering smart city development in European medium-sized cities, and how can these barriers be interpreted through a strategic-management lens?

This first sub-question establishes the dissertation's problem-driven point of departure. It addresses the under-researched implementation setting of medium-sized cities and asks why smart city development is difficult under their specific conditions. The article answers this by applying Porter's Five Forces Framework to a sample of Hungarian medium-sized cities and related actors, thereby introducing a strategic-management perspective into a field that has often remained dominated by technological, descriptive, or indicator-based approaches. Its role in the dissertation is foundational: it identifies the structural and contextual barriers that later articles examine in more specific organizational, strategic, and governance terms.

Sub-question 2 (Article 2: *Challenges and Solutions for Organizational Design in Urban Digitalization*)

What organizational barriers prevent smart city transition, and what kind of collaborative organizational model can better support urban digitalization under complex, multi-actor conditions?

The second sub-question shifts the analysis from general hindering factors to the organizational mechanisms through which those barriers are reproduced or overcome. This article argues that scalability, complexity, and procedural problems cannot be solved through technological innovation alone and explicitly asks whether conventional organizational models contain inherent barriers to smart city transition and whether alternative collaborative models can overcome them. Its contribution to the dissertation is twofold: it deepens the explanatory role of organizational design and introduces a constructive response through the SmartCEPS platform concept. Within the overall dissertation logic, this article therefore bridges diagnosis and design.

Sub-question 3 (Article 3: *The Many Faces of the Smart City*)

What benefits are anticipated from smart city developments, how are these benefits distributed across cities' smart city activity portfolios, and how can cities be comparatively interpreted on this basis?

The third sub-question broadens the dissertation beyond barriers and governance by asking what cities are actually trying to achieve through smart city development. The article explicitly investigates the anticipated benefits embedded in smart city activities, their distribution across activity portfolios, and the comparative categorization of cities based on these benefit profiles. This is a crucial part of the dissertation because it

introduces the analytical concepts of value proposition and portfolio logic. It helps explain not only whether cities are active in smart development, but what kind of smartness they are pursuing. Within the cumulative framework of the dissertation, this article connects strategic intent to implemented activity patterns and anticipated public value.

Sub-question 4 (Article 4: *What Are the Conditions to Become Smart?*)

How can the strategic orientation of a Central and Eastern European capital city be systematically diagnosed through the four smart city dichotomies, and what does this reveal about the conditions of becoming smart in the Hungarian context?

The fourth sub-question moves from cross-city and conceptual analysis to a focused city case in Budapest. The article explicitly aims to establish better linkages between Hungarian and international smart city research by applying a validated case-study methodology to a less successful Eastern European example. It asks how Budapest's strategy and development activities can be interpreted through the four dichotomies identified by Komninos and Mora, and what this reveals about the city's strategic orientation. In the dissertation, this article has a pivotal role. It operationalizes the strategic-dichotomy framework in the Hungarian context, demonstrates the empirical usefulness of the diagnostic approach, and provides the capital-city reference point against which Debrecen can later be interpreted.

Sub-question 5 (Article 5: *Smart City Governance in a Medium-Sized European City*)

How is the smart city development of a medium-sized Central European city structured in practice, and what do project-level strategic diagnostics and stakeholder-network analysis reveal about its governance model?

The fifth sub-question brings together the dissertation's earlier threads in a mature medium-sized-city case. The Debrecen article examines strategic orientation through the four dichotomies, but also extends the methodology through project-level coding and stakeholder-network analysis. Its role in the dissertation is especially important because it provides the most integrated empirical answer to the overall research question: it connects medium-sized-city context, strategic orientation, governance structure, activity portfolio, and stakeholder relations in one case. It also sharpens the dissertation's distinct contribution by showing how governance bundles can emerge in medium-sized cities and

how top-down coordination can coexist with multi-domain breadth while still limiting quadruple-helix inclusiveness.

Taken together, these five sub-questions produce a cumulative line of inquiry. The first identifies **why** smart city development is hindered in medium-sized urban contexts. The second examines **how** organizational arrangements reproduce or mitigate those constraints. The third clarifies **what kinds of benefits** cities seek through their smart development portfolios. The fourth shows **how strategic orientation can be diagnosed** in a Hungarian capital-city case. The fifth demonstrates **how these dynamics are concretely structured** in a medium-sized Central European city through governance and network relations. The logic is therefore progressive rather than repetitive: each article answers a distinct analytical problem, while also preparing the ground for the next one.

For dissertation purposes, it is also useful to state explicitly what the integrated answer is expected to demonstrate. The dissertation does not proceed from the assumption that there is one universally optimal path to smartness. Rather, it assumes that smart city trajectories are shaped by the interaction of place-specific constraints and strategic choices. Nevertheless, the combined sub-questions also reflect a more general proposition: cities are more likely to pursue coherent and publicly valuable smart development when they move beyond narrowly technology-led and supplier-driven approaches toward more integrated, strategically articulated, and organizationally supported governance arrangements. This proposition is not fully tested in any single article, but it is gradually assembled through the article portfolio as a whole.

Finally, the formulation of the overarching question and sub-questions clarifies why the dissertation is appropriately article-based. The five studies do not merely apply different methods to related topics. They jointly investigate a layered problem that cannot be adequately captured through one monographic design without becoming either overly abstract or empirically too narrow. The article portfolio allows the dissertation to move from structural barriers to organizational solutions, from value propositions to strategic diagnostics, and from capital-city analysis to medium-sized-city governance. In that sense, the dissertation's article-based architecture is not simply a format choice; it is an integral part of the research design.

1.6 Methodological architecture of the five studies

The methodological architecture of this dissertation is designed to match the layered character of the research problem. As argued in the previous sections, the dissertation does not address smart city development as a single-variable phenomenon, nor does it reduce the field to a question of technological adoption, city ranking, or one-off case description. Instead, it approaches smart city development as a multi-dimensional process shaped by contextual constraints, strategic choices, organizational design, implementation logic, and stakeholder relations. For that reason, the dissertation adopts an article-based methodological architecture in which the five studies are not repetitions of the same design, but complementary analytical entries into the same overarching problem. Taken together, they combine exploratory qualitative inquiry, literature-informed design research, deductive multiple case study analysis, structured comparative case analysis, and stakeholder network analysis. The strength of this architecture lies precisely in that complementarity: each study contributes a different methodological angle, and each method is selected in line with the specific question addressed by the corresponding article.

At the broadest level, the dissertation relies on a **qualitative, interpretive, and case-oriented research strategy**, but it also incorporates structured coding, descriptive quantification, and network-analytic elements. This means that the dissertation is not purely exploratory in the loose sense, nor is it based on hypothesis testing in a narrow positivist design. Rather, it occupies an intermediate position: it uses theory-guided analytical categories to structure empirical inquiry, while remaining sensitive to contextual particularities and emergent findings. This is especially visible in the recurring use of structured frameworks. The first article adapts Porter's Five Forces Framework to the smart city field in order to identify barriers in medium-sized cities. The Budapest and Debrecen studies use the four strategic smart city dichotomies developed by Mora and colleagues as a validated framework for diagnosing city-level strategic orientation. The many-faces article uses a literature-derived value-proposition framework to code the anticipated benefits of smart city activities. The organizational design article, by contrast, begins with inductive category development from literature and expert discussion, then moves toward solution design and validation. What unifies these approaches is the effort to create comparability and analytical discipline without losing contextual depth.

It is therefore useful to state the dissertation's overall methodological stance explicitly, since the individual studies might otherwise appear to move between incompatible logics. The dissertation as a whole follows a **theory-guided, broadly abductive strategy**, rather than either a purely inductive grounded-theory programme or a strictly hypothetico-deductive one. Empirical material is consistently read through, and used to refine, theoretically derived analytical categories such as Porter's Five Forces, the value-proposition components, and the four strategic dichotomies, rather than being approached either as a blank inductive slate or as a fixed set of variables for confirmatory testing. Within this overall stance, individual studies legitimately sit at different points on the inductive–deductive continuum according to their purpose. The comparative and organizational studies draw on grounded-theory devices such as theoretical sampling (Glaser, 1978) and inductive category development, because their aim is to build and refine categories in an under-theorized space. The Budapest study, by contrast, formulates and tests explicit propositions against the city's documented activity, because at that point the diagnostic framework is mature enough to be examined deductively. These are complementary moments of a single abductive logic rather than inconsistencies.

Understood in this way, the dissertation does carry a set of guiding propositions, even where these are not always stated in formal hypothesis form. They can be made explicit: that smart city development is conditioned by a barrier environment especially visible in medium-sized cities; that organizational and governance design mediates between smart city ambition and implementation; that activity portfolios express differentiated public-value orientations; that strategic orientation cannot be read off the mere presence of projects; and that integration of portfolios and inclusiveness of governance are analytically distinct dimensions. These propositions are developed inductively across the earlier studies, examined more deductively in the city-level diagnoses, and consolidated in the integrative conclusion (Section 7.1). Presenting them here, at the outset, makes the dissertation's methodological strategy consistent and transparent, and clarifies that the mixed posture of the portfolio is a deliberate design choice rather than an unresolved tension.

The **first study**, *Factors Hindering Smart City Developments in Medium-Sized Cities*, provides the dissertation's initial exploratory and problem-identification layer. Methodologically, it experiments with the transfer of a strategic-management framework into smart city research. The article explicitly applies Porter's Five Forces Framework to

a sample of Hungarian medium-sized cities in order to identify barriers and enabling factors of smart city development. The empirical material is primarily qualitative: it is based on two three-hour focus groups with a total of fifteen participants, including senior representatives of Hungarian municipalities and public authorities responsible for smart city developments, as well as inputs from consulting companies, smart city clusters, and an additional interview with a representative of smaller Romanian settlements. The sampled cities are also characterized through contextual indicators such as inhabitants, GDP per capita, industry tax per capita, and higher-education attainment. In dissertation terms, this study serves as an exploratory barrier-mapping exercise. Its methodological role is not to produce a final model of medium-sized-city smartness, but to identify the main structural constraints and to demonstrate that strategic-management reasoning can enrich a field otherwise dominated by technological and descriptive approaches.

The **second study**, *Challenges and Solutions for Organizational Design in Urban Digitalization*, shifts the methodological emphasis from exploratory diagnosis to **practice-based organizational design research**. The article begins from the observation that smart city transition is hindered by sociotechnical scalability problems, complexity, and procedural difficulties, and asks whether conventional organizational models contain inherent barriers to transition and whether collaborative network models can overcome them. The methodology is explicitly multi-phase. First, an extensive literature review is conducted to identify the organizational challenges of smart city transition in relation to multi-stakeholder ecosystems, data-driven applications, knowledge-intensive innovative services, and urban planning. The literature is processed through inductive category development. This is followed by three semi-structured focus group sessions with key stakeholder categories, city managers, urban planning professionals, and technology suppliers, used to validate, refine, and extend the emerging categories. Finally, the identified organizational barriers are translated into a problem space for designing the SmartCEPS organizational framework, and the resulting solution concept is validated in follow-up focus groups. Methodologically, this article contributes something distinct to the dissertation: it does not only analyse existing urban reality, but also develops and validates an alternative organizational model. Its function in the overall architecture is therefore generative and design-oriented.

The **third study**, *The Many Faces of the Smart City*, adds the dissertation's strongest **comparative multiple-case design**. The article explicitly adopts a deductive-based

multiple case study analysis in order to examine what benefits cities anticipate from smart city development, how these benefits are distributed across urban activity portfolios, and how cities can be categorized on this basis. The research framework is built through a literature review that identifies nine principal value proposition components of smart city activities. These components then guide the empirical coding. Case selection follows a theoretical sampling logic rather than random sampling, combining six cities recognized as demonstrated smart city excellence cases with three cities treated as emerging excellence cases. The database is built from a large body of digital records gathered from city governments, private-sector actors, academic institutions, policy documents, project repositories, reports, videos, and online materials. Each of the identified activities is coded against the value proposition categories, allowing comparative analysis of the distribution of anticipated benefits across cities and time periods. This article therefore contributes the portfolio-comparative layer of the dissertation. Methodologically, it is crucial because it moves beyond single-case diagnosis and demonstrates how smart city activity patterns can be studied systematically across multiple urban contexts using a common conceptual framework.

The **fourth study**, *What Are the Conditions to Become Smart?*, brings the dissertation into a **structured single-case study** design centred on Budapest. This article explicitly replicates and applies a validated methodology developed in the international smart city literature in order to analyse an Eastern European capital-city case that is not generally regarded as an example of smart city excellence. The study applies the four smart city dichotomies identified by Mora and colleagues as its analytical framework. Methodologically, it uses convenience sampling to select Budapest as a pilot case among larger European cities with an existing smart city strategy but relatively limited success. Data collection proceeds in multiple phases through online sources, especially Budapest Portál and the Lechner Knowledge Centre's smart city project repository, supplemented by policy documents, local government acts, web pages, and related digital materials. The identified activities are coded in a structured way, including domain, year, activity type, spatial level, and participating organizations. The analysis then interprets the city's strategic orientation through the four dichotomies. In the dissertation's methodological architecture, this study has a bridging role: it operationalizes the dichotomous strategic framework in a Hungarian case, demonstrates the comparability of the method, and creates the direct methodological precursor to the Debrecen study.

The **fifth study**, *Smart City Governance in a Medium-Sized European City*, represents the most methodologically integrated article in the portfolio. Like the Budapest study, it applies the dichotomous model as an empirical diagnostic, but it also extends the design through a curated project dataset and stakeholder collaboration network analysis. The study is based on a validated dataset of 120 smart city initiatives in Debrecen, identified from municipal project documentation, the official smart city strategy, press releases, and stakeholder contributions, with each initiative cross-checked where possible against at least two sources. The projects are coded by domain, description, partner organizations, and activity type, and then analysed along the four dichotomies: technology-driven versus holistic, top-down versus bottom-up, double- versus quadruple-helix, and mono-dimensional versus integrated logic. In addition, the study constructs an undirected collaboration network from co-participation data among 161 organizations, enabling the identification of central actors, bridging roles, and the overall relational structure of the smart city ecosystem. This makes the Debrecen article methodologically distinct from the Budapest study: while both are case studies using the same basic strategic framework, the Debrecen study adds a relational-structural layer that reveals how strategic orientation is embedded in stakeholder networks. For the dissertation as a whole, this article functions as the culminating empirical synthesis.

When viewed together, the five studies reveal a deliberate **logic of methodological complementarity**. The first and second articles rely strongly on qualitative, exploratory, and stakeholder-based inquiry, but they do so for different purposes. The first identifies barriers in medium-sized-city smart development through a strategic lens; the second explains and redesigns organizational arrangements that could address such barriers. The third article introduces broader comparative reach by analysing value propositions across multiple cities. The fourth article applies a structured diagnostic framework to a Hungarian capital case, showing how a validated international methodology can be localized to a Central and Eastern European setting. The fifth article then deepens that same diagnostic approach in a medium-sized-city case while adding network analysis to illuminate governance structure. Thus, the methods are cumulative rather than redundant: exploratory diagnosis, design-oriented inquiry, cross-case comparison, structured single-case replication, and network-embedded case analysis together provide a more complete understanding of smart city development than any one method alone could offer.

A further strength of the dissertation's methodological architecture is that it combines **different units and scales of analysis**. The first article studies medium-sized cities as a segment and focuses on barriers affecting their maturity. The second focuses less on a specific city and more on the organizational architecture of urban digitalization as such. The third analyses city activity portfolios comparatively across nine cities. The fourth and fifth then concentrate on individual cities (Budapest and Debrecen) at a deeper level. Within those city cases, the unit of analysis becomes even more fine-grained: individual smart city activities, categories of interventions, participating organizations, and inter-organizational relations. This movement from segment-level diagnosis to city-level portfolio analysis and then to project- and network-level diagnosis strengthens the dissertation's ability to connect abstract strategic questions with concrete implementation practice.

The studies also complement one another in terms of **data sources**. Across the portfolio, the dissertation uses focus groups, expert interviews, literature reviews, strategy documents, municipal repositories, project documentation, digital records, online archival materials, and stakeholder project databases. This variety improves robustness. For example, the comparative city article deliberately triangulates city-government materials with company, academic, and secondary sources; the Debrecen article cross-checks initiatives against multiple independent sources where possible; and the organizational design article combines literature-derived categories with expert validation. Even where the dissertation remains predominantly qualitative and interpretive, it does not rely on a single source type. Instead, it repeatedly uses triangulation to strengthen credibility and to reduce the risk that smart city rhetoric is taken at face value.

At the same time, the methodological architecture is not without limits, and these limits should be acknowledged at the integrative level. Several studies rely on non-probability or theoretically selected cases rather than statistically representative sampling. The portfolio is strongest in analytical depth, contextual sensitivity, and theory-building potential, but weaker in statistical generalizability. Similarly, the structured coding of projects and actors inevitably involves interpretive judgement, especially in borderline cases where smart city activities span multiple domains or where the boundary between top-down and bottom-up, or between technological and holistic, is not perfectly clear. Nevertheless, these limitations are not accidental flaws, but characteristics of a research

design aimed at understanding an emergent and context-sensitive field. The dissertation does not claim universal causal laws for all cities. Rather, it offers a theoretically informed, empirically grounded explanation of how smart city development is shaped in medium-sized and Central and Eastern European urban contexts.

In sum, the methodological architecture of the dissertation can be characterized as **sequentially cumulative, theory-guided, and multi-method within a qualitative core**. The five studies do not merely sit next to one another as autonomous publications. They are arranged so that each article extends the previous ones: from barriers to organizational solutions, from value propositions to city strategies, and from strategic diagnostics to governance networks. This complementarity is central to the article-based design of the dissertation. It is what allows the dissertation to answer the overarching research question at a level of richness that neither a purely monographic narrative nor a single empirical study could easily achieve.

1.7 The five studies: coherence, synergies and difference

The five studies included in this dissertation form a coherent research portfolio, yet they do not do so by repeating the same argument in slightly different empirical settings. Their coherence lies in the fact that all of them address the same underlying problem: how smart city development is shaped in practice by strategic orientation, organizational conditions, governance arrangements, and contextual constraints. Their distinctiveness lies in the fact that each study approaches that problem from a different analytical angle, with a different empirical emphasis and a different contribution to the dissertation-level argument. For this reason, the studies should be read neither as standalone publications merely assembled into one volume, nor as interchangeable chapters of a monograph. Rather, they constitute a cumulative article-based dissertation in which coherence and difference are equally important.

At the most general level, the coherence of the five studies is grounded in a shared understanding of the smart city as more than a technological category. Across the portfolio, smart city development is treated as a socio-technical, organizational, and governance process rather than as the mere adoption of digital infrastructure or the possession of advanced ICT solutions. This common position is visible from the earliest article onward. The first study, although it uses a strategic-management framework to map barriers, already argues that the most important hindering factors of smart city

development in medium-sized cities cannot be reduced to technology alone. The second study reinforces this point even more explicitly by showing that organizational barriers, scalability problems, and procedural difficulties are central to urban digitalization. The third study approaches the issue from the perspective of anticipated benefits and city activity portfolios, but likewise assumes that smart city development reflects strategic choices rather than only technological maturity. The Budapest and Debrecen studies then demonstrate empirically that smartness must be interpreted through broader strategic and governance configurations, not simply through the visibility of digital interventions. In this sense, the first source of coherence is conceptual: all five studies reject a narrow techno-centric reading of the smart city and seek to explain the institutional and strategic logic of becoming smart.

A second source of coherence is the dissertation's sustained concern with the relation between **strategy and implementation**. One of the recurrent weaknesses in the smart city literature is that it often oscillates between abstract definitions and descriptive project lists without fully explaining how strategic ambitions become realized through concrete urban activities. The five studies collectively address this problem from different positions. The first study shows what kinds of barriers can interrupt the translation of ambition into practice. The second asks what organizational design would be needed to support implementation more effectively. The third reconstructs the value propositions embedded in real activity portfolios, thereby showing what cities in fact prioritize. The fourth and fifth studies then examine how city-level smart development can be diagnosed through strategic dichotomies and how those strategic orientations materialize in actual initiatives and stakeholder structures. Thus, strategy and implementation are not treated as separate topics across the portfolio, but as two sides of the same overarching research problem.

A third source of coherence is the dissertation's strong and recurring emphasis on **governance and organization as explanatory variables**. Even when governance is not the sole explicit focus of a given article, it remains present as an analytical concern. In the first article, governance appears in the form of institutional barriers, resource asymmetries, and external dependencies affecting medium-sized cities. In the second article, governance and organizational design become the central focus, especially through the question of how collaboration can be structured across urban stakeholders. In the third article, governance is less explicit, but still latent in the analysis of activity

portfolios and the distribution of anticipated benefits. In the Budapest study, governance becomes visible through the top-down versus bottom-up and double- versus quadruple-helix dichotomies. In the Debrecen study, it becomes even more concrete through stakeholder-network analysis. The studies therefore cohere not because each uses the same governance theory, but because each contributes to a shared dissertation-level claim: governance and organizational design are indispensable for understanding smart city development in practice.

The portfolio is also coherent geographically and contextually, though not in a narrow sense. Three studies are directly embedded in the Hungarian context, and two of these focus specifically on Hungarian cities. Two studies place medium-sized cities at the centre of the analysis, and another culminates in the Debrecen case, which gives the medium-sized-city issue a deeper empirical grounding. Budapest serves as a contrasting capital-city case within the same national and regional environment. The comparative portfolio study broadens the geographical reach of the dissertation beyond Hungary, while still serving the same conceptual concerns. This means that the dissertation is not a single-country study in a restrictive sense, but neither is it a geographically diffuse collection of unrelated cases. Its empirical design maintains a clear core orientation toward medium-sized urban settings and the Central and Eastern European problem context, while also using broader comparative material to sharpen conceptual interpretation.

At the same time, the five studies differ in important ways, and these differences are necessary for the dissertation's cumulative value. The first major difference concerns **theoretical emphasis**. The first study introduces a strategic-management perspective through Porter's Five Forces Framework, using it to interpret hindering factors in medium-sized-city smart development. This distinguishes it from the rest of the portfolio, because it explicitly imports a framework more typical of business strategy into urban and smart city research. The second study shifts away from strategic-management diagnosis toward organizational theory, collaborative innovation, and urban digitalization design. The third study focuses on value propositions and portfolio logic, drawing more heavily on comparative smart city strategy literature. The fourth and fifth studies share a common theoretical backbone in the four smart city dichotomies associated with Mora and co-authors, but the Debrecen study extends this with a network-governance

perspective. Thus, the studies are coherent at the level of the overarching problem, but theoretically differentiated in the lenses they apply.

A second major difference lies in **methodological orientation**. The first study is exploratory and diagnostic, using focus groups and a strategic framework to identify barriers. The second is partly design-oriented, combining literature review, inductive category development, and stakeholder validation in order to propose an alternative collaborative model. The third is the most strongly comparative, using deductive multiple case study analysis and systematic coding of activity portfolios across several cities. The fourth is a structured single-case study that applies a validated framework to Budapest. The fifth is also a structured case study, but it adds project-level coding and stakeholder-network analysis, giving it a stronger relational and governance-structural dimension. These methodological differences prevent the article portfolio from becoming repetitive. They also enable the dissertation to move from exploratory diagnosis to comparative interpretation and then to deeper case-based synthesis.

A third difference concerns **the empirical object under analysis**. Although all five studies relate to smart city development, they do not examine the same unit of analysis. The first study focuses on the barriers affecting a category of cities, namely Hungarian medium-sized cities, rather than on one specific city. The second focuses primarily on organizational arrangements and transition models, making the architecture of collaboration the central empirical object. The third analyses smart city activities and their value propositions across a set of cities. The fourth centres on Budapest's smart city development trajectory and strategic orientation. The fifth focuses on Debrecen's smart city project portfolio and stakeholder network. These distinct empirical objects allow the dissertation to examine the smart city from multiple levels: city segment, organizational model, multi-city portfolio, single-city strategic diagnosis, and networked governance structure.

A fourth difference lies in the **type of contribution** each study makes. The first article contributes mainly by identifying and categorizing barriers. The second contributes by proposing and validating an organizational response. The third contributes by showing how cities can be compared through the anticipated benefits embedded in their activity portfolios. The fourth contributes by applying a structured international framework to a Hungarian capital-city case and thus connecting Hungarian and international smart city research more directly. The fifth contributes by integrating strategic diagnosis with

stakeholder-network analysis in a medium-sized Central European city. These are not merely incremental variations. Each article adds a different layer of knowledge to the dissertation. Taken together, they produce a dissertation that is richer than the sum of its parts.

The synergies among the studies become clearer when they are read sequentially. The first and second articles form the dissertation's initial analytical pair. The first identifies the key hindering factors of smart city development in medium-sized cities, while the second addresses the organizational and collaborative conditions needed to respond to such barriers. In this respect, the second article can be read as a partial answer to the problems raised by the first. The third article then broadens the perspective by showing that the analysis of smart city development should not focus only on barriers and organizational problems, but also on the value propositions and benefit structures embedded in urban activity portfolios. The fourth article provides a focused empirical application of a strategic diagnostic model to Budapest, thereby localizing the broader conceptual debates in the Hungarian context. The fifth article can then be seen as the most integrative empirical study, because it combines the dissertation's core concerns, medium-sized city context, strategic orientation, implementation portfolio, governance, and stakeholder relations, within one case. Thus, the dissertation evolves from diagnosis to design, from portfolio interpretation to strategic diagnosis, and finally to governance-network synthesis.

Another important synergy is that the later studies retrospectively deepen the meaning of the earlier ones. For example, the first article identifies vendor dependence, weak standards, knowledge deficits, and biased approaches as major barriers. These become more analytically intelligible in light of the second article's organizational critique and the fifth article's network perspective. Similarly, the third article's emphasis on value propositions enriches the Budapest and Debrecen analyses by providing a language for interpreting what the cities' smart developments are expected to achieve, not merely how they are governed. The Budapest study, in turn, clarifies the empirical application of the strategic dichotomies that are later deployed more extensively in the Debrecen article. In this way, the studies are not only sequentially ordered but mutually illuminating.

It is equally important, however, to show that coherence does not imply uniformity. The five studies differ in empirical setting, scale, method, and contribution because the dissertation's central problem is itself multi-dimensional. A dissertation that aimed to

explain smart city development in practice through only one framework, one case, or one method would likely become either too narrow or too abstract. The value of the present portfolio is precisely that it preserves analytical diversity while maintaining a stable integrative logic. This is one of the advantages of the article-based format in this case. It allows different dimensions of the same broad research problem to be investigated with appropriately tailored methods, without forcing artificial uniformity across studies that address genuinely different sub-problems.

For these reasons, the dissertation should be understood as a coherent but differentiated research programme. Its coherence stems from the common focus on smart city development as a strategic, organizational, and governance process, especially in medium-sized and Central and Eastern European contexts. Its synergies stem from the way the articles cumulatively build on and clarify one another. Its differences stem from their distinct theoretical lenses, empirical units, methodological designs, and contribution types. Far from weakening the dissertation, these differences are what make the integrated dissertation-level contribution possible. The five studies do not simply repeat the same claim. They collectively demonstrate that smart city development is best understood as a layered process in which context, barriers, organizational arrangements, strategic choices, project portfolios, and stakeholder networks interact to shape how cities become smart in practice.

1.8 Structure of the dissertation

The dissertation is organized into seven main chapters, followed by a unified reference list and appendices. Its structure reflects the logic of an article-based dissertation, in which the individual studies form the core chapters of the thesis, while the opening and closing chapters provide the integrative framework necessary to ensure conceptual coherence, methodological transparency, and cumulative scholarly contribution.

- **Chapter 1, Introduction and Integrative Research Framework**, establishes the dissertation-level foundation of the thesis. It defines the research field, explains the relevance of smart city development with particular attention to medium-sized cities and the Central and Eastern European context, identifies the main research gap, and clarifies the conceptual boundaries of the study. It also presents the integrative conceptual framework, formulates the overarching research question and article-specific sub-questions, explains the methodological architecture of the

five studies, and demonstrates the coherence, synergies, and differences across the article portfolio. In this way, Chapter 1 provides the theoretical and analytical frame within which the subsequent studies are to be read.

- **Chapter 2, Factors Hindering Smart City Developments in Medium-Sized Cities**, serves as the dissertation's starting empirical and analytical chapter. It identifies the principal barriers that hinder smart city development in medium-sized urban contexts and interprets these barriers through a strategic-management lens. The chapter establishes the dissertation's problem-driven point of departure by showing that the limits of smart city development are not merely technological, but also structural, organizational, and institutional.
- **Chapter 3, Challenges and Solutions for Organizational Design in Urban Digitalization**, builds on the problem diagnosis developed in the previous chapter by shifting the focus to organizational design. It examines the barriers embedded in conventional organizational models of urban digitalization and develops a collaborative alternative intended to support smarter urban transition under complex, multi-actor conditions. This chapter therefore deepens the dissertation's argument that organizational and governance arrangements are central to the practical realization of smart city ambitions.
- **Chapter 4, The Many Faces of the Smart City**, broadens the analysis through a comparative perspective. It investigates the anticipated benefits and value propositions embedded in smart city activity portfolios and compares how these are distributed across cities. This chapter contributes an important strategic layer to the dissertation by showing that cities do not merely differ in the extent of their smart developments, but also in the kinds of benefits and development logics they prioritize.
- **Chapter 5, What Are the Conditions to Become Smart?**, turns to the Hungarian context through the case of Budapest. Using the four strategic smart city dichotomies, the chapter analyses the city's strategic orientation and examines the conditions under which a Central and Eastern European capital city attempts to become smart. This chapter links the broader conceptual debates of the dissertation to a specific national and regional setting, while also providing a capital-city reference point for the later medium-sized-city case.
- **Chapter 6, Smart City Governance in a Medium-Sized European City**, presents the Debrecen case as the dissertation's most integrative empirical

chapter. It combines strategic diagnosis, project-level analysis, and stakeholder-network analysis in order to examine how smart city development is structured in practice in a medium-sized Central European city. This chapter brings together the dissertation's central concerns with context, governance, organizational design, implementation logic, and stakeholder relations, and therefore functions as the empirical culmination of the article portfolio.

- **Chapter 7, Integrative Conclusion**, returns from the individual studies to the dissertation level. It synthesizes the findings of the five articles, revisits the overarching research question, and reflects on what the combined results reveal about the conditions under which cities become smart in practice. It also highlights the dissertation's theoretical, methodological, and empirical contributions; discusses implications for smart city research and urban policy; acknowledges the limitations of the study; and outlines possible directions for future research.
- Following the seven main chapters, the dissertation includes a **unified bibliography**, which brings together the references cited in the integrative chapters and in the five article chapters into one consolidated reference list. This is followed by the **appendices**, which contain the list of abbreviations, a glossary of key terms, and the list of the author's publications related to the dissertation.

The chapter order is therefore neither arbitrary nor merely formal. It follows a deliberate progression from integrative framing, through the five core studies, to final synthesis. The dissertation begins by establishing the broader problem and conceptual architecture, then moves through the individual articles in an order that reflects analytical accumulation: from barriers to organizational responses, to comparative portfolio logic, to city-level strategic diagnosis, and finally to governance-network analysis in a medium-sized-city case. The final chapter then draws these strands together into a unified answer to the dissertation's central question. In this way, the structure of the dissertation mirrors the cumulative logic of the research itself.

1.9 Article portfolio matrix

The table below summarizes the main analytical role of each article, its guiding question, methodological approach, empirical focus, and dissertation-level contribution.

Table 1 Article portfolio matrix of the dissertation.

Article	Main question	Method	Empirical focus	How it contributes to the dissertation
Factors Hindering Smart City Developments in Medium-Sized Cities (2018)	What factors hinder smart city development in European medium-sized cities, and how can these barriers be interpreted through Porter's Five Forces?	Exploratory qualitative study using **Porter's Five Forces Framework**, based on **two focus groups** with public-sector and market actors, plus an additional interview.	Hungarian medium-sized cities and city districts, with attention to barriers such as knowledge gaps, data problems, vendor lock-in, biased approaches, and lack of standards.	Establishes the dissertation's **problem-driven starting point** by showing that smart city transition is constrained not only by technology, but also by structural, strategic, and institutional barriers in medium-sized-city contexts.
Challenges and Solutions for Organizational Design in Urban Digitalization (2020)	What organizational barriers are inherent in conventional smart city transition models, and can a collaborative alternative overcome them?	**Literature review**, **inductive category development**, **three semi-structured focus groups**, and design/validation of an alternative organizational model.	Organizational barriers in urban digitalization across public, private, and professional stakeholders; SmartCEPS as a proposed collaborative platform model.	Adds the dissertation's **organizational-design layer** by explaining why implementation stalls and by proposing a collaborative model that responds to the barriers identified in the first article.

The Many Faces of the Smart City (2021)	What benefits are anticipated from smart city developments, how are these distributed in cities' activity portfolios, and how can cities be categorized on that basis?	**Deductive multiple case study analysis** with literature-based coding of value propositions, comparative analysis, and cluster-based interpretation.	Nine cities' smart city activity portfolios; 637 activities coded from a large database of digital records and grouped by nine anticipated benefit categories.	Introduces the dissertation's **value-proposition and portfolio logic**, showing that cities differ not only in how much they do, but in the kinds of benefits and strategic priorities embedded in their smart city activities.
What Are the Conditions to Become Smart? (2022)	How can the smart city strategy and activity portfolio of Budapest be interpreted through the four strategic smart city dichotomies, and what does this reveal about becoming smart in a Central and Eastern European capital?	**Single-case study** using a validated **dichotomy-based framework**; structured coding of Budapest's strategy and activities.	Budapest as a less successful Central and Eastern European capital-city case, analysed through the four dichotomies: technology-led/holistic, top-down/bottom-up, double-/quadruple-helix, mono-dimensional/integrated.	Brings the dissertation into the **Hungarian and Central and Eastern European context**, operationalizes the dichotomy framework, and provides the capital-city comparison point for the later Debrecen analysis.
Smart City Governance in a Medium-Sized European City (2026)	How is the smart city development of Debrecen structured in practice, and what do project-level coding and stakeholder-network analysis reveal about its governance model?	**Structured case study** using a validated **dataset of 120 initiatives**, dichotomy-based coding, and **stakeholder collaboration network analysis**.	Debrecen, Hungary; project portfolio across smart city domains and a network of 161 stakeholder organizations.	Functions as the dissertation's **most integrative empirical chapter**, combining medium-sized-city context, strategic diagnosis, governance structure, and stakeholder-network analysis into one cumulative case.

This chapter has established the integrative foundation of the dissertation. It has shown that smart city development should be understood not as a narrowly technological process, but as a context-dependent urban transition shaped by strategy, governance, organizational design, and stakeholder relations. The chapter first situated the dissertation within the broader smart city field and highlighted the particular relevance of medium-sized cities and the Central and Eastern European context. It then identified the main research gap, namely the insufficient integration of contextual, organizational, and governance-oriented perspectives in the explanation of how cities become smart in practice.

The chapter also clarified the conceptual boundaries of the dissertation by defining its key terms and by distinguishing process-oriented smart city development from static and purely indicator-based interpretations of smartness. On this basis, it introduced the dissertation's integrative conceptual framework, which links urban context, strategic orientation, barriers and enabling conditions, governance and organizational design, activity portfolios, stakeholder networks, and the resulting smart city development trajectory. It further translated this framework into one overarching research question and five article-specific sub-questions, thereby making explicit how the individual studies collectively address the dissertation's central problem.

In methodological terms, the chapter demonstrated that the five studies form a cumulative and complementary research architecture. Rather than repeating the same inquiry, they approach the overarching question through different but mutually reinforcing methods, empirical objects, and analytical levels. The chapter then showed that the coherence of the article portfolio lies in its shared concern with the practical conditions of smart city development, while its strength lies in the differences among the studies in theory, method, empirical scope, and contribution. Finally, it outlined the structure of the dissertation and summarized the role of each article within the overall design.

With this integrative framework in place, the dissertation now turns to the first core study. The next chapter examines the barriers hindering smart city development in medium-sized cities and establishes the problem-driven point of departure for the empirical analysis that follows.

2. Factors Hindering Smart City Developments in Medium-Sized Cities

2.1 Chapter preface

This chapter presents the first core study of the dissertation and serves as the empirical point of departure for the article-based analysis. Its placement at the beginning of the article portfolio is deliberate. After Chapter 1 established the broader research field, research gap, and integrative framework of the dissertation, the present chapter moves to the first concrete analytical problem: what hinders smart city development in medium-sized cities, and why these barriers matter for understanding smart urban transition in practice.

The study is particularly important at this point because it identifies the structural and strategic constraints that recur, in more specific forms, throughout the later chapters. By applying Porter's Five Forces Framework to the context of smart city development, the article introduces a strategic-management perspective into a field that is often dominated by technological, descriptive, or benchmarking-oriented approaches. It shows that medium-sized cities face not only technological limitations, but also knowledge gaps, data-related constraints, vendor dependence, biased approaches, and the absence of widely accepted standards. In this sense, the chapter establishes the dissertation's core claim that smart city development is shaped by organizational, institutional, and governance conditions as much as by digital technologies themselves.

The chapter also creates a direct bridge to the chapters that follow. Chapter 3 builds on the barriers identified here by focusing more specifically on organizational design and on the institutional arrangements that may help cities overcome implementation problems. Chapter 4 extends the discussion from barriers to value propositions and activity portfolios, showing not only what hinders smart city development but also what kinds of anticipated benefits cities pursue through it. Chapters 5 and 6 then move to the structured case-based diagnosis of Budapest and Debrecen, where several of the problems first raised in this chapter reappear in the form of strategic imbalance, top-down governance, uneven stakeholder engagement, and constrained local capacities. The present chapter should therefore be read not as an isolated early publication, but as the dissertation's problem-formulating chapter: it identifies the barriers that make the subsequent focus on organization, governance, and strategic orientation necessary.

At the dissertation level, the chapter contributes especially to the medium-sized-city dimension of the overall research question. It argues that medium-sized cities deserve dedicated analytical attention because they dominate the European urban landscape, yet are often underserved both by the smart city literature and by the strategic models and solution packages offered to them. The findings therefore provide the first empirical grounding for one of the dissertation's central propositions: the pathways through which cities become smart cannot be understood adequately without taking city size, local capacity, and contextual constraints seriously.

A note on the study's methodological design at the dissertation level. Because the prefaces to the later chapters set out their methods in some detail, it is useful to make the design of this first study equally explicit. The study deliberately adopts a qualitative, exploratory, and practitioner-grounded design, because its objective is not to measure the prevalence of already-known barriers but to surface and structure the barriers as they are experienced by those responsible for smart city development. For this reason, it imports a strategic-management lens, Porter's Five Forces, into a field more often approached through technological or benchmarking perspectives, and it gathers evidence through focus groups rather than a survey instrument. Focus groups are appropriate here because the barriers of interest are partly tacit, interdependent, and shaped by interaction among municipal, supplier, and professional perspectives, and because the aim is theory-structuring rather than statistical generalization.

The **empirical basis and the characteristics of the sampled municipalities** also warrant emphasis. The core evidence comes from two three-hour focus group sessions involving fifteen participants in total, drawn principally from senior representatives of Hungarian municipalities and public authorities responsible for smart city development, and supplemented by participants from two consulting companies and two smart city clusters representing the supplier and solution-provider side, together with an interview with a representative of smaller Romanian settlements. The sampled cities and city districts (presented in Figure 6) were characterized through indicators chosen for their strategic relevance: population size, used as the primary segmentation variable in line with established practice (Giffinger et al., 2007); GDP per capita, as a proxy for economic role and the presence of multinational actors; local industry-tax revenue per capita, as an approximation of the discretionary resources a municipality can direct toward smart city initiatives; and the share of residents holding higher-education qualifications, as a

measure of available social capital. This deliberately diverse, multi-stakeholder sample reflects the participatory and multi-actor nature of smart city development and ensures that the identified barriers are seen not only from the municipal side but also from those of suppliers and professional intermediaries.

2.2 Bibliographic record and author contribution

Full citation	Csukás, M. S., and Szabó, R. Z. (2018). *Factors Hindering Smart City Developments in Medium-Sized Cities*. TMP, 14(1), 3-14. https://doi.org/10.18096/TMP.2018.01.01
Publication status / outlet	Published journal article in *TMP* (Theory, Methodology, Practice), Volume 14, Number 1, 2018.
Co-authors	Máté Szilárd Csukás and Roland Z. Szabó.
Doctoral candidate contribution	The doctoral candidate was the lead author of the study and contributed to the conception of the research problem, the positioning of medium-sized cities as the empirical focus, the adaptation of Porter's Five Forces Framework to smart city development, the empirical data collection through focus groups and interviews, the interpretation of the findings, and the preparation of the manuscript.
Relation to dissertation research question	This article addresses the dissertation's overarching research question by identifying the principal barriers that hinder smart city development in medium-sized cities and by showing that the transition toward smart urban development is shaped by structural, strategic, and institutional constraints, not only by the availability of technology. It therefore provides the dissertation's initial barrier-diagnosis layer and establishes the medium-sized-city problem context that later chapters develop further through organizational, strategic, and governance analysis.
Editorial adaptation note	The full text of the published article is reproduced in this dissertation as a core chapter of the article-based thesis. Minor editorial adaptations may have been made to ensure consistency with the overall dissertation format, including chapter numbering, layout, figure and table numbering, citation

	harmonization, spelling standardization, and alignment with the unified bibliography. No substantive changes have been made to the argument, methodology, or findings of the original publication.

2.3 Introduction

The concept of the Smart City (SC) is not a new phenomenon; however, it started to rapidly gain momentum in the academic literature in the last five years. Based on a Scopus document search, the number of publications with the keywords "Smart City" and "Smart Cities" increased from 465 in 2012 to 4247 in 2017. (see Figure 2).

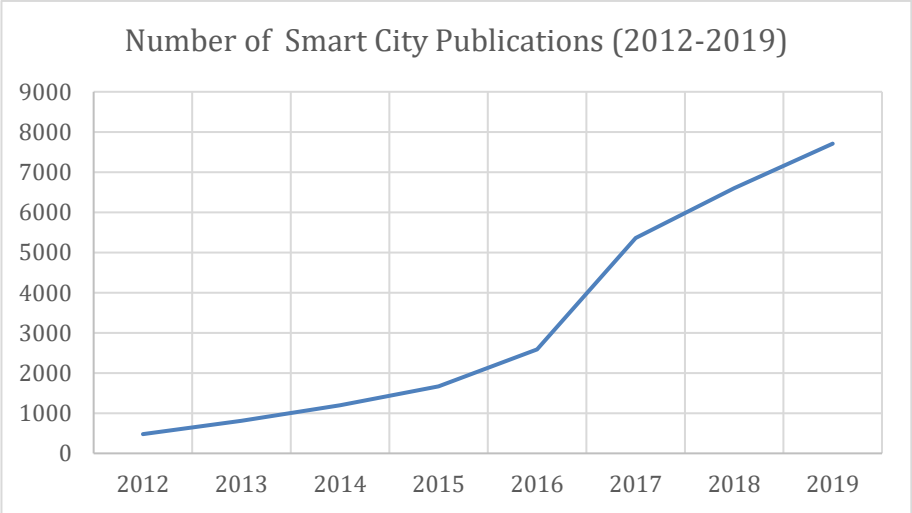


Figure 2 Search terms are 'Smart City' or 'Smart Cities' in the keywords of all types of documents. Source: Own edition based on Scopus Database.

At same time, not only academia considers SC an important topic, but also economic actors have great expectations, from startups to multinational companies, policy makers and governments. Wellington Webb, the former mayor of Denver and past president of the U.S. Conference of Mayors, once said: "The 19th century was a century of empires, the 20th century, a century of nation states. The 21st century will be a century of cities" (Eger 2016).

This popularity can also be expressed in the thriving environment of conferences, expos and other professional events with SC content. The reasons for this unprecedented popularity primarily originate from global urbanization growth trends. Today, humans are considered to be an urban race, as more than half of the globe's population lives in an urban environment. This ratio is predicted to grow to 68.4% by 2050, which means that

6.67 billion people are expected to live in urban areas covering only 2% of the Earth's surface (United Nations, 2018). It is predicted that 27 megacities[1] will be formed by 2025. To put this into context, there were only two megacities in 1950, New York - Newark and Tokyo (United Nations, 2015).

Another way to demonstrate the significance of cities is by looking at their economic weight compared to the number of inhabitants. Only 16% of France's population lives in Paris, but 27% of its national GDP originates from the city. This is even more extreme in less developed countries: for instance, 13% of Congo Democratic Republic's inhabitants live in the capital, while 85% of the GDP comes from there (Hawksworth et al. 2009). Besides economic context, environmental issues are also huge. 75% of the globe's energy consumption and 80% of greenhouse gas emissions are in urban environments. Realizing these trends, the world's governments are planning to invest 35 trillion USD in infrastructure and urban development in the next two decades (United Nations, 2015). This amount exceeds the GDP of China by more than three times in 2016[2].

The dynamic clustering of people, built environment, resources, capital and infrastructure poses new and even unknown challenges, therefore placing an enormous amount of stress on existing urban systems, creating a great demand for new ways and new approaches from researchers, policy makers, governments, company executives and the civil society itself.

2.4 Literature review

There is no evidence for clear origins of the smart city concept in the scientific literature. Some say that its roots date back to the 'cybernetically planned cities' of the 1960s (Gabrys 2014), while some aspects of it have been present in proposals for networked cities since the 1980s. It is claimed the concept was introduced in 1994 (Dameri and Cocchia 2013). Despite the fact that Smart City is a buzzword, gaining increasingly high attention from multiple stakeholders of the urban development ecosystem, and although it has been present in the literature for quite a time, there is no clear and consistent understanding of its meaning. There are many definitions available, proposed by different

[1] According to the United Nations, megacities are "cities with more than 10 million inhabitants"

[2] Source: World Bank, URL: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2017&locations=CN&name_desc=false&start=2017&view=bar

stakeholders. Two types of focuses can be differentiated: (1) approaches that put the focus on technological advances (ICT mainly) and (2) approaches that highlight the role of the people and their quality of life (see Figure 3).

From the ICT point of view, five different approaches can be identified: (1) interconnectedness and monitoring of the infrastructure, (2) managing and optimizing resources, (3) enhancing communication channels and bringing different urban actors closer to each other, (4) data generation, analytics and deploying intelligence solutions (research about 'Big Data' in the urban context is more and more popular), and (5) supporting business model innovations (Hall 2000; Washburn et al. 2010; Harrison et al. 2010; Nam and Pardo 2011; Barrionuevo et al. 2012; Zygiaris 2013; Marsal-Llacuna et al. 2015; Albino et al. 2015).

Definitions focusing more on people are primarily concerned about five aspects, which are: (1) enhancing the quality of life of citizens (this seems to be the most widely used term when explaining the ultimate goal of Smart Cities), (2) investment and development of social capital and human capital, (3) promoting social innovations such as increased participation of citizens in governance, (4) enhancing the quality of city services and (5) promoting and preserving cultural heritage (Hall 2000; Caragliu et al. 2009; Giffinger et al. 2010; Thuzar 2011; Albino et al. 2015).

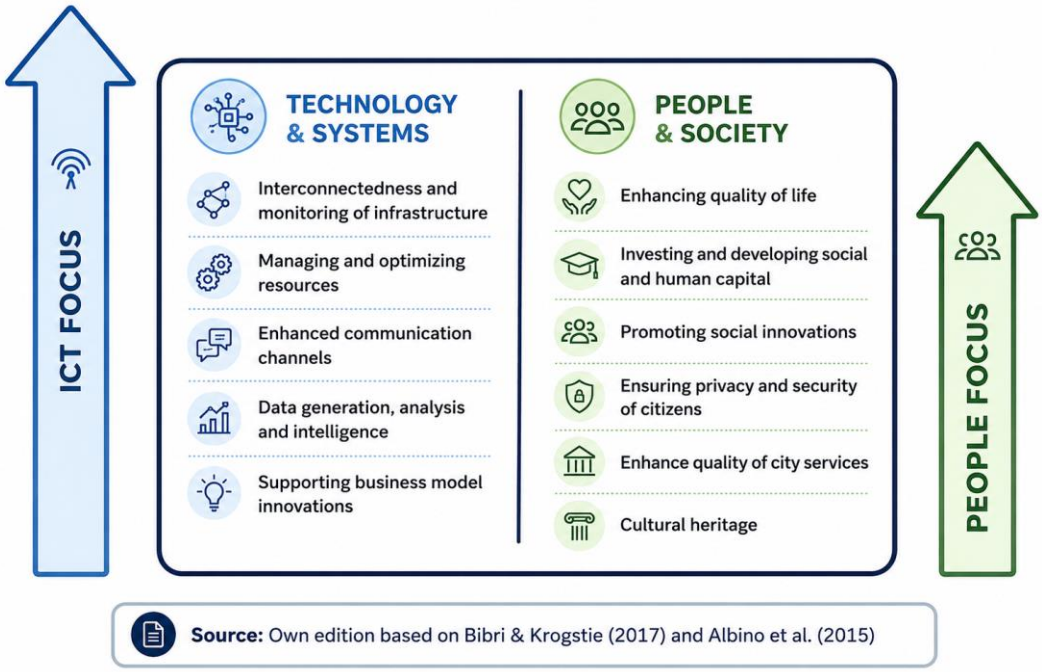
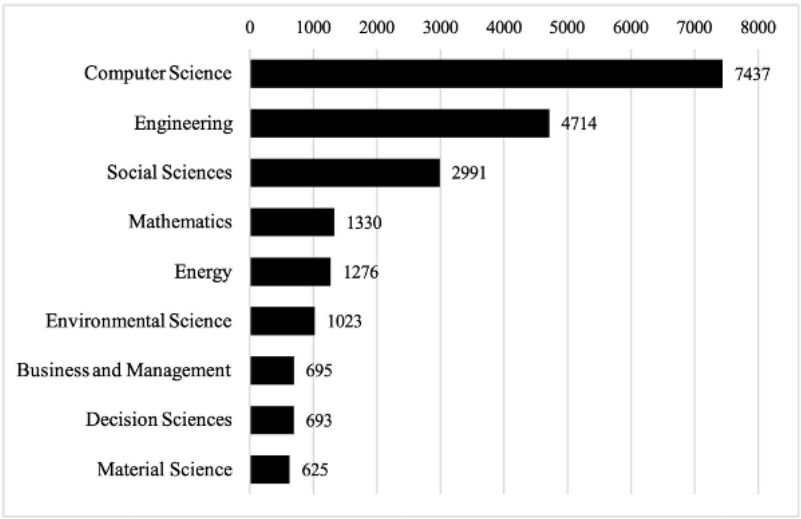


Figure 3 Main focus areas of Smart City definitions

This technological dominance is also confirmed by the share of different subject areas of publications with keywords Smart City and Smart Cities: in the specific searching criteria, Computer Science and Engineering documents were four times as frequent as those in Social Sciences. The share of Business and Management publications is only marginal (see Figure 4). It must be said that environmental and sustainability goals are also often occurring elements of the definitions; however, they are lacking the proper interpretation and context in most of the cases. Table 2 gives a quick overview of these definitions, with the interpretations suggested by the authors.



Source: Own edition based on Scopus Database. Search terms are the keywords 'Smart City' and 'Smart Cities' in all types of documents.

Figure 4 Distribution of publications from different academic fields

The most commonly occurring words in the definitions are Information, Infrastructure, Sustainable, Life, Social and Capital, while phrases are 'Quality of life', 'Social capital', 'Sustainable economic', 'Economic development', 'Using new technologies' and 'Investment in Human' (own analysis). The strong connection between the deployment of advanced ICT solutions and social innovations – included in these proposed definitions – confirm the new innovation paradigms characterized by Balaton et al. (2016). The most important purpose of all of this research is the outline of an easily adoptable, widely acceptable and strong smart city model. This was the key challenge for academic endeavours in recent years, but the gap is still vacant, there is no such model at the moment. Bibri and Krogstie (2017) identified at least 19 existing gaps in the research within the field of smart sustainable cities, e.g. "There is a need for integrated models for spurring the practice of the development and deployment of smart sustainable cities" (p. 204) and "There is no comprehensive model for merging the informational and physical landscapes of smart sustainable cities" (p. 203). Besides definitions, the 'Smartness' of

cities are measured by their performance in specific domains that identified by researchers. These assessments are similar to strategic assessments and audits, enabling benchmarking, comparisons and justifying urban strategies. As with the definitions, these models are also heterogeneous and none of them has become a standard, which actually leaves cities exposed to the uncontrolled influence of promoters of these models. Approaches that are city specific but comparable and holistic approaches are missing from the canvas of the models. The following graph illustrates the existing gaps in the research (and market viable solutions) in the field of SC models.

Table 2 Existing definition of Smart Cities with the author's interpretation

Interpretations of definitions[3]	Author	Date
Use ICT to interconnect different domains to maximize the quality of life of citizens	Silva et al.	2018
Use ICT to optimize existing infrastructure, connect economic actors and deliver better services to citizens	Marsal-Llacuna et al.	2015
Use ICT to enhance and interconnect infrastructure, optimize resources and apply good management to deliver superior services to citizens	Kitchin	2014
Enhance the quality of life of citizens by social-economic and environmental factors, considering the local specifics of cities.	Neirotti et al.	2014
Network of technologies for sustainability, attractiveness and security	Lazaroiu & Roscia	2012
Use ICT technology for social and environmental purposes	Lombardi et al.	2012
Use ICT technology and optimize resources in an intelligent way for social and environmental purposes	Barrionuevo et al.	2012
Resilience to maximize quality of life for citizens	Guan	2012
Use ICT technology and highly efficient governance for quality of life for citizens and for the economy	Gabriel Cretu	2012
Optimizing available capital (e.g. human, social) by strategies for enhancing social, economic and environmental dimensions	Kourtit & Nijkamp	2012

3 Source: Own edition based on Albino et al., (2015, pp. 6–8) supplemented with Kitchin (2014) and Neirotti et al. (2014)

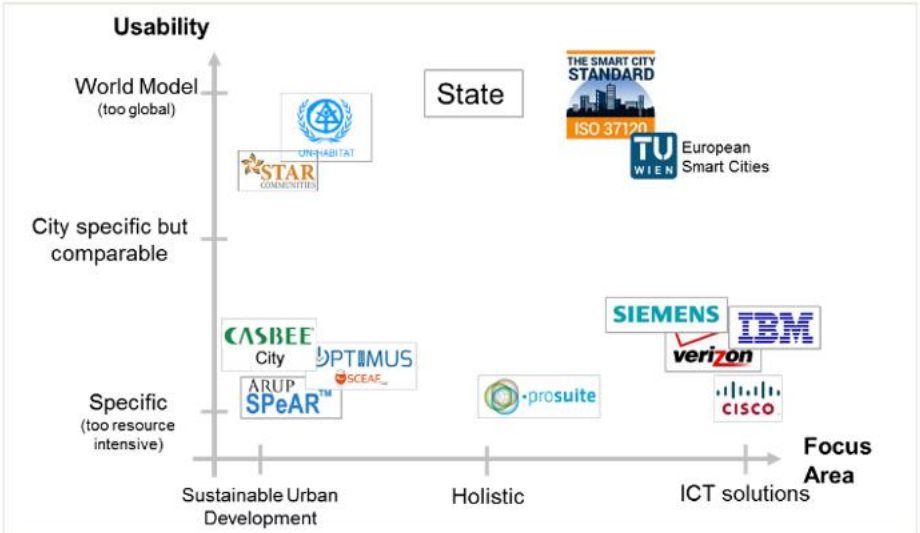
High productivity and output oriented management for sustainability purposes	Kourtit et al.	2012
Excellent performance in the dimensions of environment, interconnectedness, ICT technology deployment, innovation and education.	Zygiaris	2012
Territories with excellent conditions for education and innovation, supported by technologies and good management	Komninos	2011
Availability to generate and to be attractive to talented people	Thite	2011
Optimize resources; invest in local capital and infrastructure to maximize quality of life and have sustainable economic development. Existence of targets for these activities	Thuzar	2011
Infrastructure for collective intelligence	Harrison et al.	2010
Use ICT technology to make services and infrastructure intelligent, interconnected and efficient	Washburn et al.	2010
Use ICT technology and optimize resources to maximize quality of life for citizens	Chen	2010
Invest in local capital and infrastructure to maximize quality of life and have sustainable economic development, together with civil participation and good management	Caragliu et al.	2009
Use ICT technology to be resilient in social and economic dimensions, relying on interconnectedness for maximizing quality of life for citizens	Eger	2009
Territories with excellent conditions for innovation and education supported by ICT technology for interconnectedness	Hollands	2008
Measure performance in specific domains, with civil participation and interconnectedness	Giffinger et al.	2007
Manage and optimize infrastructure for citizens	Hall	2000
Maximize citizens' quality of life by ICT technology	Mahizhnan	1999

Besides the different approaches, geographical discrepancies are also present in Smart Cities research, policy maker's attitude, company strategies and actual implementations as well. In this matter, this paper focuses on the European Union's context. Narrowing down the field to the EU illustrates well the problem with 'world models' or multinational companies using global strategies, while each city is different. The EU is already very highly urbanized (75%), the weight of megacities is rather low, and medium-sized cities

dominate the urban landscape. For the sake of clarity, here the author adopts the definition of Giffinger et al, (2007) of medium-sized cities as those being between 100,000 and 500,000 inhabitants.

On the policy level, the European Union adopted an approach with six pillars in 2015[4] (European Economic and Social Committee), which resembles the four pillars outline (Giffinger et al,, 2010) and since then the number of studies and projects has grown rapidly. As a rising topic with vast areas of research potential, the author believes that it is yet an untapped field, and synthesizing methodological components, models, reasoning and concepts from enterprise strategic management theories and applying them to SC model research would bring great added value to the discussion.

This paper is intended to move this unsettled field forward with the experimentation and application of currently neglected scientific methodologies. Furthermore, current discussion rarely takes into consideration the diverse backgrounds of cities, their history, local conditions, environment, etc. This essay attempts to explore the factors hindering SC developments for European medium-sized cities, based on a sample of Hungarian medium-sized cities utilizing Porter's Five Forces Framework.



Source: Own edition based on the SmartCEPS project's working documents (2017)

Figure 5 Mapping of existing Smart and Sustainable City frameworks and models

[4] Opinion of the European Economic and Social Committee on 'Smart cities as drivers for development of a new European industrial policy' (own-initiative opinion) (2015/C 383/05)

City	Inhabitants	GDP/capita (EUR)	Industry tax per capita (EUR)	Higher education degree holders
IX District of Budapest	59,000	52,459	198	33.5%
XI District of Budapest	152,620	34,108	168	38.2%
VIII District of Budapest	76,811	19,298	156	25.3%
XVII District of Budapest	87,793	2,213	203	19.6%
XVIII District of Budapest	101,738	8,167	234	19.3%
Kaposvár	63,186	2,826	107	19%
Debrecen	203,059	5,016	136	22.2%
Győr	129,568	24,422	406	20.8%

Figure 6 Overview of sampled cities[5]

2.5 Methodology

For experimentation of strategic management methodologies, the author utilizes the Porter Five Forces Framework (Porter, M.E., 1998) to deepen our knowledge about European medium-sized cities regarding Smart City deployments and experience. The primary source of information is two focus groups with 15 people in total with 3 hour sessions in both cases. Senior representatives from Hungarian municipalities and public authorities responsible for Smart City developments in Hungary were invited. In focus of the questions was their attitude towards Smart Developments and experience with completed or ongoing projects. An interview with a representative of smaller Romanian settlements was also conducted. Figure 6 gives an overview of the sampled cities and city districts. In focus groups insights were also gained from two consulting companies and two Smart City clusters, representing primarily suppliers and solution providers of SC services. Having a diverse sample is important because SC development affects multiple stakeholders and, as defined by many authors (Yin et al. 2015), participatory governance and social innovations are core parts of the whole concept.

[5] Source: Own edition, based on data derived from TEIR database. Data extracted on 2018.04.28. Available here: https://www.teir.hu/its/

The indicator ‘Inhabitants’ is a key data for segmenting cities. Giffinger et al. (2007) and others also use population size to create categories for research, while multinational companies use the same method to segment cities in their strategic assessments and business models, e.g. based on observation of Cisco SC projects, the company considers its target segment as cities with at least 250,000 inhabitants. GDP/capita suggests the city’s role in the economy and the presence of multinational companies, which is a key driver for SC endeavours. The previously described geographical concentration of resources is clearly shown by this data; deviation is quite large between territories, especially outside of the capital. Industry tax per capita is used with the assumption that it is a good indicator to measure the discretionary income of local governments that can be spent on SC initiatives. Considering the fact that investment can be financed from non-local sources, e.g. the European Regional Fund, central governmental sources or corporate investments, it is difficult to measure the financial capability of a city. Indicators like FDI flows, realized corporate investments or awarded subsidies are also possible metrics for measuring incomes of cities and predicting their financial capacities to invest in Smart City developments. The proportion of inhabitants holding college or university degrees is an indicator for measuring the available social capital, which was identified as a key driver factor.

2.6 Porter’s Five Forces Framework

For empirical research about these cities, the author applies the Porter’s Five Forces Framework to examine their maturity to deploying SC technologies, strategies and other initiatives and identify what are barriers that hinder them from becoming more mature. The scope of this analysis is highly focused on the solution providers entering this specific segment of ‘medium-sized’ cities. The five-factor model describes industrial structure as a determinant of profitability in the industry (Balaton and Hortoványi 2018). In this context the model is interpreted as a tool to identify barriers and enabling factors of ‘Smart Cities’ developments through the different drivers and channels of resources, stakeholders and transactions. This framework is a vehicle to structure and show empirical evidence found during qualitative research for the better understanding of hindering factors in medium-sized cities.

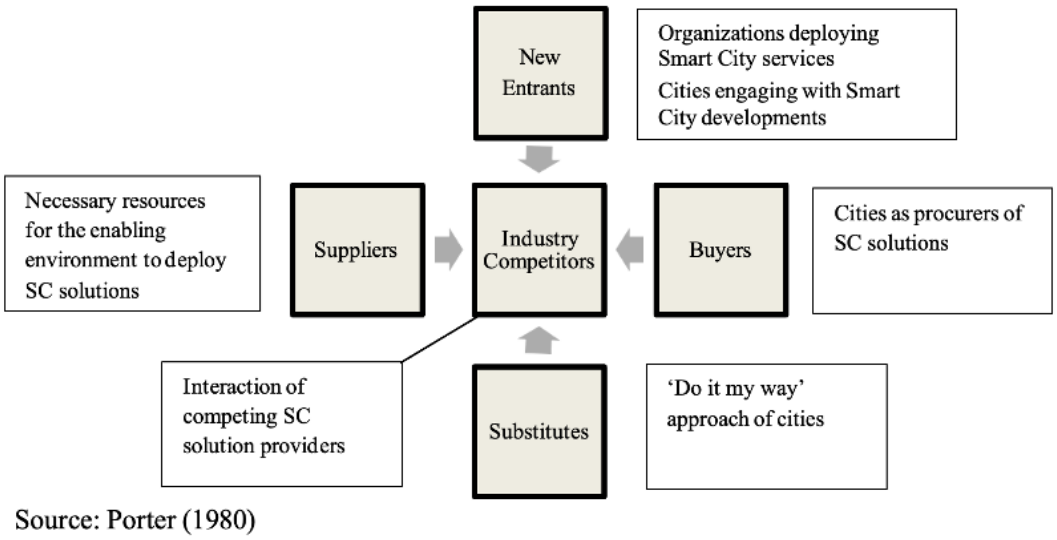


Figure 7 Application of Porter's Five Forces Model on Smart Cities

2.6.1 Bargaining Power of Suppliers

Companies and organizations engaged in deploying 'Smart City' solutions are considered to be part of 'emerging industries', where employees face complex problems that can be solved only by higher and more general knowledge which fosters high-level innovation (Boda 2017). The most important inputs for these actions are experts and specialists with knowledge, an appropriate skillset and competences for solving problems and also for implementing the planned solutions. In sample cities these resources are not easily accessible, but of course capital regions are in a better position compared to cities in the country side, where human resources are harder to access. Talent and social capital is concentrated in Budapest, and primarily in the for-profit sector, so there is a huge demand for specialists and experts that can manage SC developments in smaller settlements, create knowledge within public bodies, etc.

Currently this topic is being neglected in Hungarian higher educational courses; however, examples abroad can be found, e.g. University College London (UCL) – MSc in Smart Cities and Urban Analytics (United Kingdom-London), Universidad Ramon Llull (URL) – Postgrado en Smart City (Spain-Barcelona), Aalborg University (AAU) – Master's Programme in Sustainable Cities (Denmark-Aalborg). SC experts have diverse competencies including engineering, economics and sustainability (García and Sisto 2015), so people coming from one specific sector and creating SC strategies for municipalities tends to result in a biased analysis: one of the cities in the sample has an

energy-orientated strategy due to the background of the people responsible for the assessment. These biased analytics are a serious issue that probably originates from a lack of standards and the lack of governmental thresholds for creating such strategic documents.

Data is a key resource just as important as humans. Data is required in quantity, excellent quality, and must be up to date, accessible and reliable. In sampled cities 'Data issues' are uniformly considered to be barriers of deploying SC services. Data available from statistical offices is usually outdated and highly inaccurate. Bad data distorts whole strategies, and this is a very relevant issue nowadays, so policymakers are encouraged to address this phenomenon. The few existing Hungarian studies also indicate how data availability can distort analysis (Nagy et al. 2016). The utilization of big data is welcomed in sample cities; however, the maturity of the data industry is quite low yet in Hungary and companies are focusing on Business Intelligence, and not on urban clients. Also, data about the cities is in many cases in the hand of external owners and providers, who are usually reluctant to provide data and offer limited cooperation with many mistakes. During interviews, it was mentioned that personal connections to these data owners (utility companies in many cases) or specific requests from higher political circles usually dissolve this barrier. It is clear that the policy framework for such requests and data provision is not adequately addressed by policymakers.

2.6.2 Bargaining Power of Buyers

In this context, SC solution providers are 'selling' their products and services to municipalities. For the sake of simplifying this special interaction between the sample cities and companies, the author narrows down the scope of the framework to 'switching costs', 'backward integration', and 'buyer information about supplier products'.

Switching costs are a key issue in SC development, not only in Hungary but all over Europe. Vendor lock-in is the phenomenon in which suppliers deploy technologies to cities (e.g. CCTV, energy grids, broadband networks, etc.), which are long lasting, capital intensive, and knowledge intensive, so that switching to another vender would incur very high costs. This issue is very serious, considering that there are still no standards, reliability of technology is a question and developments are rapid, so cities can be locked into outdated and inefficient technologies. This also makes decision makers suspicions of suppliers, and they are very hard to convince about deploying SC solutions. Vendors usually neglect to detail exactly how the proposed technologies can be integrated with

existing systems in complex municipal environments. Only smaller projects are easily adopted, where smaller investments are required.

Backward integration is interpreted in this context as the cities taking control in their own hands. This is the make-or-buy decision: do-it-yourself or hire an external smart city expert. The study reveals that the standard choice for Medium Hungarian cities, like Győr or the XI District in Budapest is to give the job to an external party. The buyer may also do the work themselves by setting up a staff or project team of local experts. One scenario is that the city establishes a publicly owned company, foundation or an internal office in its administration to do the job. This happened in Debrecen, for example, and signs are indicating that Budapest also plans to establish a competence centre company for this purpose. As we examine practical choices of cities, there can be an exponential trend noticed. According to our observation, the higher the city, the higher the chance that it will deploy its own capacities to deal with managerial and professional issues of Smart City Developments.

Another important issue is buyer information about supplier solutions. Decision makers in cities are not experts on every field in which suppliers approach them, so they need special channels and methods to present the value proposition for the city. These solutions are usually technological and hard to understand, city- specific challenges are rarely referenced, and there are concerns about transparency of the added value. Considering that the multinational companies in Hungary rarely commit resources to innovation in the country, rather mainly in their headquarters (Boda 2017), Hungarian cities have inferior conditions for having these ICT solutions adjusted to their local needs by solution providers. Also, vendors often neglect to explain how the financing and operating models are meant to work until much later on. Another interesting finding is that just like companies and scientific researchers, each city has its own ‘definition’ for Smart Cities, so in many cases their developments are biased, and they do not continue developing because their perception is that they are already ‘smart’.

It is also worth mentioning that if decision makers, e.g. the budgetary council, mayor or central government, have incentives for keeping down expenses or avoiding indebtedness, they will be more price sensitive to SC solutions. Take for example Hungary, where local governments can only be involved in debt generation if they are given permission from central government; this is a rather strict incentive for them (Lentner 2014). It is also a barrier that governments actually favour specific multinational

supplier companies, therefore reducing the freedom of choice for cities in Hungary and in Romania as well. This was mentioned by multiple respondents. Furthermore, the districts of Budapest have authority to some extent, but they are limited in their actions by the Mayor's Office. Generally, in other countries, keeping to the budget is a standard as we are talking about public money and the general public expenditure climate is yet to recover after the economic difficulties of the European Union.

2.6.3 New Entrants

Press releases on new entrants to the Hungarian Smart city market are daily phenomenon. From start-ups to large companies, including public and private market actors, a wide range of entities are becoming more and more engaged in the industry. The motivation and market driving force originate from a wide range of aspects. It seems that the overall benefits that companies perceive go beyond market barriers. In sample cities, supplier salespeople are daily approaching departments about SC technology solutions.

Economies of scale is a special attribute which differentiate medium-sized cities from larger ones, especially from megacities, which are in the focus of the largest and most competent multinational SC solution providers (e.g. IBM, Cisco). Smaller cities are neglected in the moment, mainly because of profitability and the shortage of local knowledge and capacities. This puts pressure on small and medium-sized cities. The above-mentioned barriers also reduce the attractiveness of smaller cities for larger suppliers. They have to rely on less innovative and less competent service providers. Product differentiation means that established firms have brand identification and customer loyalties, which stem from past advertising, customer service, product differences or simply being first into the industry (McNeill 2015). This differentiation creates high barriers for new entrants to spend heavily and overcome existing loyalties and increases vendor lock-in. Cities rely on external expertise on choosing their suppliers and personal connections or political incentives play significant role in the process. This aspect coincides with 'access to distribution channels'. Lobbying activities are very important; however, they distort strategical approaches and widen the already existing gaps between actual needs and implemented solutions, so policy guidance and political will to intervene is very desirable.

2.6.4 Industry Rivalry

Global market size is expected to significantly grow in the coming years (from 529.55 billion USD in 2017 to 1944.67 billion USD in 2023), with a Compound Annual Growth Rate of 24.21% (Orbis Research, 2018). In a rapid industry growth climate, market share competition is more volatile and financial and managerial resources are consumed by the expansion of the industry. Competing firms have to keep up with each other and the industry as well. Very high growth rates are usually the result of increasing penetration or sales to new consumers and repeating sales to existing ones. In the Smart City solutions deployment market both are true, which partly explains high growth rates: ever more cities are requiring such services. The market growth phase itself leaves room for all businesses to grow.

The ability of consumers to differentiate market products from each other by tangible specifications has a high influence on rivalry. If products are highly diverse, then competitors have some kind of protection from rivalry, because consumers value those differences and choose based on them. This creates layers of insulation against competitive warfare because buyers have preferences and loyalties to particular sellers. On the other hand, if they perceive that products on the market are similar, that will enhance industry rivalry. Based on our observations in the Smart City market, we assume that service providers, especially multinational companies (e.g. T-Systems) are trying to use their leverage on governments and deliver their solutions in all the value chain. This is of course sometimes carried out by subcontractors, but the behavioural pattern is similar in several cities. The director of a municipality company in one of the sample cities mentioned that a successfully implemented public Wi-Fi solution by a smaller company was forcefully removed and implemented again by a multinational company with political support. From the point of view of consulting companies and other less technology related service providers, we can see that consultancies see very great potential in Smart Cities but they are not yet prepared and confident to enter the market; however, leaving it out of their portfolio is a sign of weakness on the market. This also coincides with ‘corporate stakes’. Rivalry in an industry can be intense if a portion of companies have high stakes in being successful. For example, diversified firms are forced to show success in particular industries to catch up with trends and market leaders. As megacities are estimated to be located in developing markets, leading multinational companies have to establish a strong position on these markets to build up global prestige and technological credibility. These expansionary companies are willing to sacrifice profitability in short

terms to reach out their potential market share. The Hungarian market is also part of the ‘greenfield’ areas for expansion. As Smart City developments in Europe gain more and more public attention (Bibri and Krogstie 2017), smaller consultancy firms also have stakes at offering relevant services, even with little competence. Connections and political lobbying are also key attributes of successful consulting companies on the market.

The ease of understanding a product has an important effect on rivalry. Easier understanding of the product means a higher risk of competition. The Smart City concept is not yet well known to city officials and even if they are familiar with the theme and have projects or concepts, that does not mean that their way of perception is correct or optimal in case of city development. This area of research, including business models (as there are no standards yet), is a soft field, therefore the author considers it hard to interpret, which lowers the risk of industry rivalry.

2.6.5 Substitutes

I differentiate two types of substitute cases. First one is when cities build their own capacities to deal with Smart City developments. They hire experts and specialists, or found a public company, owned by the municipality and assign every single related issue to this organization. It is not limited to be a company, it can be a project organization, a development agency, a department or a foundation as well. In Debrecen, a public company deals with investment promotion, enterprise development and smart city, called EDC (Debrecen Város- és Gazdaságfejlesztési Központ). In another sample city, the responsibilities are assigned to a local development agency. Nevertheless, these centres are providing important capacities and targets for knowledge spill overs, but often fail to attract the fitting experts and operate under reduced scope without the appropriate authorization.

2.7 Conclusions

Applying the Five Forces Framework to identify barriers that hinder the deployment of Smart City solutions and better understand the special needs of medium-sized cities in the complex interactions of multiple stakeholders brought some novel insight to the discussion. The author believes the further utilization of corporate strategic management methodological components, models, reasoning and concepts can move forward the discussion on Smart City model development and the understanding of the complex environment of these actions. It is clear that the specific needs of each city have not yet

been addressed by solution providers and that this also a neglected field in scientific research. As every company, cities are also unique entities, and thus global strategies of multinational suppliers and global models of smart cities assessment are not suitable for them. Eventually these 'local needs' are the needs of the citizens, so new types of approaches are needed for business models of solution provider companies as well, to demonstrate the added value of their service in context with the local population. The results achieved by this methodology were supported primarily by qualitative research techniques, including interviews and focus group exercises. Table 3 highlights some of the key identified barriers that hinder the development of SC solutions and undermine its ever growing maturity.

Table 3 Summary of identified barriers

	Industry Competition	**New Entrants**	**Buyers**	**Substitutes**	**Suppliers**
Identified barriers	Cherry-picked suppliers are favoured by governments Corruption No standards Dominance of big companies SMEs neglected	Information overload Cherry-picked suppliers are favoured by governments Corruption Focus on Megacities Already established distribution channels	Vendor lock-in Not transparent value proposition No city-specific proposals Biased performance indicators and targets 'Do it my way' approach No standards	Lower attractiveness for solution providers Biased interpretations, strategies	Knowledge gaps Shortage of experts Access to data Quality of data No standards Policy immaturity

For further research, it is necessary to test these assumptions on other European cities by repeating the focus group research methodology in more cities, including local stakeholders in focus groups. Considering the multidimensional nature of Smart Cities, this way of research seems to be the most efficient one. Using this Framework definitely

provided added value. In addition, the assessment of other models is necessary to further elaborate the discussion of Smart Cities from the strategic management point of view.

2.8 Chapter takeaway for the dissertation argument

This chapter advances the dissertation-level argument by establishing the first empirical and analytical foundation of the thesis: smart city development, especially in medium-sized cities, is constrained not primarily by the absence of technological solutions, but by a broader set of structural, institutional, strategic, and knowledge-related barriers. In the overall architecture of the dissertation, this is a decisive starting point. The dissertation seeks to explain how cities become smart in practice, and this chapter shows at the outset that such a process cannot be understood adequately if smartness is interpreted only through innovation rhetoric, ICT deployment, or benchmarking indicators. The findings of the study indicate that medium-sized cities face a complex environment in which local capacities, external dependencies, information asymmetries, and weak standards shape the possibilities of smart development in a fundamental way.

At the dissertation level, the most important contribution of the chapter is that it reframes the smart city problem from a technology-centred question into a context-sensitive and strategy-sensitive one. By applying Porter's Five Forces Framework to the field of smart city development, the study introduces a perspective that is unusual in the literature but highly productive for the dissertation's purposes. Rather than asking only what technologies cities adopt, or how "smart" they appear on ranking systems, the article asks what kinds of constraints operate in the environment of medium-sized cities and how these constraints affect their strategic room for manoeuvre. This move is particularly significant because it reveals that the smart city field is not a neutral space of innovation opportunities. It is also a field structured by uneven access to knowledge, market power imbalances, weakly standardized models, and dependencies on technology suppliers and external expertise. As a result, the chapter helps demonstrate one of the dissertation's central propositions: cities do not become smart simply because digital tools are available; they become smart, or fail to do so, within a complex environment of constraints and enabling conditions.

A second major contribution of the chapter lies in its medium-sized-city focus. This is crucial for the dissertation as a whole, because medium-sized cities are not treated here

as scaled-down versions of metropolitan flagships, but as analytically important urban settings in their own right. The study shows that the European urban landscape is dominated by cities of this size, yet both the academic literature and practical solution models often remain disproportionately oriented toward capital cities and highly visible smart city leaders. This creates a mismatch between the dominant narratives of smart urbanism and the actual conditions under which many cities must operate. By highlighting the specific vulnerabilities of medium-sized cities, including more limited human and financial capacities and a weaker ability to internalize advanced smart city expertise, the chapter grounds the dissertation's later argument that city size and local context are not secondary variables. They are part of the explanation of smart city trajectories themselves.

The chapter also contributes to the dissertation by identifying the substantive content of those barriers in a systematic way. Its findings point to several interconnected problem areas: knowledge deficits among key actors, poor or incomplete data availability, low data quality, the absence of robust and widely accepted standards, biased or partial approaches to smart city assessment, and dependence on large external suppliers. These findings matter not only because they describe obstacles, but because they already imply a broader theoretical lesson for the dissertation. Smart city development is not hindered by one isolated bottleneck. It is hindered by the interaction of institutional weakness, fragmented knowledge, market asymmetry, and strategic ambiguity. This is consistent with the dissertation's broader conceptual framework, which links local context, strategic orientation, barriers, governance, and implementation. In that sense, the chapter does more than identify individual problems. It specifies the first major layer of the dissertation's explanatory model: the barrier environment within which smart city strategies must be formed and enacted.

Another important dissertation-level contribution is methodological. The use of **Porter's Five Forces Framework** signals that smart city research can benefit from concepts and reasoning drawn from strategic management. This is a meaningful intervention in a field that often remains either normative or descriptive. The chapter does not claim that cities are firms, nor that an urban system can be fully captured through a business framework. Instead, its methodological importance lies in demonstrating that the strategic environment of cities can be analysed more rigorously when concepts such as bargaining power, market dependency, substitute approaches, and structural constraints are brought

into the discussion. This broadens the dissertation's methodological and conceptual horizons and supports its effort to interpret smart city development as an organized strategic process rather than merely as a collection of digital projects.

The chapter is equally important for what it does not yet resolve. It diagnoses barriers, but it does not fully explain how cities might reorganize themselves to address these barriers effectively. This is precisely why it occupies the first position among the article chapters. Its role in the dissertation is problem-formulating rather than solution-exhausting. It demonstrates that the barriers to smart city development are real, multi-layered, and especially acute in medium-sized cities, but it leaves open the question of what kinds of organizational arrangements could respond to them. This open question is not a weakness of the article in the context of the dissertation. On the contrary, it creates the analytical need for the following chapter. Once this chapter has established that many smart city difficulties are rooted in organizational and institutional conditions rather than in technology alone, the dissertation can move logically to the next step: the study of organizational design in urban digitalization.

This is where the link to Chapter 3 becomes especially clear. The present chapter identifies the symptoms and structural causes of constrained smart city development. Chapter 3, by contrast, takes up the problem from the perspective of organizational design and asks whether conventional organizational models themselves contain barriers to smart city transition. In this way, the two chapters form a closely connected analytical pair. Chapter 2 shows that medium-sized cities face barriers such as fragmented knowledge, supplier dependence, weak standards, and limited internal capacity. Chapter 3 then investigates how urban digitalization is organized and whether more collaborative and platform-based arrangements could help overcome those barriers. The progression is therefore deliberate: from barrier diagnosis to organizational response. The dissertation argument depends on this sequence, because it reinforces the claim that the decisive issues of smart city development are institutional and organizational as much as technological.

The chapter also prepares the ground for the later empirical chapters in less direct but still important ways. The strategic and institutional imbalances identified here reappear later in the dissertation in more concrete forms. In the Budapest and Debrecen chapters, for example, the questions of top-down versus bottom-up development, narrow versus broader stakeholder inclusion, and fragmented versus integrated intervention logic can all be read partly as downstream expressions of the structural barriers first identified here.

Likewise, the later attention to activity portfolios and stakeholder networks gains interpretive depth because Chapter 2 has already shown that smart city development does not unfold on a level playing field. The configuration of projects, partnerships, and governance models must be understood against a background of capacity constraints, market dependencies, and uneven local readiness. Thus, although the present chapter is the dissertation's first article chapter, its relevance extends well beyond its immediate findings.

In sum, this chapter advances the dissertation argument in three principal ways. First, it establishes that smart city development in medium-sized cities is hindered by a structured set of barriers that go beyond technology and include knowledge, data, standards, and dependency problems. Second, it grounds the dissertation's medium-sized-city orientation by showing why this urban category deserves dedicated analytical attention. Third, it opens the dissertation's wider line of inquiry into governance and organization by demonstrating that the conditions of becoming smart are deeply shaped by institutional and strategic factors. Its main contribution is therefore diagnostic but foundational: it identifies the problem space within which the rest of the dissertation operates.

The next chapter builds directly on this foundation. If Chapter 2 explains why smart city development is difficult in medium-sized urban contexts, Chapter 3 asks how urban digitalization should be organized so that such barriers can be addressed more effectively. The transition from the present chapter to the next is therefore not merely formal. It reflects the internal logic of the dissertation itself: once the barriers to smart development have been identified, the analysis must turn to the organizational and collaborative arrangements through which cities may attempt to overcome them.

3. Challenges and Solutions for Organizational Design in Urban Digitalization

3.1 Chapter preface

This chapter occupies a pivotal position in the dissertation because it moves the analysis from **barrier diagnosis** to **organizational response**. Chapter 2 demonstrated that smart city development in medium-sized cities is hindered by structural and strategic constraints such as knowledge gaps, data limitations, vendor dependence, weak standards, and biased or fragmented approaches. The present chapter builds directly on that diagnosis by asking a more specific and solution-oriented question: if smart city transition is hindered not only by technology but by institutional and organizational conditions, then what kinds of organizational arrangements are better suited to support urban digitalization in practice?

The chapter is therefore included at this point in the dissertation because it provides the first explicit **organizational-design answer** to the problems identified earlier. The article argues that the slower-than-expected impact of smart city investments is closely related to challenges of sociotechnical scalability, complexity, and procedural coordination, and that these cannot be solved by technological innovation alone. Instead, the attention of both scholarship and practice must turn toward organizational structures capable of handling multi-actor collaboration, data-driven planning, knowledge integration, and implementation under conditions of urban complexity. In this respect, the study deepens the dissertation's overarching argument that governance and organizational design are not secondary implementation concerns, but central explanatory dimensions of how cities become smart in practice.

A further reason for the placement of this chapter is that it introduces an important shift in the dissertation from **diagnostic analysis** toward **constructive model development**. Whereas the previous chapter established what hinders smart city development, the present study investigates whether conventional organizational models themselves contain inherent barriers to smart city transition and whether an alternative, collaborative network model can better address them. Methodologically and substantively, this makes the chapter distinct within the dissertation. It does not only analyse existing urban reality; it also formulates and validates a proposed organizational solution through the SmartCEPS platform concept. That platform is designed as a multi-stakeholder, data-driven, participatory urban planning model intended especially for small and medium-

sized cities, and it therefore connects closely to the dissertation's medium-sized-city orientation.

This chapter also creates a bridge to the chapters that follow. If Chapter 2 showed that smart city development is constrained by structural barriers, Chapter 3 demonstrates that these barriers are reproduced through organizational forms that are often too fragmented, too hierarchical, too closed, or too weakly integrated to support complex urban transition. Chapter 4 then broadens the dissertation's focus from barriers and organizational arrangements to the **strategic content** of smart city development by examining the value propositions embedded in city activity portfolios. In this way, the sequence of chapters is cumulative: Chapter 2 identifies the problem environment, Chapter 3 addresses the organizational and collaborative conditions of response, and Chapter 4 moves further toward the comparative interpretation of what cities actually seek to achieve through their smart city activities. Chapters 5 and 6 later return to these organizational questions in the more concrete settings of Budapest and Debrecen, where issues of coordination, stakeholder inclusion, governance architecture, and strategic integration become empirically visible at the city level.

At the dissertation level, this chapter contributes most directly to the part of the overarching research question concerned with **organizational design and governance arrangements**. It advances the argument that smart city transition requires institutional forms capable of connecting municipalities, technology suppliers, professionals, and citizens in a more adaptive and collaborative manner than conventional models allow. For this reason, the chapter should be read as the dissertation's organizational-response chapter: it transforms the previously identified barriers into a more explicit question of how urban digitalization ought to be organized if smart city ambitions are to become operationally coherent and publicly meaningful.

A note on the study's methodological design at the dissertation level. This chapter is methodologically distinct within the dissertation because it is not only analytical but also design-oriented: it moves from diagnosing organizational barriers to formulating and validating a proposed organizational solution, the SmartCEPS platform. Its design therefore combines a structured literature review with iterative expert consultation across three phases. The literature review was not a conventional narrative survey but a systematic, theme-driven exercise organized around four foci of smart city transition, namely multi-stakeholder ecosystems, data-driven applications, knowledge-intensive

innovative services, and urban planning, and it proceeded through inductive category development (Mayring, 2000), in which analytical categories of organizational challenge were derived from, and progressively revised against, the material. The limitations of this approach should be acknowledged: the body of papers reviewed was purposively rather than exhaustively selected, and the formation and boundaries of the categories inevitably involved interpretive judgement, so the resulting category system should be read as an analytically grounded ordering rather than a definitive taxonomy.

It is equally important to clarify **how the expert-based evidence related to, and differed from, the literature**. After roughly half of the selected papers had been processed, the provisional categories were taken into three semi-structured focus group sessions with experts from the three most relevant stakeholder groups, namely city managers, urban-planning professionals, and technology suppliers. These sessions did not merely confirm the literature: they tested the reliability of the categories and, importantly, surfaced additional organizational challenges that the literature alone had not made visible, particularly those rooted in day-to-day coordination, accountability, and collaboration. The validated set of barriers was then distributed across the relevant stakeholder groups to define the problem space, from which the organizational framework of SmartCEPS was designed; the resulting design decisions were in turn re-examined in follow-up focus groups and revised accordingly. Making this sequence explicit clarifies that the chapter's contribution rests on a deliberate interplay between literature-derived categories and practitioner validation, in which the divergence between the two is itself a source of insight rather than a discrepancy to be smoothed over.

3.2 Bibliographic record and author contribution

Full citation	Csukás, M. S., Bukovszki, V. and Reith, A. (2020) 'Challenges and Solutions for Organizational Design in Urban Digitalization', *European Journal of Sustainable Development*, 9(2), pp. 615-629. https://doi.org/10.14207/ejsd.2020.v9n2p615.
Publication status / outlet	Published journal article in the *European Journal of Sustainable Development*, Volume 9, Issue 2, 2020.
Co-authors	Máté Szilárd Csukás, Viktor Bukovszki, and András Reith.

Doctoral candidate contribution	The doctoral candidate was the first author of the study and contributed substantially to the conception of the research problem, the literature review on organizational challenges of smart city transition, the design and conduct of the focus group process, the development of the analytical categories, the interpretation of the findings, and the drafting of the manuscript. The candidate also played a leading role in formulating the SmartCEPS organizational concept presented in the article.
Relation to dissertation research question	This article addresses the dissertation's overarching research question by examining how organizational structures shape the practical realization of smart city transition. More specifically, it contributes to the dissertation by identifying barriers inherent in conventional organizational models and by proposing a collaborative network-based alternative that is better suited to manage sociotechnical scalability, complexity, and procedural difficulties in urban digitalization. It therefore provides the dissertation's main organizational-design contribution and develops the governance and implementation dimension that was opened in the previous chapter.
Editorial adaptation note	The full text of the published article is reproduced in this dissertation as a core chapter of the article-based thesis. Only minor editorial adaptations have been made for dissertation integration, including formatting, chapter and figure numbering, citation harmonization, and alignment with the unified bibliography. No substantive changes have been made to the original scholarly argument, methodology, or findings.

3.3 Introduction

The increasing rate of population growth and concentration has resulted in mounting demands in resources in cities amidst a global effort to sustainably meet these demands, mitigating and adapting to environmental, economic and social pressures (United Nations Human Settlements Programme, 2009). Many cities in the EU seek to cope with these challenges through a smart city (SC) approach to urban planning and management (UPM), referring to the uptake of cutting edge ICT (mostly data-driven) solutions to inform and integrate problem-solving in urban processes (Manville et al., 2014; Ruhlandt, 2018).

Although such digitalization in cities carries the potential for highly inclusive, evidence-based decision making in UPM, investments have thus far been slow to deliver the expected impacts (Barns, 2018). Various frameworks, methodologies, and supporting tools have been developed by academia, the public sector, and suppliers to support SC implementation, each with their specific limitations. Supplier-driven frameworks are too narrow in scope, focusing on urban subsystems relatable to their products and services (Robinson, 2015), (Barns, 2018). City-based and some academic frameworks are too specific to a type of city (Manville et al., 2014; Shen, Jorge Ochoa, Shah, and Zhang, 2011); or to a discipline (Bibri and Krogstie, 2017a); while broader frameworks are too generic and abstract (Klopp and Petretta, 2016). The utilization of urban data itself is limited to indicator listing, without analytic and decision-support functionalities for UPM (Mori and Christodoulou, 2012; Nordregio, 2004). On the other hand, the mismatch of a fast-paced SC market supply and a slow-to-react demand in UPM is driving cities into ad-hoc investments. It is therefore important to investigate why SC frameworks fail to enable transition on the cities side.

One possible explanation for the lack of progress is the cross-cutting nature of its challenges. SC transition challenges can be classified as problems of sociotechnical scalability, the complexity of the subject matter, and procedural difficulties (Dezi, Pisano, Pironti, and Papa, 2018; C. Lim, Kim, and Maglio, 2018a; Nel, du Plessis, and Landman, 2018; Offenhuber and Schechtner, 2018; Reed, 2008; Vanolo, 2014; Zhang et al., 2017). Each of these axes combines social and technical aspects. First, sociotechnical scalability refers to challenges rooted in the addition of more and more people, organizations, information, and hardware in UPM. On the one hand, various data producing and processing systems and actuators need to be interoperable, and the data models integrated (C. Lim, Kim, and Maglio, 2018b).

On the other hand, it is challenging to identify, address, empower stakeholders, and incentivize them to participate in a multi-actor decision-making process (Offenhuber and Schechtner, 2018). It is not apparent which information will be crucial for whom (Reed, 2008), how knowledge is diffused (Dezi et al., 2018), how security is ensured (Zhang et al., 2017) and how the power asymmetries in delicate social structures translate to a more digitalized UPM (Vanolo, 2014). Second, complexity challenges stem from cities being multidimensional complex adaptive systems with deeply interconnected subsystems and interdependent actors (Nel et al., 2018), which is difficult to formalize in a digital

environment. Moreover, practical SC implementation must overcome a standardization - customization problem: the breadth of contextual information used in UPM inhibits the replicability and mainstreaming of approaches to practical SC implementation (Manville et al., 2014). Finally, procedural difficulties refer to unpreparedness in the planning process: failure to link urban data to users (Badii et al., 2017), lack of methods to consider city goals and outcomes (Yigitcanlar et al., 2018), a lack of data-based services (Aguilera, Peña, Belmonte, and López-de-Ipiña, 2017), and lack of tools supporting planning (Mora, Deakin, and Reid, 2018).

Scalability, complexity, and procedural challenges cannot be solved through technological innovation alone. Indeed, the attention of SC discourse is turning towards organizational structures to deliver transition (Ruhlandt, 2018). Academia, supplier, and public sector governed SC frameworks are sharing one particular attribute: they were initiated, sponsored and maintained and used by single or few entities, even if the development itself was a result of a collaborative effort. The goal of this study is to make a case for an alternative organizational composition based on collaborative networks that are better suited to deliver SC transition. More specifically, the goal of this study is to answer: are there barriers inherent in the conventional organizational models meeting the challenges of SC transition? If so, do an alternative, collaborative network models exist to overcome these barriers?

3.4 Methodology

SmartCEPS (Smart City Evaluation Platform and Services) is an ongoing research work, intending to develop and roll out a data-driven, scalable, evidence-based, participatory decision-support system for UPM in small and medium-sized cities. It consists of (1) an urban data analytics toolbox, (2) a methodology to use urban data analytics in multi-actor UPM, (3) a virtual marketplace of ICT solutions with urban applications. SmartCEPS is a multi-stakeholder service actively involving municipalities, technology suppliers, citizens, sectoral urban specialists, and generalist consultants – with the business model being training and supplying these generalist consultants. This paper presents the management, particularly the organizational challenges of an application of an innovative data-driven urban planning service and methodology that involves the orchestration of a wide range of urban stakeholders.

The research has three distinct phases. As a first step, an extensive literature review was undertaken to identify challenges of SC transition, regarding (1) multi-stakeholder ecosystems, (2) data-driven applications, (3) knowledge-intensive innovative services, and (4) urban planning. Key ideas were revealed during an inductive category development procedure (Mayring, 2000). After processing about 50% of selected papers, revision of categories and pre-validation of findings begun in the next phase. Three separate focus group sessions were conducted, with a selected group of experts, from the three most essential stakeholder categories: city managers, urban planning professionals, and technology suppliers. These events aimed to validate, check the reliability, and formulate new categories of organizational challenges. They were semi-structured to allow the identification of additional concepts. Next, information gathered in these events was processed, parallel with the remaining literature, and findings were incorporated into the category development task.

After the categories were finalized, organizational barriers were distributed to their respective stakeholder groups, which served as a problem space for designing the organizational framework of SmartCEPS. Finally, the design decisions in the corresponding solution space were validated in follow-up focus groups, and the proposed organizational concept has been revised accordingly.

3.5 Results

Organizational barriers manifest differently among the three main stakeholders involved: (1) public, (2) private and (3) professional, while some (4) general barriers are not unique to any of them. Tables 4–7 summarize the organizational barriers to SC transition.

3.5.1 Public organizational barriers

In this paper, we partly adopt the stakeholder classification of Ruhlandt (Ruhlandt, 2018), including public, private, academic, and civic. Public stakeholders are described as “institutions”, “public subject”, “government agencies”, “political leadership and administrative proponents” in the literature. Category development process identified that public organizational barriers fall into the following groups: Management, Power & influence, Networks, and Innovation.

In governance, the capacity to adapt and integrate is mentioned to be a critical barrier to the SC transition. Given the volatility of the SC market and urban pressures in general, the need for dynamic control mechanisms is accentuated (O’Reilly and Tushman, 2008).

The current practice in Europe is characterized by weak convergence and integration mechanism among interventions, a failure to realize the added value offered by coordination of resources and from the joint efforts of stakeholders (Praharaj, Han, and Hawken, 2018). Both barriers are connected to an authoritative governance approach which fails to enable knowledge, resource, and responsibility pooling (Sørensen and Torfing, 2018). According to interviewed city managers, such approach also results in trading evidence-based planning with political struggles when resources are constrained, which leads to inertia against any public innovation both in the leadership and down the chain of command. The lack of collaborative governance and planning is seen as a critical obstacle to an SC-ready level of adaptive and integrative capacity.

Incapable organizational structures hinder the SC transition. Despite the high relevance, there were participants from all stakeholder groups, who expressed concerns about the viability of their respective organizational background, to be able to address all the needs of SC transition. Especially the 'old' structure of city governance that operates in these "byzantine labyrinth" of silos, requires cross-organizational management. Roles and responsibilities must be clearly defined in the case of external and internal transactions as well. Again, a non-technological, but management and planning problem was identified as a problem for the transition. Without cross-departmental governance, collaboration with various stakeholders cannot be guaranteed (Whyte et al., 2014). It is also a vital issue, mentioned by city managers, that their processes are slow and inefficient, due to the lack of inter-departmental connections.

Furthermore, SC project and developments usually realized in a multi-collaborative (open) environments, where the roles and responsibilities of city managers are challenging to determine (Angelidou, 2014). These difficulties can include their position or even their authority. Some practitioners from technology provider companies mentioned that in many cases, negotiations fail because they do not meet with the right person who is qualified to understand the subject matter but also has the authority to make decisions. In other cases, city managers are afraid to decide on specific issues because of a risk aversive culture inherent in the public sector (Sørensen and Torfing, 2018).

The threat to power and influence is also an often-mentioned factor across different groups. It is also a general hindering factor for organizations that face changes and resist them. Some stakeholders or departments might play a more prominent role in the transition, while others' are excluded or oppressed. Participants perceive that there are

beneficiaries but also disadvantages, which can cause stress in and in-between organizations. That is an excellent reason to adopt an inclusive and participative SC design. Otherwise, the particular power dynamics of longstanding stakeholders are invoked, causing tensions in the city, inevitably hindering SC development.

Inability to properly engage stakeholders is a distinct category of organizational barriers. It is the responsibility of SC developers to design and implement meaningful public-private partnerships, which will function as a sustainable ecosystem (Vanolo, 2014). They have to take the role of stakeholder leadership, because they are the most credible actor, with legitimacy. Engagement of relevant ecosystem participants is a very challenging task because they must be provided with viable incentives to stimulate them. In most SC investments and development processes, practitioners feel as if there are always important actors who are not at the table. There is a knowledge gap among relevant actors. This collaborative thinking is also real for the co-initiation of participatory processes (Daniell et al., 2010). If SC transition is not co-initiated from the bottom-up, it is met with resistance or indifference (Sørensen and Torfing, 2018). SC success is very vulnerable to the degree of public engagement. The knowledge gaps above have spillover effects on the collaboration as well. Beside others, civic engagement is of the highest importance in SC development. Despite its perceived importance, citizen involvement is still not an integral part of the practice. There are several platform-based ICT solutions for this challenge – i.e., Citizen Relationship Management (CRM), Knowledge Hub, but currently, they are not appropriately informed, have no agency in decision-making, and treated mostly as sources of information at best (crowdsensing).

Another critical category in public services is connected to innovation. One significant capability of public actors in SC transition is to combine the innovativeness of a diverse group of stakeholders, through partnerships. The resulting interactions will be the source of creativity and novel solutions (Anttiroiko, 2016). Urban openness degree enables a user (citizen)-driven innovation in existing and new services. Similarly, to governance barriers, there is an utmost need for multi-stakeholder management. Table 4 below collects the identified public barriers.

Table 4 Public Organizational Barriers

Public Organizational Barriers

Management	*Power & influence*	*Networks*	*Innovation*
Lack of coordination mechanisms Authoritative strategic approaches Lack of horizontal integration (functional silos)	Conflict of Interests Power asymmetries Resistance to change	Underperforming collaborative design Insufficient collaborative capabilities Lack of co-initiation	No mutual learning and knowledge diffusion practices Lack of innovation capabilities Closed organizational design Inadequate learning from peer cities

3.5.2 Private organizational barriers

Private organizations are mostly described as firms and enterprises, but also industry, or market (Ruhlandt, 2018). Many ‘general' organizational barriers identified in the case of public and professional actors are also recognizable in this group. It is challenging for companies to align their value-creating processes into the SC transition context. As mentioned before, the immaturity and complexity of the concept force ventures to focus on particular domains of SC within their preexisting competencies, they while they lack a holistic view, and the capacity to thrive with such a context-dependent value offering as smart cities. Both the literature and the city manager focus group identified technology push from companies (Angelidou, 2015). Today, cities and technology providers do not speak a common language regarding technology and social outcomes of SC developments. There is a massive gap between vision and implementations, causing stress between the two actors (Bibri, 2018).

Furthermore, sales processes are not efficient because of different organizational structures. Private organizations - despite the high expectations – are still exploring the market, accumulating investments, and expect high growth in the future. Vendors claim that advanced and sophisticated technologies are inadequate to gain user satisfaction in realistic SC environments. In an unstandardized market, where individual cases require a high-level specification, successful implementation of tech solutions is very challenging, particularly the design, optimization, and requirement checks.

Another significant organizational barrier is related to collaboration, knowledge diffusion, and innovation. Competitive strategies of the private sector result in wasted

resources on rivalry and conflicts, but which is more critical, limited exchange of knowledge (Sørensen and Torfing, 2018). Considering the complexity of urban challenges and requirements, the absence of mutual learning jeopardize the highly desired innovation capabilities. Ad-hoc approaches are present in case of private actors as well. They deploy technologies and solutions that become available with technological advancement, but without an adequately demonstrated customer need and value proposition. Table 5 below sums up the identified private organizational barriers.

Table 5 Private Organizational Barriers

Private Organizational Barriers	
Competitive drive	*Innovation & Technology*
−Product focus over needs −Biased assessments	−Closed innovation process −Applicability over real needs

Distortions between technology push and application pull results in a mismatch between supply and demand. The imbalance is partly because of the difficulty to articulate SC expectations in terms of product specification (Bukovszki, Apró, Khoja, Essig, and Reith, 2019). Suppliers also find it challenging to create new products and services for specific city needs, as they are more inclined to work with their existing portfolios. They experience considerable tension between standardization and customization because there are trade-offs between these two categories: cities require solutions that are entirely based on their local particularities, but firms want to commercialize efficiently scalable products. In the case of private and professional groups, there is an ‘oversupply' because supplier driven SC frameworks are designed around the products and services offered by the issuing companies.

3.5.3 Professional organizational barriers

Private organizations are mostly described as universities and research bodies in the literature (Ruhlandt, 2018). Practitioners – i.e., consultants may also be treated in this category. Many organizational barriers of professional actors are related to knowledge diffusion and capabilities. Until now, there is no common understanding of the SC concept, which makes the interpretation and practical intervention challenging for firms. Results of the focus group with professionals also confirm this status, showing that SC is a fuzzy concept; everyone sees a different meaning in it. The interpretation of smart cities today is a capability that requires immersive knowledge. Otherwise, the adverse effects – i.e., technology dependence, exclusion of social impacts will prevail (Yigitcanlar et al.,

2018). UPM is interdisciplinary, and SC frameworks either represent a single dimension, field, discipline, or they become too vague when trying to be holistic (Bibri and Krogstie, 2017b; Sabatini-Marques, da Costa, Chang, Yigitcanlar, and Selig, 2018). Furthermore, SC development is still treated as an outcome, not as a planning process. Table 6 below collects the identified professional organizational barriers.

Table 6 Professional Organizational Barriers

Professional Organizational Barriers		
Dissension	*Collaboration*	*Operational*
− Biased assessments Disciplinary complexity & immaturity − Fragmented knowledge generation − Biased interpretations	− Closed innovation process − Applicability over real needs	− Lack of actionable outputs − Missing practice-oriented qualifications − Focus only on outcomes

Similarly, to public organizational barriers, resistant to change is also a phenomenon among professional stakeholders' group. During the focus group session, they were conflicted with data-driven planning approach, opposing their current practice. In academic publications, there is a myriad of SC indicator systems. Problem is with their practical usability, the difficulty of transposing theory to practice. They provide good descriptions, but no executable programs (Mori and Christodoulou, 2012). This challenge is an organizational barrier because relevant actors work independently. Horizontal action among practitioners is desired. Focus group participant also expressed that SC frameworks choose between offering comparability and accuracy, since adding more and more contextual information is needed during the planning process (standardization and customization conundrum) (Bukovszki et al., 2019). Another issue is ad-hoc approaches, which is closely related to the lack of inter-organizational collaboration and meaningful engagement of stakeholders. Ad-hoc approaches make it risky to correctly identify and select interventions that can deliver the desired complex socio-spatial outcomes. Table 7 below summarizes the identified generic barriers.

Table 7 Generic Organizational Barriers

Generic Organizational Barriers	
Management	*Cultural*
−Too large number heterogeneous of actors −Interdependencies (system complexity) −Communication channels (information flow)	−Divergent value perspectives −Different frames of reference −Different mindset

3.6 Discussion of a Proposed Model: Urban Planning Platform

In this chapter, we are going to describe our proposed model and how it can address the previously identified organizational barriers. The diversity of stakeholders and technological solutions require new models of cooperation to parallel regulate urban actors by governance but provide an innovative, evolving environment at the same time. The authors argue that the SC transition has a fundamentally a disruptive nature, transforming existing markets and conventional organizational or business structures, which will eventually create new public- and technology management models. In such an environment, the knowledge-intensive digital transformation of cities requires open innovation models - with particular attention to the inflows and outflows of knowledge (Chesbrough and Brunswicker, 2014) – because of the challenges posed by the unique urban features, multi-collaborative environments, and immaturity of the market. The proposed model is a platform that facilitates an open innovation network, with a Community of Innovation (CoI) (M. Lim and Ong, 2019) and Technology Matchmaking mechanism. The adoption of platform thinking to urbanism and particularly smart cities is getting more and more attention in the literature, as a solution for participatory innovation (Anttiroiko, 2016), mediating public-private partnerships (van der Graaf and Ballon, 2019), or delivering services (Rajakallio, Cuthbertson, Pulkka, and Junnila, 2018). Platforms contend the linearity of existing SC developments, facilitating space for interdependencies, increasingly dominating the urban landscape. Platform-based ecosystems, as demonstrated in the, e.g., high tech industry that they are capable of orchestrating a diverse group of innovative actors towards a common goal with a set of rules and incentives, surpassing the traditional organizational boundaries (Gawer and Cusumano, 2014). The SmartCEPS urban planning platform incorporates the design and value creation logic of platforms.

3.6.1 Platform attributes

The SmartCEPS platform architecture is nested, comprising of two layers. The first layer would function for UPM. It is a discourse in a network of stakeholders, municipal admin, specialist professionals, solution providers, data-producing infrastructure, and peer cities. Orchestration and leadership of the ecosystem would be carried out by a certified consultant network, with a lean project management approach, meaning with early and persistent user-oversight minimizing waste. The second layer would be an urban information system, continuously developed by a discourse in a network of urban professionals. This layer would be a cooperative platform, which is managed and improved by the SmartCEPS consultant community through the platform's infrastructure. This second layer hosts content creation and curation for the analytic tools supporting multi-actor collaboration on the first layer, which would enable a procedure where new technological solutions and concepts evolve from bottom-up collaborations among various stakeholders. Monitoring of urban performance and correcting deviations from urban planning goals makes it possible for a city-level cybernetic control (Carver and Scheier, 2012). Figure 9 below illustrates the layers of the platform architecture.

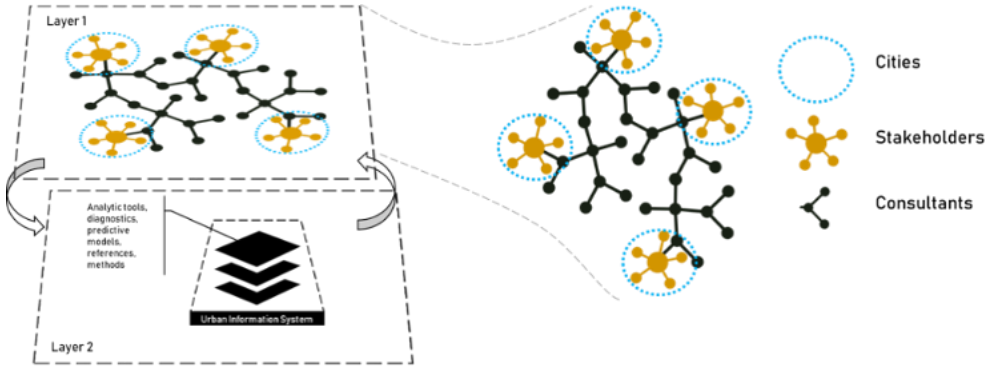


Figure 8 SmartCEPS Platform Layers (Source: own edition)

The first layer facilitates the core interaction of transacting urban performance data that is generated by the city assessment framework. Key actors are consultants, a community of certified professionals, city managers, who initiate joining the platform, civic community, participating in whole of the process and technology suppliers, who contribute to the materialization of the proposed solutions. Knowledge is exchanged among actors to collaboratively (1) diagnose city problems and define strategic priorities (2) propose and select policy and urban development (3) invest in SC applications of ICT solutions. The principal value proposition of the platform is solving the organizational barriers by translating different actor frames of reference to a standardized data model

and vice versa. As this value depends on the accuracy of underlying models, the SmartCEPS consultants are incentivized to actively contribute to the second layer, which in this sense is an open innovation platform. More accurate diagnostic, predictive models, references, increasingly sophisticated methods to transfer contextual information to global models boost both the individual and collective value of the consultants. Figure 10 below is intended to explain the multi-collaborative and multi-level characteristic of the proposed model.

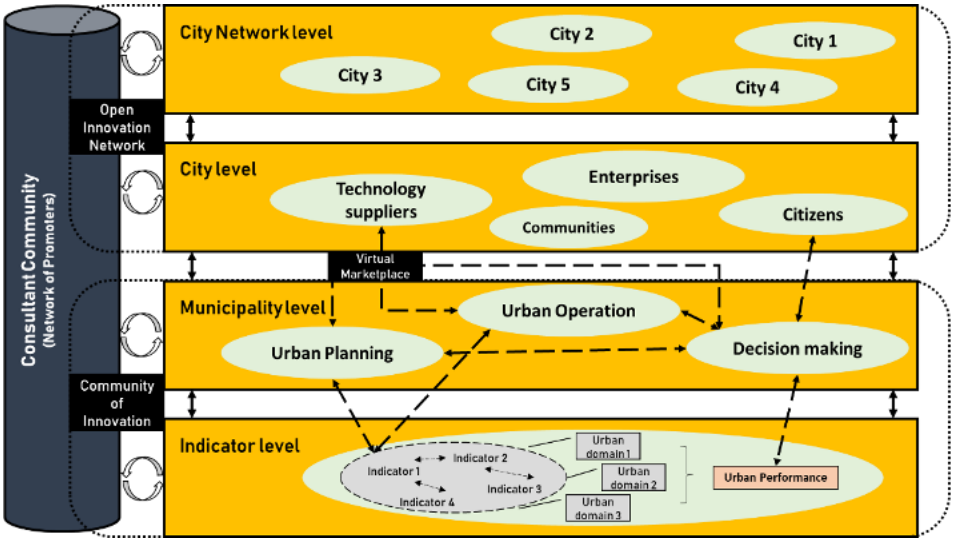


Figure 9 High-level platform architecture with stakeholder relations

SmartCEPS Urban Planning Platform adopts conditions for value creation in the following way:

- **Modularity**: the proposed model consists of self-functional components that are separately upgradable, contributing to the adaptability of the system. Modules are the (a) Consultancy network, which is a community of certified SC professionals, who are bounded by shared frames of references; (b) Virtual Marketplace that is an expanding network of technology provider firms; (c) urban analytics toolset, which facilitates a common 'language' to communicate urban problems in-between multiple stakeholders, and to be evolved by the community.
- **Customizable standardization**: the platform is using common standards to assess cities, formulate action plans, and initiate action in practice, based on the analytics and translation of urban performance data. However, the more in-depth data content is built up iteratively by UPM stakeholders during the planning process, ensuring customizability.

- **Complementarity**: complementarity manifests in both actions and technical systems as well. First, consultants work together with public administration and professionals to design interventions that are co-initiated and validated by citizens, which are realized by private companies. Second, from the technical system point of view, city assessments provide each city an ‘algorithm', a set of data that define the city, which translates to the Virtual Marketplace in the form of interventions.
- **Connectivity**: coordination and management of each module and the stakeholders are assigned to city dedicated consultants who act as ‘conductors’, or community managers of the urban planning ecosystem. Inputs and outputs are all shared and accessible by users on the SmartCEPS platform infrastructure. System components are connected in an integrative way.

3.6.2 Overcoming organizational barriers

Public organizational barriers: The ecosystem creation is in the heart of the proposed model, where new channels are established, through a common language to cooperatively initiate solutions, implement existing products/services and capitalize on the competences in the local ecosystem. The consultants provide management in the process, following municipality goals. They take multiple roles – e.g., promoting the network, managing the community, enabling knowledge flows. They act as conductors of the discourse, encompassing specialists, municipal managers, civic communities, and other stakeholders. Consultants are trained to use and interpret data and analytics to evolve and expand this discourse. UPM platform layer establishes new connections in the departmental and stakeholder network. Responsibilities are assigned in the design process, and consultants provide leadership, capacities, and bridge knowledge gaps. The platform facilitates the creation and accessibility of continuous feedback from the consulting community on the interactions, synergies, contextual factors, impacts of urban development and policy recommendations, in a shared urban performance architecture, which ensures the integrative nature of the platform. Figure 11 visualizes the identified challenges and the offered solutions of the platform in the public sector.

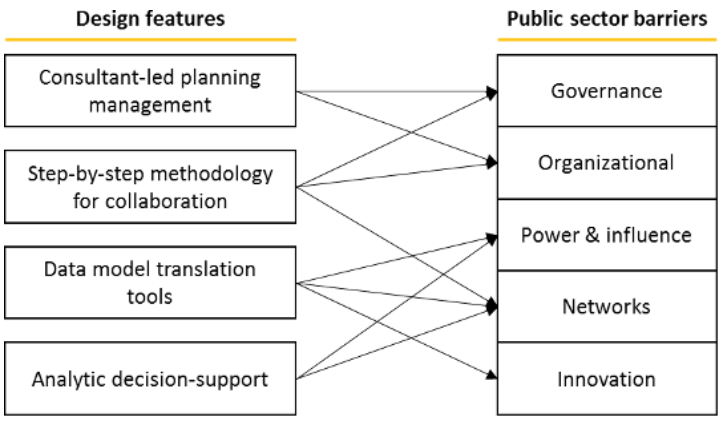


Figure 10 Design features overcoming public barriers

Collaboration and co-initiation are ensured by step-by-step methodology, identifying crucial multi-stakeholder decision points, modules to outline stakeholder impacts and to involve relevant stakeholders. Through the information system reference projects are linked to context, goals, city performance. They are described with a universal language and shared underlying data. Latent city relationships – i.e., similarity, complementarity can be defined because of continuous monitoring with a shared reference frame and underlying data, operated by a network of consultant professionals.

Private organizational barriers: the Virtual Marketplace (VM) module of the platform is intended to resolve the tension between the technology push and application pull forces, providing a convenient, yet efficient forum for companies to register their products or solutions, directly linked to the potential impact on the cities' algorithms – meaning the quantified effect of the solutions. Mediation creates matchmaking between cities and companies, in a way that the platform translates problems and needs into solution (innovation) requests, decomposing them into specific impact measures. These indicators transcribe to specific technical descriptions, disseminating requests through the network. VM enables a more accurate presentation of products and services in terms of urban performance, while the consultant network specifies city needs in term of technology solutions. Figure 12 illustrates the identified challenges and the offered solutions of the platform in the private sector.

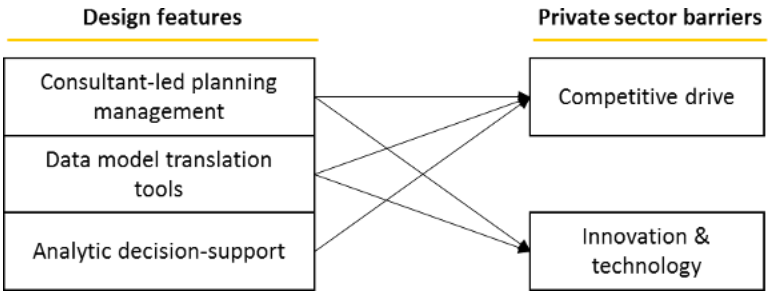


Figure 11 Design features overcoming private barriers

Professional barriers: the SmartCEPS platform is centred on urban performance, translated to different actors' perspectives by common standards and modules. Discourse is not running on obscure conceptualizations and inauthentic approaches, but on performance-based analytics that increases transparency. Platform modules support data analytics in an open innovation framework, continuously peer-reviewed, updated, and developed by a wide range of dedicated professionals. Mutual learning incentivized by providing an integrative and scalable, yet city-specific service model, that is globally transferable. The urban information system module is gradually customized during the planning process from global standards maintained by a community of consultants. Protocols to integrate consultant feedback into different layers of standards - i.e., global, context-bound, city-specific. Figure 13 illustrates the identified challenges and the offered solutions of the platform in the professional-academic sector.

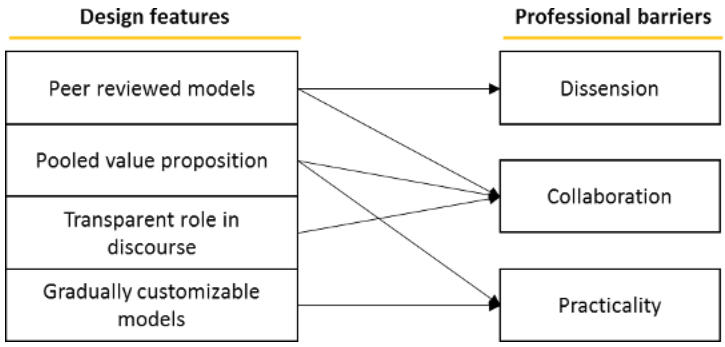


Figure 12 Design features overcoming professional barriers

Generic barriers: VM module address interoperability issues, and in the planning process, additional costs of possible incompatibilities are considered. Different levels of the assessment provide flexibility in a data-scarce and information divided environment. Missing or insufficient values are imputed. The dedicated consultants individually address the peculiarities of the local data environment. Organizational and cultural differences are aligned by using urban data and analytics to support inter-stakeholder discourse, which is the core competence of SmartCEPS consultants. Methodologies and tools to translate among frames of reference are added to the system and are continuously

developed by the consultants. Figure 14 illustrates the identified challenges and the offered solutions that are non-specific to any target groups.

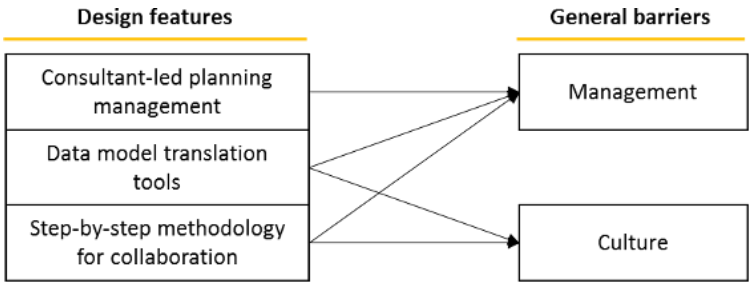


Figure 13 Design features overcoming generic barriers

3.7 Conclusion

The platform framework is shown to be a viable organizational model for SC transition because such a transformation is reliant on long-term, cross-cutting, and cross-sectoral collaboration. In the design study, this is achieved by positioning SC transition as a continuous self-reinforcing protocol for the day-to-day process of UPM.

SmartCEPS is a nested platform for collaborative planning on the first layer, and the continuous evolution of underlying methods and models on the second layer. The backbone of the first layer is the translation of stakeholder frames of reference to a standardized, open-ended, dynamic model of urban performance, which allows for more transparent participation at lower transaction costs. The second layer creates a plus-sum game to continuously evolve and adapt the supporting tools for UPM, by pooling the value proposition of professionals while rewarding active contributors, thus for the first layer. It is notable, however, that the SmartCEPS design is limited in addressing increased data security needs (due to more interactions), it has a high entry barrier for many stakeholders to participate, and is disruptive to conventional deliberative processes – all of which are consequences of a collaborative UPM process.

The SmartCEPS project will continue with demonstrating its design in real-life experiments, but further research will be needed to expand on the trade-offs and minimal entry criteria of a platform-based UPM.

3.8 Chapter takeaway for the dissertation argument

This chapter advances the dissertation argument by demonstrating that the barriers of smart city transition are not only external constraints or contextual disadvantages, but are

also embedded in the organizational forms through which urban digitalization is currently pursued. If Chapter 2 established that medium-sized cities face knowledge gaps, data limitations, vendor dependence, weak standards, and structural asymmetries, the present chapter shows why many of these barriers persist even when cities attempt to act: conventional organizational models are often too fragmented, too hierarchical, too closed, and too weakly integrated to support the complexity of smart city transition. In the logic of the dissertation, this is a crucial step forward. The dissertation does not merely ask what prevents cities from becoming smart; it asks how cities become smart in practice, and this chapter shows that organizational design is one of the central mechanisms through which that process is either enabled or blocked.

The chapter's main dissertation-level contribution is therefore to shift the analysis from a broad diagnosis of barriers to a more specific explanation rooted in organizational and governance arrangements. The article begins from the observation that digitalization in cities has been slower than expected to deliver meaningful impacts, despite the proliferation of frameworks, methodologies, and technological solutions. It argues that this is partly because smart city transition is characterized by sociotechnical scalability problems, systemic complexity, and procedural difficulties, and that these challenges cannot be solved through technological innovation alone. Instead, they require organizational structures capable of handling multi-actor interaction, coordination across silos, data-driven urban planning, and the continual translation of different stakeholder perspectives into implementable decisions. This insight directly supports one of the dissertation's central claims: smart city development is not primarily an engineering problem, but a governance and organizational problem expressed through urban digitalization.

A second major contribution of the chapter is that it makes the dissertation's governance argument much more concrete. In Chapter 1, governance and organizational design were identified as key mediating dimensions between context and implementation. This chapter now shows what those mediating dimensions consist of in practice. The article identifies public organizational barriers such as lack of coordination mechanisms, authoritative strategic approaches, functional silos, conflict of interests, power asymmetries, underperforming collaborative design, insufficient collaborative capabilities, lack of co-initiation, and weak innovation capabilities. It also identifies private-sector barriers such as product focus over needs, biased assessments, closed

innovation processes, and weak alignment between technology supply and urban demand, as well as professional barriers including fragmented knowledge generation, biased interpretations, lack of actionable outputs, and the continuing treatment of smart city development as an outcome rather than a planning process. Generic barriers such as system complexity, heterogeneous actors, information-flow difficulties, divergent value perspectives, and different frames of reference further reinforce the conclusion that the challenge is deeply organizational and inter-organizational.

These findings are important at the dissertation level because they show that the transition toward smart city development is hindered not by one organizational flaw, but by an interconnected set of institutional deficiencies. Public organizations struggle with integration and collaborative capacity; private actors struggle with technology push, closed innovation, and the standardization-customization tension; professional actors struggle with conceptual fragmentation and weak translatability into practice. The dissertation argument benefits from this because it becomes possible to interpret later city-level findings not as isolated local peculiarities, but as expressions of more general organizational pathologies in smart city transition. When later chapters analyse strategic orientation, activity portfolios, and stakeholder networks in Budapest and Debrecen, they do so against a background already clarified here: smart city implementation unfolds through organizational environments that may systematically favour fragmentation, asymmetry, and top-down control over genuinely collaborative and adaptive governance.

A further major contribution of the chapter is that it does not stop at diagnosis. Unlike Chapter 2, whose main role was problem formulation, this chapter offers a constructive design response in the form of the SmartCEPS platform model. This makes it one of the most distinctive studies in the dissertation. The chapter argues that the disruptive and knowledge-intensive nature of smart city transition requires open innovation models and collaborative platform thinking rather than conventional linear arrangements. The proposed SmartCEPS platform is explicitly designed as a nested structure: a first layer for collaborative urban planning and management among city managers, citizens, specialists, consultants, and technology suppliers, and a second layer for the continuous development of the underlying urban information system and methods by a community of urban professionals. Its value proposition lies in translating the frames of reference of different actors into a shared, standardized but adaptable urban performance model,

thereby lowering transaction costs and improving transparency, coordination, and learning.

For the dissertation, the significance of SmartCEPS is not that it offers a final universal blueprint for all cities. Rather, its importance lies in showing what kind of organizational logic the dissertation sees as more promising for smart city transition. The model embodies several principles that recur throughout the wider dissertation: collaboration instead of isolated action, integrative coordination instead of siloed management, open innovation instead of closed organizational boundaries, and contextualized but comparable planning instead of ad hoc interventions. It is especially notable that the model attempts to address both public and private barriers through platform design, consultant-mediated orchestration, shared standards, and iterative learning. In this respect, the chapter strengthens the dissertation's general proposition that smart city development becomes more coherent and publicly valuable when cities move beyond narrow, technology-led, supplier-driven implementation logics toward more integrated governance and organizational arrangements.

At the same time, the chapter is analytically valuable because it does not present the proposed model uncritically. The conclusion acknowledges that the SmartCEPS design also has limitations, including increased data-security needs, relatively high entry barriers for participation, and its potentially disruptive relationship to conventional deliberative processes. This strengthens the dissertation argument rather than weakening it. It suggests that organizational innovation in smart city transition is itself politically and institutionally consequential. More collaborative, platform-based models may promise better coordination and learning, but they also alter power relations, participation requirements, and operating routines. This is an important point for the dissertation as a whole, because it anticipates the later focus on stakeholder structures and governance bundles. Organizational solutions are not neutral technical fixes; they reshape the ecosystem of urban development itself.

In relation to the overall dissertation, this chapter therefore performs three connected functions. First, it deepens the diagnosis of smart city barriers by demonstrating their specifically organizational character. Second, it introduces a design-oriented response that clarifies what kinds of collaborative arrangements may better support urban digitalization. Third, it sharpens the dissertation's theoretical orientation by positioning governance and organizational design as central mediating mechanisms between context

and implementation. These functions make Chapter 3 far more than a standalone article on urban digitalization. It becomes the dissertation's main organizational-design chapter and the key bridge between structural barriers and the more explicit analysis of strategic content, city trajectories, and governance models in the later chapters.

The link to Chapter 4 is particularly important. While Chapters 2 and 3 together establish why smart city transition is difficult and how organizational arrangements may respond to those difficulties, they still focus mainly on constraints and institutional design. Chapter 4 broadens the analysis by asking what cities are actually trying to achieve through smart city development. In other words, once the dissertation has shown that smart city transition depends on organizational and governance conditions, it must also examine the strategic substance of that transition. The next chapter therefore turns from barriers and organizational models to value propositions and activity portfolios. It asks how cities' smart city activities reflect anticipated benefits and development logics. This transition is analytically necessary: if Chapter 3 explains how smart city transition might be better organized, Chapter 4 asks toward what kinds of outcomes and benefit structures those organizational efforts are directed.

In sum, the present chapter advances the dissertation argument by showing that the practical realization of smart city development depends on organizational architectures capable of handling complexity, participation, coordination, and learning. Its main contribution is to move the dissertation from problem diagnosis to organizational explanation and constructive model building. It demonstrates that smart city transition cannot be meaningfully understood without examining how urban actors are organized, how collaboration is structured, and how knowledge and decision-making are translated across institutional boundaries. With this, the dissertation is ready to move from the organizational conditions of smart city transition to the comparative analysis of the strategic benefits embedded in smart city activity portfolios.

4. The Many Faces of the Smart City: Differing Value Propositions in the Activity Portfolios of Nine Cities

4.1 Chapter preface

This chapter appears at this point in the dissertation because it extends the analysis from **barriers and organizational conditions** to the **strategic substance and anticipated benefits** of smart city development. Chapters 2 and 3 established that smart city transition is constrained by structural, institutional, and organizational problems, and that more collaborative organizational arrangements may be necessary to address them. The present chapter adds the next essential layer to the dissertation argument by asking a different question: beyond barriers and organizational form, **what are cities actually trying to achieve through smart city development, and how are those intended benefits reflected in their activity portfolios?**

The study is particularly important here because it provides the dissertation's main **comparative portfolio perspective**. Whereas the previous two chapters focused primarily on why smart city development is difficult and how urban digitalization might be better organized, this chapter turns to the distribution of **value propositions** across smart city initiatives. It begins from the observation that, although the strategic principles of smart city development have been widely discussed, there are still relatively few studies examining what beneficial outcomes cities anticipate from smart city developments and how these are represented in implemented activities. The article therefore seeks to establish a stronger connection between smart city theory and practical implementation by deconstructing the anticipated benefits of smart city activities and analysing their presence across the portfolios of nine cities.

Its placement is also justified by the role it plays in the dissertation's cumulative logic. Chapters 2 and 3 show that smart city development is shaped by barriers and organizational arrangements; Chapter 4 shows that it is also shaped by **the kinds of benefits and development logics cities prioritize**. This broadens the dissertation's analytical frame in an important way. Smart city trajectories cannot be understood only by asking whether cities have the right organizational model or whether they face strong barriers. They must also be understood by examining how cities interpret the purpose of smart development itself, whether through efficiency, quality of life, stakeholder

engagement, inclusion, connectivity, knowledge creation, cost reduction, scalability, or environmental impact. In this sense, the chapter contributes directly to the dissertation's effort to explain not only the conditions of becoming smart, but also the differing directions that smart city development may take in practice.

The chapter also functions as a bridge between the earlier organizational chapters and the later case-study chapters. By identifying value proposition components and showing how smart city activities can be grouped and compared on that basis, it creates a conceptual and empirical basis for interpreting the later city cases. In Chapter 5, when Budapest's trajectory is examined through the strategic dichotomies, and in Chapter 6, when Debrecen's smart city development is analysed through projects and stakeholder networks, the present chapter provides an important interpretive background: cities differ not only in governance style and organizational structure, but also in the anticipated benefits embedded in their activity portfolios. The comparative patterns identified here therefore help explain what later appears in the Hungarian cases as strategic selectivity, imbalance, or emphasis.

At the dissertation level, this chapter contributes most strongly to the part of the overarching research question concerned with **activity portfolios and public-value orientation**. It shows that smart city development can be analysed through the distribution of anticipated benefits across concrete urban activities, and that these benefit structures differ substantially across cities and periods. For this reason, the chapter should be read as the dissertation's **value-proposition chapter**: it demonstrates that smart city development is not only a matter of governance and organization, but also of what cities understand smartness to be for.

4.2 Bibliographic record and author contribution

Full citation	Csukás, M. S. and Szabó, R. Z. (2021) 'The many faces of the smart city: Differing value propositions in the activity portfolios of nine cities', *Cities*, 112, 103116. https://doi.org/10.1016/j.cities.2021.103116.
Publication status / outlet	Published journal article in *Cities*, Volume 112, 2021.
Co-authors	Máté Szilárd Csukás and Roland Zsolt Szabó.

Doctoral candidate contribution	The doctoral candidate was the lead author of the study and contributed substantially to the conceptualization of the research problem, the literature review on smart city value propositions, the construction and coding of the activity database, the comparative case analysis, the visualization of results, and the drafting of the manuscript. The candidate also played a leading role in the development of the analytical framework that deconstructed smart city activities into anticipated benefit components. The article's credit statement identifies the doctoral candidate's contribution as including conceptualization, data curation, original draft preparation, visualization, investigation, and software.
Relation to dissertation research question	This article addresses the dissertation's overarching research question by examining how smart city ambitions are translated into concrete activity portfolios and what kinds of anticipated public benefits are embedded in those portfolios. It contributes to the dissertation by introducing the value-proposition dimension of smart city development, showing that cities differ not only in governance arrangements or organizational conditions, but also in the strategic benefits they prioritize across their smart city activities.
Editorial adaptation note	The full text of the published article is reproduced in this dissertation as a core chapter of the article-based thesis. Only minor editorial adaptations have been made for dissertation integration, including formatting, chapter and figure numbering, citation harmonization, and alignment with the unified bibliography. No substantive changes have been made to the original scholarly argument, methodology, or findings.

4.3 Introduction

Ever since fundamental controversies were reported by Hollands (2008) in the smart city (SC) research, covering the period between 1990 and 2007, studies aiming for untangling the contradictory nature of the literature have been gaining ground in the scientific community. Mora et al. (2017); Mora et al. (2018) and Komninos and Mora (2018) unveiled the significant differences of SC research streams, by capturing four distinct dichotomies, present in scientific publications. Mora, Deakin, and Reid (2019) introduced a rigorous case-study based methodology to analyse SC developments. With their proposed research methodology framework, they tested and validated the four

dichotomies as the divergent strategic principle of SC development and tested their hypothesis in leading examples of cities (Mora, Deakin, Reid, and Angelidou, 2019).

The purpose of this paper was to establish a better connection between the theory of SC and practical implementation. There are still misunderstandings and differing opinions about what a SC is (Kitchin, 2015; Komninos, 2011). Additionally, the implementation of smart city developments ought to be realized with strategic methods (Angelidou, 2015; Komninos, 2014; Mora and Bolici, 2016, 2017). The particularities of how these strategic principles should be considered are relatively well researched; however, there are only of few publications available on what beneficial outcomes cities are anticipating from SC developments, and how are they represented in their implemented activities. Moreover, the theory lacks empirical research.

To address this knowledge gap, we investigate (1) what benefits are anticipated from SC developments; (2) how these benefits are present and distributed among SC activity portfolio of cities; (3) how SC activity portfolios and cities are categorized based on their anticipated benefits. To answer these questions, in this paper, we deconstruct the principle value proposition components - or in other words, anticipated benefits - of SC development activities, identifiable in the SC literature. Then, we analyse their presence in the activity portfolio of eight European and one North American examples of smart city development. To achieve this, we adopt a deductive-based multiple case study analysis, following the methodological research principles, introduced by Mora, Deakin, Reid, and Angelidou (2019). In the sampling procedure, we included six cases, reported by researchers as best practices, the excellence of SC practices. Other three samples are covered to a lesser extent in the literature, labelled as emerging excellence cases of SC development.

The paper is structured accordingly. After this Introduction section, a comprehensive literature review follows, where the anticipated benefits of SC development activities are collected. Papers range from 1999 to 2020. The identified value proposition components are eventually used as a conceptual framework for the analysis. The next section explains the particularities of the case study methodology and reasoning for the sampling of the cities and their SC development activities. The Results section provides descriptive statistical data on the distribution of value proposition components, and other factors, that were considered in the analysis. Based on the identified anticipated benefits and temporal data, SC activities are categorized with cluster analysis, and the sampled cities are studied

with comparative analysis, considering different periods of the reported activities. The results are followed by the Discussion section, which outlines the conclusions resulting from the study. The last section explains limitations, validity of the results and future research directions.

This paper may be useful to policymakers and urban managers, SC specialists involved in strategic planning processes, and mainly when designing portfolios of SC solutions for a city, benchmarking, and peer learning activities. Practitioners can gain insights to create development pathways for their SC strategies that fit their cultural context.

4.4 Literature review and research framework

This part of the paper reviews the literature on the anticipated benefits of SC activities, which will be the foundation of our empirical research. The emerging concepts serve as a structure for building the database to analyse in the next section. The adoption of a SC model promises advantages for decision-makers, including various benefits across the different urban subsystems. However, there are still differing opinions on what constitutes a smart city. We argue that SC, as a concept, can be better understood by deconstructing its value proposition components. This part of the study collects and classifies the most critical anticipated benefits of SC activities. Referring authors and definitions for each value proposition component are summarized in Table 8.

4.4.1 Efficiency

Ever since the SC concept emerged in global discussion, improved efficiency in cities has played a pivotal role in the discourse, assumed to be one of the most referred benefits. As Bibri and Krogstie (2017:191) point out, "a smart city represents essentially efficiency". However, this is often considered as an exclusive trait, a compromise of an achievable outcome, promised by technology and its dealers (Söderström et al., 2014), which on the other hand is a key disadvantage (Angelidou, 2014).

One of the earliest, and influential publication[6] the "Vision of a Smart City" (Hall et al., 2000:1) stresses the importance of efficiency, as one of three main factors of future cities, which are supposed to be "made safe, secure environmentally green, and efficient" and they shall be "models for efficiency" ultimately. Subsequently, it remains as a defining

[6] Most cited among pieces published around 2000, before the significant uptake of the topic in academia (568 and 321 citation as per Google Scholar)

factor in further publications (Dodgson and Gann, 2011; Nam and Pardo, 2011a; Barrionuevo et al., 2012; Batty et al., 2012; Chourabi et al., 2012; Vanolo, 2014). Another early study argues that the inherent economic excellence of competitiveness implicitly "cause benefits to the public. In terms of time, effort and cost, there are numerous instances of efficiency" (Mahizhnan, 1999:17).

Based on our review, that majority of researchers have considered the efficiency gain potential of technology and particularly ICT on hard infrastructure (Caragliu et al., 2011; Desdemoustier et al., 2019; Lombardi et al., 2012). In parallel, studies also highlighted "soft" factors, referred to the political and social efficiencies, covering the topic of the efficient government and its services to the public.

Regarding hard infrastructure or physical capital, researchers draw our attention to an idealized efficiency gain (also referred as optimization), caused by the increased interconnectedness and interactions of city systems ("system of systems"), which is claimed to be superior, in contrast to alleged existing inefficiencies (Dirks and Keeling, 2009; Dirks et al., 2010; Washburn et al., 2010; Nam and Pardo, 2011b). From this perspective, smartness can also be interpreted as a new level of efficiency by the integration of public and private systems into the aforementioned 'system-of-systems' (Naphade et al., 2011). In their analysis of SC performance, Giffinger et al. (2007) primarily associate the term with environmental sustainability and resource management.[7] A great deal of previous research on SC models has focused mainly on energy efficiency (Deakin and Reid, 2018; Lazaroiu and Roscia, 2012). This research stream is labelled as "European Path: Smart City for a Low-Carbon Economy" by Mora et al. (2018)., which organizes studies around this subject.

Parallelly, from a knowledge communication and social capital perspective, Komninos (2006) suggests that cities may be able to carry out "knowledge work", utilizing effective education and training for the local workforce, and effective marketing that attracts new, desirable employers. Hollands (2008) claims that besides economic, there is political efficiency that is also a key outcome of "networked infrastructure". Therefore, Hollands extended the understanding of efficiency to far-reaching terms, directly connecting it with social and cultural development. In a narrower sense, highly efficient city governance and

[7] Efficient use of water and electricity, as Smart Environment indicators.

local policymaking (Kourtit and Nijkamp, 2012) became another critical issue, in the field of overall city management (Angelidou, 2015; Belanche et al., 2016; Hao et al., 2012) and public services (Almirall et al., 2016; Bakici et al., 2013). This extends to private services, affecting various stakeholders (Dameri and Rosenthal-Sabroux, 2014).

Collectively, these studies outline a critical role for efficiency; however, the term is used in various instances that makes no clear interpretation. Readers might have the impression; it is merely an expletive to transcribe something that is superior. The specific cases are energy efficiency, environmental efficiency, transport efficiency (Debnath et al., 2014; Neirotti et al., 2014) resource efficiency (Fernandez-Anez et al., 2018), economic efficiency (Hollands, 2008), operational efficiency, infrastructure efficiency, data management efficiency, technology efficiency (Vanolo, 2014), information management efficiency, decision-making efficiency, service efficiency, political efficiency (Albino et al., 2015), institutional efficiency, design efficiency, mobility efficiency, and (urban) management efficiency (Bibri and Krogstie, 2017).

4.4.2 Citizen (stakeholder) engagement

The literature on community growth management has already highlighted the critical role of active citizen engagement (Porter, D.R., 1997). Despite the economic growth focus, stakeholder engagement soon became a topic of discussion, an alleged necessity for the successful transformation of smart cities. The reason for this is the need for developing social capital and smart communities, where stakeholders can meaningfully utilize ICT technologies in the smart city (Hollands, 2008). To achieve this, a growing construct of social relations, stake-holder partnerships and empowerment of communities are required, (e. g., citizen engagement (Dezi et al., 2018)), which create the 'city intelligence' (Komninos, 2011). Community engagement is also a key anticipated benefit, where a SC constitutes meaningful collaboration between various stakeholders – i.e. "public institutions, private sector, voluntary organizations, schools and citizens" (Nam and Pardo, 2011a:286) – through diverse channels in order to jointly tackle urban challenges (Batty et al., 2012). Co-creation or co-production of these solutions and services are also a key topic. With advancements in ICT, researchers and practitioners have argued that cities will be able to facilitate improved participation of communities and citizens, coupled with a shift in paradigm from the centralized silos of bureaucracy to a decentralized participative model, including platforms (Anttiroiko, 2016; Rajakallio et al., 2018). Almirall et al. (2016) describe this new form as platform-based governance,

where the city takes a role like technology platform owners, an orchestrator of different ecosystems – i.e. civic, digital, innovation.

Giffinger et al. (2007) incorporates these traits to the 'Smart People' and 'Smart Governance' in their SC characteristics, while proposing the fundamental role of "independent and aware citizens" or "informed, educated, and participatory" as phrased by Chourabi et al. (2012). Be-sides social capital, others consider civic engagement as a domain of institutional capital, contributing to 'city intelligence' (Barrionuevo et al., 2012). Caragliu et al. (2011) measure e-government by downloadable forms, as an indicator for citizens to interact with public administration, while Lombardi et al. (2012) use internet usage for interaction with public authorities. Aside citizen-government interactions, general, proactive stakeholder engagement (Bakici et al., 2013), particularly public-private interactions are crucial for the SC (Washburn et al., 2010; Gil-Garcia et al., 2015; Meijer and Bolívar, 2016), specifically for their strategies (Angelidou, 2014). The difficulties, cities face in engaging wide-ranging stakeholders, are recognized as potential pitfalls in developing SCs (Lam and Ma, 2019).

Some have suggested that cities can only achieve 'real' smartness by integrating official city management with the democratic participation of its diverse stakeholders (Fernandez-Anez et al., 2018). The spheres of decision making and public or social services both required for the idealized Smart governance (Albino et al., 2015). Citizens may be able to address particular urban challenges if they systematically orchestrate their actions (van der Graaf and Ballon, 2019). Through digital solutions such as urban platforms, people can collaborate, co-create, and solve specific problems on their own. They can also act as sensors (crowd-sensing) for corporate or public bodies by, for example, reporting events or creating content. There are multiple channels for citizen engagement, including political decision-making (participatory governance), innovation, urban planning and design, or "problem-solving".

Trencher (2019) argued that second-generation smart city paradigms define the role of citizens as active contributors to problem-solving and planning, in contrast to the passive role of 'users' provided by the first generation, describing a higher level of engagement of citizens. Mora et al. (2018) found the most significant role of stakeholder engagement in the "Holistic Path: Digital, Intelligent, Smart" approach.

4.4.3 Quality of life

Improving the quality of life of citizens is a central concept, and we assume it to be an ultimate goal of SC developments. Singapore's first agency for exploiting IT stated that both economic excellence and Quality of Life (QoL) are their objective, the latter, particularly for the ordinary citizen. In their interpretation, QoL means a higher level of comfort, in the forms of lower costs, effort or time, which mainly comes from efficiency gains (Mahizhnan, 1999), showing a direct cause of QoL, by specific efficiency type of gains. The term is included in several definitions for the SC, as the desired outcome in cities (Giffinger et al., 2007; Chen, 2010; Caragliu et al., 2011; Thuzar (2011); Bakici et al., 2013; Anttiroiko, 2016).

Previous studies have explored the relationships between social capital and QoL. Eger (2003) states that the higher QoL attracts employees in knowledge-intensive sectors. Shapiro (2006) analysis the relationship of "more educated population" and growth in QoL, and showing a high level of influence, besides productivity. Others also claim that QoL attracts knowledge-based population (Caragliu et al., 2011; Dirks et al., 2010).

The services available for citizens largely determine QoL (Komninos, 2011). Giffinger et al. (2007) associate QoL with the Smart Living factor of the SC, which comprise – e.g. culture, health, housing, social cohesion. Similarly, Dirks and Keeling (2009) categorize QoL to one of the six core systems of a city - People - which is defined as "human and social networks", and it comprises health, education and safety. They conclude that the performance of the core systems improves QoL, and consequently, social capital. One interpretation about this claim explains that better services presumably cause less stress, which improves QoL. Further research often considers it as a factor of "People" and "Living" in other SC frameworks (Belanche et al., 2016; Chourabi et al., 2012; Fietkiewicz and Stock, 2015; Neirotti et al., 2014).

QoL studies show a renewed interest, with the emerge of "Science of Happiness"; however, this is a new field for urban research. There is a growing discussion on how to measure happiness, considering both subjective and objective approaches (Ballas, 2013). Robinson (2014) deconstructs QoL in cities through the Maslow's (1954) hierarchy of needs framework but admits that various contextual factors influence citizen's perception of QoL.

The range of technological solutions available has often been questioned and criticized by researchers because these solutions fail to address this fundamental factor (Hollands,

2015; Thomas et al., 2016). A sole focus on efficiency could cause a less pronounced focus on societal aspects (Angelidou, 2014). The techno-led or holistic dichotomy identifies QoL, as a critical factor of tension between a market-oriented, and a human-centric vision of SCs (Mora, Deakin, and Reid, 2019).

4.4.4 Inclusion and equality

Social Inclusion or (in)equality are becoming a vital element in the discourse. SC labelled initiatives were criticized for being only a variation of urban entrepreneurship, which begun to spread various attempts to characterize a more inclusive SC, by introducing a social justice component to the debate (Harvey, 2000). As discourse moved the concept to a more sustainable agenda, inclusiveness in urban environments became the desired outcome (Batty et al., 2012; Komninos, 2011; World Bank, 2016). Caragliu et al. (2011) highlight the aim of achieving social Inclusion, as a critical characteristic of SCs, in a sense, how equally different social classes benefit from urban technology. Neirotti et al. (2014:27) classifies this benefit as "Social inclusion and welfare", within the "Soft domain" of their framework, focusing on reducing the barrier of social groups in social learning and participation processes.

Growing social distance affects the number of interactions, the potential for knowledge-sharing and creation, and trust in communities. The digital or technology divide is a specific issue that smart actions address by - e.g., providing access to technology or specific knowledge for all citizens. It is acknowledged, that technology per se opens up various divides, while the SC carries the promise of ending them. The SC should be anticipating and planning for both cases: "Efficiency must be balanced with equity." (Batty et al., 2012:485). The target groups of these solutions are usually marginal, disadvantaged groups. These solutions are intended to reduce barriers for such groups, i.e. digital initiatives may provide better access to government for underprivileged citizens with a less powerful network of relationships with political figures (Nam and Pardo, 2014).

Many SC frameworks define an inclusive society in the 'smart people' domain (Manville et al., 2014). Effectuating social Inclusion in European cities became an objective, declared by the Mission Board for Climate-neutral and Smart Cities of the European Union (European Commission, 2020). Social Inclusion appears to be a key expected benefit (Anttiroiko et al., 2014). However, others often criticize this for being fundamentally paradoxical and suggest that inequality is always present across various

dimensions (Hollands, 2008). While some SC actions are expected to contribute to social Inclusion, it is not excluded, that others amplify that divide. It is also shown that SC initiatives with potential inclusiveness might produce other inequalities (Beretta, 2018).

Social Inclusion is understood in this study as an anticipated benefit of social equality, equitable urban growth, reduction of the divide between groups of the local population in terms of – e.g. education, wealth, and providing support for disadvantaged groups – e.g. assistance for disabled citizens. Actions that recognize inequalities and strive for greater social justice in the local population.

4.4.5 Connectivity

Cities are viewed as systems of networks, with an unprecedented scale of interdependencies (Batty et al., 2012). They shall be instrumented, interconnected and intelligent (Harrison and Donelly, 2010). Connectivity is, therefore, an exceptionally essential element of SC theory (Lazaroiu and Roscia, 2012). Researchers have interpreted connectivity from both a technological perspective, where ubiquitous technologies are gaining higher space, and a social perspective, or increasing social interconnectedness of local inhabitants, businesses, communities, and policymakers. Members of smart communities are connected (Komninos, 2011), and both public and private actors hold a capacity to successfully achieve this (Dezi et al., 2018). Besides these two distinct categories, the interconnectedness of people and urban systems represent another area of interest (Allam and Dhunny, 2019). However, it is claimed that SCs must be more than just broadband networks, connected is no guarantee for being smart; it would only resemble a ‘wired city’ (Hollands, 2008).

Singapore’s strategy centred around an excellent IT infrastructure, connecting its households and business spaces to the national optical fibre network, with a user-centric design (Mahizhnan, 1999). Others interpret connectivity with the interconnectedness of core city systems (‘connected infrastructure’), which brings smartness (Dirks and Keeling, 2009), or devices (IoT components) and city-wide networks (Lam and Ma, 2019).

The term appears to have various definitions in the literature. It may refer to the connectedness of different infrastructures (e.g., physical, IT, business, and social) (Harrison and Donelly, 2010); physical and virtual (Zygiaris, 2013); stakeholders (e.g., companies, citizens, institutes, and sectors) (Schuurman et al., 2012); people; technologies (e.g., sensors and mobile devices); networks (e.g., broadband); systems

(e.g., communication and city domains); data; linking local actors with the necessary resources and competencies or other actors (e.g., entrepreneurs with tools, investors, and mentors, or labour with employers) (Adler et al., 2019), local and global interconnectedness in the smart economy (Giffinger et al., 2007); and services (Lee et al., 2014).

Based on these findings, we define connectivity as a feature, creating links among data, systems and people.

4.4.6 Knowledge creation and sharing

Knowledge and innovation are key drivers of the SC discourse (Angelidou, 2015), considered to be critical enabling factors for creating smart cities (Heaton and Parlikad, 2019; Sepasgozar et al., 2019; Yigitcanlar and Velibeyoglu, 2008). It is knowledge and innovation that influenced technological advancements to have such a substantial impact on cities (Komninos, 2011). Creating a knowledge-intensive economy and becoming a knowledge society is stimulated and influenced by the use of ICT, i.e., superior approaches (faster, safer, cheaper) to advancing, sharing and storing knowledge, that is otherwise distributed throughout the society (Caragliu et al., 2011; Kummitha and Crutzen, 2017). Creativity, learning, and education are incorporated into smart communities, which supports the creation of a knowledge economy, described as a "bridging initiative" (Marsal-Llacuna et al., 2015). Knowledge creation and knowledge management are essential. The transfer of knowledge, including knowledge sharing, is a crucial facilitator in this transition (European Commission, 2020; Ruhlandt, 2018). The role of knowledge is usually classified into the "soft infrastructure" category of SC developments (Ahvenniemi et al., 2017). Desdemoustier et al. (2019) classify this anticipated benefit to the 'Human & creative' category, and they claim, SCs aim to improve the knowledge economy.

Cost reduction

'Cost reduction' is not a frequently used phrase in SC definitions. However, it is an attractive value proposition of smart solutions. Many types of transactions can be conducted in the cyberspace with virtually no costs, making considerable investments beneficial (Mahizhnan, 1999). Virtual spaces reduce costs in various forms of transactions – e.g., logistics, marketing, policy information (Komninos, 2006). One of the many reasons for initiating smart investments is that city systems are operating with growing costs (Nam and Pardo, 2011b), imposing burdens on infrastructure,

administration (i.e. e-government), businesses and citizens (Dirks and Keeling, 2009). The factor is argued to restrain competitiveness and attractiveness for the desired employers and creative population (Ballas, 2013), in the form of – i.e., energy consumption, education, real estate, transportation (costs associated with congestion) (Washburn et al., 2010). Smarter city-systems create cost-saving and additionally, increased efficiency (Dirks et al., 2010). Komninos (2011) claims that besides better procedures and problem-solving capabilities, lower operation costs are also criteria for intelligence.

In an environment of constraints on public budgets, decreased investment and increasing operational expenses of city services and infrastructure, it is likely to be one of the most significant expected impacts for city management. The value propositions of key SC market actors and implemented projects also suggest this, because they promise that their technology will provide cost reductions (Hunter et al., 2018; McNeill, 2015; van den Buuse and Kolk, 2019). Barcelona expects to become the leading place for sustainable urban development by 2020 while reducing capital costs and save in its operations (Bakici et al., 2013). The pressure to optimize the efficiency of public spending also suggests that cost reduction is a significant expected benefit of SC initiatives (Lee et al., 2013).

4.4.7 Scalability and transferability

Scalability is an essential attribute of SC solutions. There is a gap between small-scale demonstrations or pilot projects and large-scale implementation. This phenomenon is a significant challenge in achieving sustainable urban development (Winden and Buuse, 2017). Many cities want to capitalize on small-scale deployments, and technologies, products, and services that are difficult to scale, create a barrier. As Taylor Buck and While (2017:504) reminds us: “smart city innovation is most evident through well-funded niche experiments in a limited range of urban contexts”. Many projects and solutions do not scale up, and the desired impacts are lacking, after an often-subsidized initial phase. They do not operate on a larger scale (Deloitte, 2015). SC solutions are expected to have the ability to scale up. Less developed cities are particularly interested in learning from successful implementation elsewhere, which makes transferability a critical enabling factor in accelerating the diffusion of proven technologies or methods. Policymakers want to expand small scale deployments and ‘copy’ them to new areas with different boundary

conditions, to contribute to higher-level (national or supranational) goals (Ferrer et al., 2017).

There are three non-exclusive categories for scaling up in case of SC initiatives: Replication, Expansion and Roll-out (Winden et al., 2016).

4.4.8 Environmental impact

The vision of SCs suggests the urban centres of the future are environmentally green (Hall et al., 2000). As Giffinger et al. (2007:12) describe the environment subsystem of their SC concept: "attractive natural conditions (climate, green space etc.), pollution, resource management and also by efforts towards environmental protection". Besides social, environmental sustainability became an important outcome for smart cities (Albino et al., 2015; Caragliu et al., 2011; Hunter et al., 2018; Neirotti et al., 2014), as one of the determinants for urban living quality. Some authors (e.g., Dodgson and Gann, 2011; Pham, 2014) have attempted to draw subtle distinctions between environmental preservation and economic growth, stating that SC initiatives are promoted to serve a double purpose of these goals. Others question the fundamental compatibility of these outcomes (Hollands, 2008). Concerning 'Efficiency', it is claimed to be an essential distinguishing feature between the related terms of sustainable and smart cities (Bibri and Krogstie, 2017). Naphade et al. (2011) emphasize water, energy, food supplies, waste management, and reducing GHG emissions, as critical targets of environmental sustainability. Chourabi et al. (2012) find that the natural environment is one critical factor of SC initiatives, particularly the protection of natural resources and their related infrastructure. Dameri and Rosenthal-Sabroux (2014) highlights environmental considerations, to prevent further environmental degradation, as one of the three main aspects of a SC. Other classifications consider the 'Environment' domain, as utilizing technology for superior environmental resource management, to increase sustainability (Neirotti et al., 2014).

Using ICT to transform the economy to an energy-efficient and low carbon one, became an important goal for Members States of the European Union, greatly influencing the European interpretation of the SC (Mora et al., 2018; Mora, Deakin, and Reid, 2019). The European Com-mission is promoting investment in low and zero-carbon solutions to support the transition of 100 climate-neutral cities by 2030 (European Commission,

2020), which also demonstrates a significant emphasis on the "Smart Environment" factor of European SCs, showed by Manville et al. (2014).

Much of the available literature on SC performance deals with the components of environmental factors (Ahvenniemi et al., 2017; Lazaroiu and Roscia, 2012; Lombardi et al., 2012), as well in SC strategies (Angelidou, 2017; Ben Letaifa, 2015).

4.5 Methodology

We use a deductive-based multiple case study analysis that helps to investigate our research questions. The manifestation of each identified anticipated benefit in research subjects explain how theoretical benefits of SCs are present in SC developments and tested in eight European and one American city. This task is accomplished by comparing nine cities, of which six are considered to be leading examples of smart cities, while three are considered to be examples of emerging excellence.

The selection of the appropriate cases was key to adopt a successful multiple-case study analysis. The selection process relied on a theoretical sampling approach and not a random selection. Theoretical sampling is a process of data collection for generating theory whereby the researcher takes the double role of a data collector data analyst and decides what data to collect next and where to find them, in order to develop a theory as it emerges (Glaser, 1978). This also means that the case studies are "chosen for the likelihood that they will offer theoretical insight" (Eisenhardt and Graebner, 2007: 27). The basic requirement for selecting the cities was the existence of well documented and demonstrated SC development activities, with a SC strategy as an essential requirement. As a next step, our attention was drawn to intensive cases, where outstanding success or failure was observed. The selection of cases depends on the selection logic, which means either a literal replication with similar settings and similar results or theoretical replication cases have different settings and anticipated different results. There can be cities where SC development and ICT-driven approach to urban sustainability was admittedly successful, and cities where the transition process is less prominent, meaning that it is not widely recognized as an example of excellence. In order to find efficient and normative approaches for the SC, we needed to cover both successful and less outstanding cities with our sampling. Therefore, we adopted a theoretical replication logic. In order to differentiate, we label these two groups as follows: (1) Demonstrated SC Excellence, and

(2) Emerging SC Excellence. Criteria for meeting the demonstrated excellence condition is the acknowledgement by top-tier publications, influential organizations, and outstanding placement in significant SC rankings. Based on these criteria, we selected the following cities, as subjects of our investigation (Table 9) (Figure 14).

The adoption of the replication logic made it possible that all subject cases were processed with the same analytic procedure, starting with the data collection phase. To study how the identified value proposition components are present in the SC activity portfolio of cities, we built and analysed the database, which classifies all the activities that each city has implemented or currently implementing to enable SC development. The classification was conducted by considering the nine components presented in Table 8. This framework allowed the activities to be grouped according to the anticipated benefit, towards which efforts have been directed. The activities with multiple value proposition components were included in more than one group. The analysis of the percentage share related to each group made it possible to investigate the research questions, to determine how these value proposition components are distributed across cities, and what differences appear between cities and their performance.

The activities grouped in the database were mapped and analysed by cross-referencing the qualitative data extracted from multiple sources. Digital contents, reporting on the SC developments under investigation and produced by the nine city governments were considered as primary sources. The collected digital records may include press releases; newsletters; conference presentations; videos of conference speeches; reports; brochures; government documents; official project repositories; policy documents, and webpages. Additional data originates from private companies, implementing SC activities in the cities, with declared cooperation of the local government, or academic institutions, participating in activities in cooperation with the city. These sources were considered secondary sources, reports, news and articles published online, academic literature, and research or innovation project deliverables. A large part of the already acknowledged activities was taken over from the literature. This data collection process strengthened the valid of the multiple case study analysis, because multiple data sources were used, considering both external and internal observers. Overall, 2856 digital records were collected, in either written or audio-visual formats. Data were collected by conducting a series of online searches with different search engines, and multiple search strings were deployed. No restrictions for languages were set during the searches. In case of links that

were no longer working, the Internet Archive's Wayback search engine was used to collect digital records.

Digital records were extracted from the original sources, to enable the coding of the value proposition components from the research framework. During the coding process, a dichotomous variable was assigned for each of the nine categories, with a value of either 0 or 1. Each of the 637 activities was given a code for each of the nine variables to show whether a component of that type was anticipated from the activity. Further attributes of the activities that were collected: (1) year when the activity has begun, (2) status of the activity (0: research or pilot action; 1: rolling out technology or currently implementing a solution, initiative; 2: concluded initiative, or technology deployment, that was finalized), (3) outcome of the activity (0: activity's outcome not available anymore; 1: activity's outcome available).

We utilized a two-stage validation process in order to avoid subjective judgments. In the first stage, the authors performed the coding independently, and any differences were discussed with three other experts on the topic. Once the codes had been agreed, a 50-sample dataset was extracted and checked independently by the authors. When there were no differences in opinion, the variables were considered finalized.



Figure 14 Case study cities sampled in the analysis.

4.6 Results

4.6.1 Descriptive statistics of the anticipated benefits of SC activities in the case study cities

The anticipated benefits in the sample help us to identify different trends. The Connectivity component has the highest rate of distribution across the cases, ranging from 39% (Budapest) to 88.46% (Moscow). The average share of the component is 60.44% of all cases. The second most significant benefit is Efficiency Gains, ranging from 19.61% (Budapest) to 45.12% (Barcelona). Both components show a consistent share in the top-performing cities, with an average of 37.46%. The third most important trait is Quality of Life, averaging 35.79%, with a moderately higher scatter, compared to the two other benefits. Knowl-edge Sharing is observed to have also a prominent presence, averaging 29.51%. The other components of Citizen Engagement, Easy Replication and Environmental Impact have a share equating between 24 and 25%. However, while citizen engagement shows a somewhat even distribution, environmental impact is more scattered across the cases. Based on the results of the descriptive statistics, Cost saving has the lowest share, ranging from 3.39% to 22.03% (Table 10).

There is a significant difference between the two categories in the knowledge sharing component, cities with demonstrated excellence have a higher share (31.95%), in contrast to emerging ones (21.88%). Top-performing cities also have a relatively higher share in ‘Efficiency gains’ (40.09% to 32.26%), ‘Easy replication’ (27.77% to 18.10%) and ‘Environmental impact’ (26.06% to 16.97%). On the other hand, they have a moderately higher share in ‘Citizen engagement’ and ‘Cost savings’. In ‘QoL’ and ‘Inclusion and equality’ components, emerging cities have relatively higher shares, while the connectivity component is very similar (both around 61%).

Despite the differences, it is important to note that these figures do not reveal the degree of commitment related to each component. A higher value does not necessarily correspond to a more significant investment or a greater level of importance. These figures should rather be considered as an initial proof of the alignment between the approach to SC development of the studied cities and the presence of the nine identified value proposition components and assembling process.

Considering the status of the observed activities, in most of the cases, we found fully implemented solutions. The share of the pilot is research activities are also significant in several cities: 55.9% in Helsinki, and 40.70% in Vienna (Table 11).

The spatial level of the analysed activities is also reported in the analysis (Table 12). Most of the expected impacts are focusing on the whole city level, while districts are also key targets for the SC activities. There is also a high scatter between the various cases. Some cities are showing a more distinct based approach, while others were solely focusing on city-wide approaches (e.g. Moscow).

4.6.2 Clusters analysis of the anticipated benefits of SC activities in the case study cities

Based on the built-up database, we were able to group the observed activities, according to their similarities in the nine value proposition components. The purpose of this analysis is to reduce the high dimensionality of SC activities to lower-dimensional data while preserving much of the data variation. Eventually, we selected k-means clustering, as it is one of the most popular methods, and it properly minimizes variance within clusters. Using this technique, we categorized the activities into four clusters: (1) Environmental efficiency, (2) QoL Applications, (3) Social Sensitivity, and (4) Intelligent Inclusion. The influence of each component on the four clusters are presented below Figure 16. In the next subsection, we describe these clusters.

4.6.2.1 Environmental efficiency

Cluster 1 represents the SC activities, with a high share of ‘Environmental impact’, ‘Efficiency’, and ‘Cost Savings’, while the share of ‘Citizen Engagement’, ‘Inclusion and Equality’, and ‘Connectivity’ is the lowest, compared to other clusters. Activities in this group are primarily concerned with environmental goals coupled with cost reductions and efficiency gains. These solutions generally have low scalability and were generally based on the use of novel technologies, focused on mostly city-specific energy efficiency solutions, where direct QoL effects are not present, emphasis on developing city-systems. Many of the SC activities in this group are research energy-related research projects, pilot applications of technologies, or environmental programs of the city. As an example, in this cluster, the ‘Power to Protein’ _initiative in Amsterdam is piloting a modern technology solution, which produces protein for animal feeding, from sewage sludge. The Accelerated Conservation and Efficiency (“ACE”) Program in New York City provides funding for city agencies to implement energy efficiency developments. Another

important type of activities here, which are not environmentally focused, are mainly concerned with community building and strategic implications and creating intelligence for the city management.

4.6.2.2 QoL applications

Cluster 2 members have the highest share of 'Efficiency gains', 'Life Quality' _and 'Easy replication'. This cluster was named 'QoL Applications' _because activities here are mostly application-based activities. These activities directly targeted citizens. The goal of these solutions is to provide new services to citizens, directly improving their quality of life. These solutions had an exceptionally high scalability load, so were straightforward to scale up and transfer to other locations, often regarded as platforms. Typical services included mobility (parking services for municipalities, or vehicle sharing), intelligence (citizen behaviours, activities, etc.) and digital infrastructure services (Wi-Fi network). As an example, the 'Regent Street App' in London is an innovative mobile application, providing an exclusive shopping experience. The SMILE mobility platform in Vienna comes with a mobile application, to provide excellent mobility service for all type of passengers.

Table 8 Breakdown of value proposition components of SC solutions, with references

Component	Description	References
Efficiency	The superior performance of city systems, expressed in products, technologies, and processes and measurable with quantified parameters.	Mahizhnan (1999); Hall et al. (2000); Komninos (2006); Giffinger et al. (2007); Hollands (2008); Dirks and Keeling (2009); Dirks et al. (2010); Washburn et al. (2010); Caragliu et al. (2011); Dodgson and Gann (2011); Nam and Pardo (2011a); Naphade et al. (2011); Barrionuevo et al. (2012); Batty et al. (2012); Chourabi et al. (2012); Hao et al. (2012); Kourtit and Nijkamp (2012); Lazaroiu and Roscia (2012); Lombardi et al. (2012); Bakici et al. (2013); Angelidou (2014); Dameri and Rosenthal-Sabroux (2014); Debnath et al. (2014); Neirotti et al. (2014); Söderström et al. (2014); Vanolo (2014); Albino et al. (2015); Angelidou (2015); Almirall et al. (2016); Belanche et al. (2016); Bibri and Krogstie (2017); Fernandez-Anez et al. (2018); Deakin and Reid (2018); Mora et al. (2018); Desdemoustier et al. (2019)

Citizen (stakeholder) engagement	Activities that are intended to involve non-elected citizens directly and their groups in the operation of city systems.	Porter, D.R. (1997); Giffinger et al. (2007); Hollands (2008); Washburn et al. (2010); Komninos (2011); Caragliu et al. (2011); Batty et al. (2012); Chourabi et al. (2012); Barrionuevo et al. (2012); Lombardi et al. (2012); Bakici et al. (2013); Angelidou (2014); Nam and Pardo (2014); Gil-Garcia et al. (2015); Albino et al. (2015); Anttiroiko (2016); Almirall et al. (2016); Bolívar and Meijer (2016); Dezi et al. (2018); Fernandez-Anez et al. (2018); Mora et al. (2018); Rajakallio et al. (2018); Lam and Ma (2019); van der Graaf and Ballon (2019); Trencher (2019)
Quality of life	Activities directly providing better conditions for citizens to pursue happiness in their daily life, considering their needs and experience, resulting in wellbeing.	Mahizhnan (1999); Eger (2003); Shapiro (2006); Giffinger et al. (2007); Dirks and Keeling (2009); Chen (2010); Dirks et al. (2010); Caragliu et al. (2011); Thuzar (2011); Komninos (2011); Chourabi et al. (2012); Bakici et al. (2013); Ballas (2013); Robinson (2014); Neirotti et al. (2014); Angelidou (2014); Fietkiewicz and Stock (2015); Hollands (2015); Anttiroiko (2016); Belanche et al. (2016); Thomas et al. (2016); Mora, Deakin, and Reid (2019)
Social inclusion and equality	Activities to realize social equality, providing better urban living conditions for all segments of society without discrimination.	Harvey (2000); Hollands (2008); Komninos (2011); Caragliu et al. (2011); Nam and Pardo (2011a); Batty et al. (2012); Neirotti et al. (2014); Anttiroiko et al. (2014); Manville et al. (2014); World Bank (2016); Beretta (2018); European Commission (2020)
Connectivity	Activities to create information channels between humans and non-humans in order to interact with each other.	Mahizhnan (1999); Giffinger et al. (2007); Hollands (2008); Dirks and Keeling (2009); Harrison and Donnelly (2010); Batty et al. (2012); Lazaroiu and Roscia (2012); Schuurman et al. (2012); Zygiaris (2013); Komninos (2014); Lee et al. (2014); Ahvenniemi et al. (2017); Dezi et al. (2018); Lam and Ma (2019); Allam and Dhunny (2019)
Knowledge creation and sharing	Activities that support the accumulation and flow of local urban knowledge between urban stakeholders,	Yigitcanlar and Velibeyoglu (2008); Komninos (2011); Caragliu et al. (2011); Angelidou (2015); Marsal-Llacuna et al. (2015); Kummitha and Crutzen (2017); Ahvenniemi et al. (2017);

	contributing to city intelligence.	Ruhlandt (2018); Desdemoustier et al. (2019); Heaton and Parlikad (2019); Sepasgozar et al. (2019); European Commission (2020)
Cost reduction	Activities that are specifically intended to replace or substitute an existing solution, to be operated in a less resource-intensive way.	Mahizhnan (1999); Komninos (2006); Dirks and Keeling (2009); Washburn et al. (2010); Nam and Pardo (2011b); Komninos (2011); Ballas (2013); Bakici et al. (2013); Lee et al. (2013); McNeill (2015); Hunter et al. (2018); van den Buuse and Kolk (2019)
Scalability and transferability	Activities that incorporate features that make them easy to extend, replicate, and adapt in different contexts.	Deloitte (2015); Winden et al. (2016); Winden and Buuse (2017); Ferrer et al. (2017); Taylor Buck and While (2017); SCIS (2018); Borsboom-van Beurden et al. (2019)
Environmental impact	Activities with objectives related to contributing to environmental sustainability.	Hall et al. (2000); Giffinger et al. (2007); Caragliu et al. (2011); Dodgson and Gann (2011); Naphade et al. (2011); Chourabi et al. (2012); Lazaroiu and Roscia (2012); Lombardi et al. (2012); Neirotti et al. (2014); Pham (2014); Dameri and Rosenthal-Sabroux (2014); Manville et al. (2014); Albino et al. (2015); Ben Letaifa (2015); Bibri and Krogstie (2017); Ahvenniemi et al. (2017); Angelidou (2017); Hunter et al. (2018); Mora et al. (2018); Mora, Deakin, and Reid (2019)

Table 9 Demonstrated and emerging excellence of case study cities.

City cases	Evidence for demonstrated or emerging excellence
Amsterdam	Amsterdam is selected as "Benchmark of Excellence" by the European Commission, which describes Amsterdam's smart city development strategy as a best practice to be replicated in other urban contexts (reported by Velthausz, as cited in Mora and Bolici, 2017).
Barcelona	Reported as number three for Europe and ninth in the world in the smart city ranking of the Eden Strategy Institute and Ong&Ong (OXD).
London	London is ranked in the top 10 of most smart city rankings, being first in the world according to Eden Strategy Institute in 2019 (Eden Strategy Institute and ONG&ONG Pte Ltd., 2018).
Helsinki	2014: Helsinki is recognized by the European Parliament as one of six most successful smart cities in Europe and one of the most suitable cases for further in-depth analysis and benchmarking activities (Manville et al., 2014).
New York	New York City is named best smart city at the 2016 edition of the World Smart City Awards. The award recognizes the success of the city government in leveraging smart technologies to support urban sustainability.
Vienna	2014: Vienna is recognized by the European Parliament as one of six most successful smart cities in Europe and one of the most suitable cases for further in-depth analysis and benchmarking activities (Manville et al., 2014).
Berlin	Berlin has had a smart city strategy since April 2015. It is a small metropolis, member of the European lighthouse cities community. Berlin is sometimes reported as a top smart city in Europe; however, different rankings show mixed results.

Budapest	Budapest has had a smart city strategy since 2019, which makes it a late adopter of the concept. However, smart city developments were already ongoing in the last decade. The city ranked lower than its region's average (Csécsei, 2020).
Moscow	Moscow jumped 16 ranks up in IMD's global ranking of smart cities to be 56th globally. The government would like Moscow to be known as one of the smartest cities in which to live.

Table 10 Descriptive statistics of value proposition components in case study cities.

	Demonstrated excellence SC						Emerging excellence SC			Average
	Amsterdam	Barcelona	Helsinki	New York	Vienna	London	Berlin	Budapest	Moscow	
Efficiency gains	**41/116**	**37/82**	**24/59**	**32/101**	**26/59**	**24/55**	**24/62**	**10/51**	**20/52**	
	35.34%	*45.12%*	*40.68%*	*31.68%*	*44.07%*	*43.64%*	*38.71%*	*19.61%*	*38.46%*	*37.36%*
Citizen engagement	**32/116**	**24/82**	**24/59**	**22/101**	**14/59**	**12/55**	**17/62**	**13/51**	**7/52**	
	27.59%	*29.27%*	*40.68%*	*21.78%*	*23.73%*	*21.82%*	*27.42%*	*25.49%*	*13.46%*	*25.90%*
Quality of life	**26/116**	**25/82**	**20/59**	**33/101**	**26/59**	**19/55**	**28/62**	**24/51**	**27/52**	
	22.41%	*30.49%*	*33.90%*	*32.67%*	*44.07%*	*34.55%*	*45.16%*	*47.06%*	*51.92%*	*35.79%*
Inclusion and equality	**15/116**	**28/82**	**5/59**	**23/101**	**16/59**	**5/55**	**17/62**	**12/51**	**11/52**	
	12.93%	*34.15%*	*8.47%*	*22.77%*	*27.12%*	*9.09%*	*27.42%*	*23.53%*	*21.15%*	*20.72%*
Connectivity	**65/116**	**54/82**	**47/59**	**49/101**	**32/59**	**36/55**	**36/62**	**20/51**	**46/52**	
	56.03%	*65.85%*	*79.66%*	*48.51%*	*54.24%*	*65.45%*	*58.06%*	*39.22%*	*88.46%*	*60.44%*
Knowledge sharing	**36/116**	**30/82**	**20/59**	**33/101**	**20/59**	**13/55**	**13/62**	**12/51**	**11/52**	
	31.03%	*36.59%*	*33.90%*	*32.67%*	*33.90%*	*23.64%*	*20.97%*	*23.53%*	*21.15%*	*29.51%*
Cost savings	**20/116**	**6/82**	**2/59**	**18/101**	**13/59**	**11/55**	**5/62**	**6/51**	**3/52**	
	17.24%	*7.32%*	*3.39%*	*17.82%*	*22.03%*	*20.00%*	*8.06%*	*11.76%*	*5.77%*	*13.19%*
Easy replication	**27/116**	**21/82**	**20/59**	**28/101**	**17/59**	**15/55**	**12/62**	**9/51**	**9/52**	
	23.28%	*25.61%*	*33.90%*	*27.72%*	*28.81%*	*27.27%*	*19.35%*	*17.65%*	*17.31%*	*24.80%*
Environmental impact	**43/116**	**8/82**	**10/59**	**30/101**	**21/59**	**15/55**	**17/62**	**11/51**	**1/52**	
	37.07%	*9.76%*	*16.95%*	*29.70%*	*35.59%*	*27.27%*	*27.42%*	*21.57%*	*1.92%*	*24.49%*

Table 11 Status of the reported SC activities in the case study cities

	Amsterdam	Barcelona	Berlin	Budapest	Helsinki	London	Moscow	New York	Vienna
Pilot or research	36.20%	15.90%	16.10%	21.60%	55.90%	30.90%	7.70%	7.90%	40.70%
Full scale implementation ongoing	10.30%	8.50%	11.30%	2.00%	5.10%	0.00%	3.80%	18.80%	1.70%
Fully implemented and applied to intended target	53.40%	75.60%	72.60%	76.50%	39.00%	69.10%	88.50%	73.30%	57.60%

Table 12 Spatial level of the reported SC activities in the case study cities.

	Amsterdam	Barcelona	Berlin	Budapest	Helsinki	London	Moscow	New York	Vienna
City	42.20%	81.70%	56.50%	39.20%	61.00%	43.60%	94.20%	69.30%	59.30%
District	39.70%	13.40%	29.00%	49.00%	22.00%	21.80%	1.90%	37.60%	20.30%
Building	10.30%	4.90%	9.70%	15.70%	10.20%	25.50%	3.80%	8.90%	13.60%
Home	2.60%	0.00%	1.60%	0.00%	0.00%	0.00%	0.00%	0.00%	5.10%

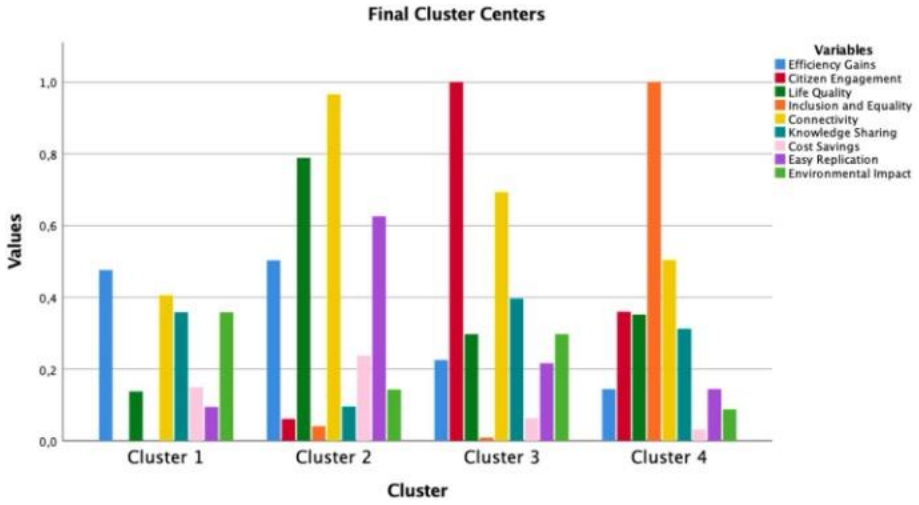


Figure 15 Influence of value proposition components on the clusters (created and exported from IBM SPSS Statistics 25)

4.6.2.3 Citizen engagement

Cluster 3 has the highest share of 'Citizen engagement' and 'Knowledge Sharing' while low values for 'Efficiency Gains', 'Inclusion and Equality', and 'Cost savings'. The most important factor for these activities is to create channels between governments and the public, and thereby involve them in making the decisions, or incorporate their needs and requirements to shaping the future of the city.

4.6.2.4 Social inclusion

Activities in Cluster 4 primarily aim to improve the everyday life of citizens, with particular emphasis on disadvantaged groups. These activities include socially sensitive areas, like elderly care, better working conditions for disabled people, or helping immigrants to settle. These solutions involved the intensive use of technology. Four main attributes were identified here are e-health, digital Inclusion, access to information, and convenience. There were a large number of healthcare-related services and programs. The healthcare-related solutions mainly focused on delivering high-quality patient services with the use of the latest technologies, e.g., implementing connected care, and better rehabilitation procedures. Digital Inclusion means public or private support of access to different technologies (city-wide Wi-Fi network, high-performance broadband) for citizens, especially in rural or less developed areas. Governments and companies typically aimed to provide these facilities to low-income citizens. Access to information was also

important in this cluster. This uses open datasets, applications or platforms to provide access for citizens to a wide range of government information such as public transport real-time data, parking information, and patient data.

Figure 16 illustrates the distribution of the four clusters in the dataset across years, between 2008 and 2019.

Observing the distribution of the four identified clusters across different years in all cities, we can observe that the activities are changing over the years, some are becoming more important, other less significant. Figure 17 shows how these clusters are represented in each case study city. Even among the best performing cities, we observe differences. For example, Barcelona has a high emphasis on Social Inclusion, while Amsterdam is the most concerned with particularities of the first cluster, on the other hand, Moscow has an outstanding share of cluster two.

Figure 18 provides an added depth to the relationship of the studied case study cities, and the clusters of the SC activities. The graph was constructed using another dimension reduction technique, Principal Component Analysis, and it shows which cities are more similar to which cluster. It provides another visualization for comparing the cities. The proximity of data points represents the degree of their similarity.

Temporal analysis of anticipated benefits of SC activities in the case study cities

Based on the temporal data in the database, we analysed the SC activities of the case study cities across years. Four types of cities are identified with analysis: (1) The Green City – in which years of activities, cities are focusing on environmental sustainability related objectives (Figure 19); (2) The App City – in which years of activities, cities are focusing on developing and rolling out platforms and applications to provide QoL improvements directly for citizens (Figure 20); (3) The Socially Sensitive City - in which years of activities, social equality, and better urban living conditions for all segments of the society are prominent (Figure 21); (4) The Participatory City – in which years of activities citizen engagement is in focus (Figure 22).

4.7 Discussion

This research contributes to the better understanding of SC theory, and its practical realization, bridging a knowledge gap in research, by studying the different value proposition components defined in the SC literature. We revealed, what different scientific approaches expect from SC developments, and identified nine components

which in turn enabled us to analyse which benefits are present and how they are distributed among SC activities. Besides, we compared SC development practices of cities. SC activities can be classified based on their value proposition components, which gave us novel methods to analyse and evaluate approaches to the concept. Our analytical framework also has a temporal dimension. We studied activities of cities across years and compared the activities of different cities to each other.

It is an important finding of the research that there could be significant deviations in performance of cities in SC development, despite carrying out activities with identical value proposition components. Excellent performance does not necessarily mean that it is an example to follow, per se. Due to the difference in periods, it shall also be considered, when was the focus of top-performing cities observed? Was it after a shift from another one? [8] Unconditionally following the strategic targets of developed (excellent) cases, by adopting similar target system, is not an enabler for success. However, there are various other factors (e.g., cultural context, governance structure and existing targets) that could be important. Longitudinal and local cultural aspects shall be considered when researching and benchmarking best practices. Few pieces of research are incorporating these contexts. Ruhlandt (2018) also highlights the lack of these parameters in research and practice. Cities embody their development vision into their SC activities, which is a possible reason for the differing understandings of the concept. Based on the distribution of value proposition components, Budapest shows quite a lot of similarities with Vienna. However, the two cities undoubtedly perform significantly different in SC developments.

Activities are not necessarily focusing on strong points. Amsterdam, for example, is well known for its high level of Quality of Life (QoL). Nonetheless, the QoL share in the studied activities shows a rather low QoL value. On the other hand, Budapest and Moscow have the highest scores, not being among top-performing cities regarding QoL. We assume that cities focus on deficit skills, and not those that they are already strong at. The overall anticipated benefits of their SC vision is dependent on the specific properties

[8] Longitudinal and local cultural aspects shall be considered when researching. Little research is incorporating these contexts. Ruhlandt (2018) also highlights lack of these parameters in research and practice. Cities embody their development vision into their SC activities. This is a reason for differing understanding of the concept.

they own, which also explain differences in the divergent distribution across top-performing cities. If cities peer learn from each other and want to follow another city's path, they can check the other one's activity portfolio, with emphasis on their value proposition components.

We also revealed that cities with excellent performance are focusing on different activities across the years. They do not settle with a specific portfolio of activities and solutions but shift focus occasionally. Most of the cities' strategy focuses on similar activity portfolios for longer periods, while others change more often. Based on the observed activities that cities carried out, we also immersed in their perception to the SC, which seems to be a fluid one, changing from time to time. One of the years with the particular focuses were identified as 'The Green City' where the implemented activities have a higher emphasis on the Environmental Impact component.

Similarly, 'The App City' implies cities with years when the implementation of application-based solutions was significant. Considering these focuses, we argue that there is a great distance between a mono-dimensional and holistic strategic approach of cities to SC developments. The differences exist across periods within one city's holistic approach. Hence cities should concentrate resources and focus on certain activities with similar value propositions.

We assume that strategic principles cities adopt in the SC approach are very dependent on the local contextual parameters (e.g. perception of new technologies, attitude towards privacy, cultural heuristics). In western European cities, citizen engagement has an overall high share; however, in Moscow, the research showed a lower one. The very same activities are not working in different contexts. Different solutions are creating different impacts: some are positive, but some may trigger other negative impacts. For example, electric vehicles improve air quality, but not able to solve the problem of congestion. A mass surveillance systems will bring efficiency, and even create QoL improvements, by decreasing crime, or easing government services. However, it also creates stress by diminishing privacy, which might outbalance the overall benefits the solution offers. Toronto's ambitious Sidewalk project incorporated all features, that new technology can offer. Yet, from the beginning, it was beset by controversy since its announcement, and eventually abandoned by Google's Alphabet on May 7, 2020. Looking at this activity through the research's framework, it would have created various benefits of efficiency, QoL, environmental impact and connectivity. At the same time, it also envisioned to

create negative impacts for citizens – e.g. increased stress through surveillance and decreasing control over privacy. The acceptance and attitude towards these activities, the perception and subjectivity of citizens are different in other cities. For example, Moscow operates one of the world's biggest surveillance camera system. The attitude of people has also resembled in the distribution of components across cities investigated. Therefore, we propose, that cities shall focus on their specified local needs, on the path for development - i.e. citizen empowerment by investing in citizen engagement activities.

We also strongly recommend that the assessment of smart city performance should not only use output indicators that measure the efficiency of deployment of smart solutions but always include impact indicators that measure the contribution towards the ultimate goals such as environmental, economic or social sustainability. Indicator systems do not consider the local people's needs (specific parameters), because they probably have different utility curve. Rankings only show an output, which might be the result of various other factors.

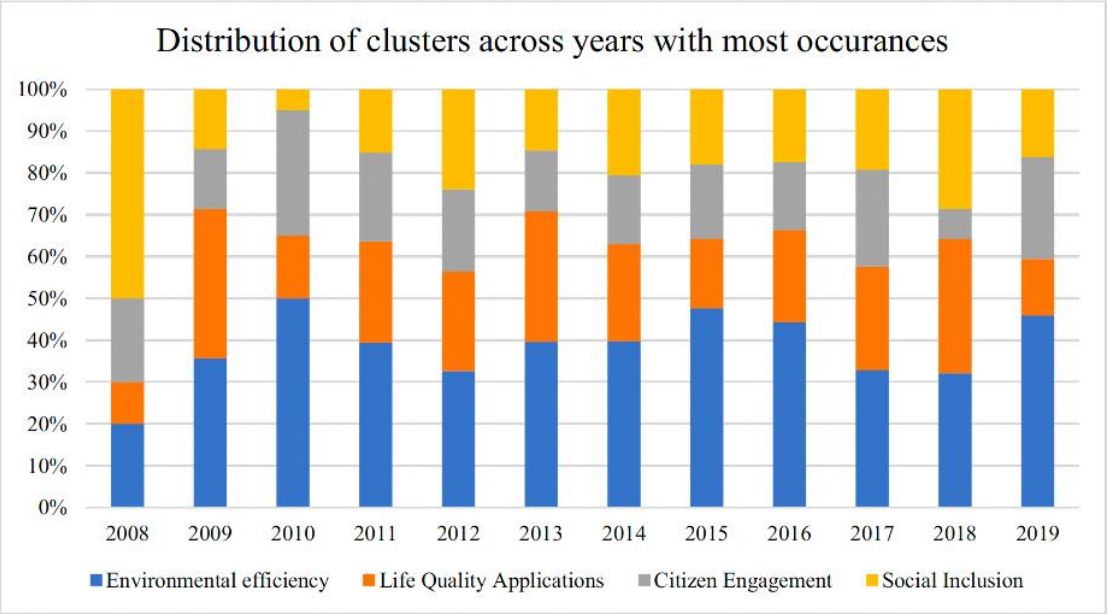


Figure 16 Distribution of clusters across years with most occurrences

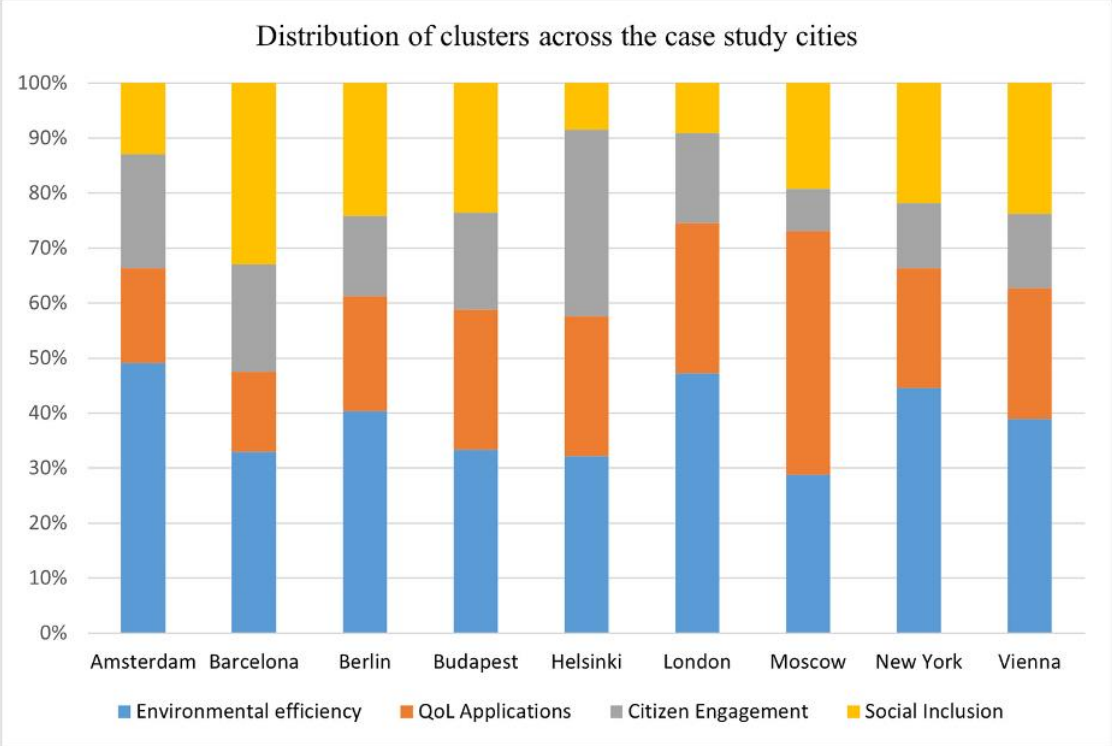


Figure 17 Distribution of clusters across the case study cities in the dataset

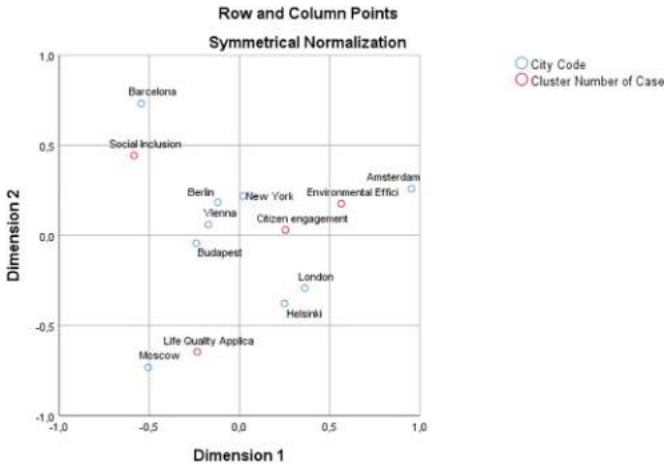


Figure 18 Principle Component Analysis (PCA) of case study cities and clusters (created and exported from IBM SPSS Statistics 25).

4.8 Limitation, validity and future research

It is important to note that the multiple-case study selection process and the number of replications always determine the external validity of the study and the extent to which the results are generalizable. The extent of iteration is highly dependent on the confidence the researcher wants to achieve, and "the greater certainty lies with, the larger number of

cases" (Yin, 2009: 58). (Eisenhardt, 1989) argues that the ideal number of cases ought to be between 4 and 10, which would provide adequate fundamentals for generalizing findings. The final number of nine selected city cases was based on this statement. On the other hand, the depth of the related activities collected was in line with researches, applying similar methods. However, the number of observations in each case could be further increased to ensure a higher level of confidence. Besides, analytical generalization is also affected by two contextual conditions: the geographical distribution of the selected cases and their size. A more heterogeneous sample determines a broader generalization of the results. This research framework enables to improve the common understanding of such effects in Europe and North America. However, additional research is required to test whether the findings are of wider significance because they also apply to other territorial contexts. As 50% of SC projects are claimed to be situated in China, we believe that the current sampling of cities does offer an acceptable level of certainty to generalize results for Asian examples of SC development. Nevertheless, we believe that replicating the research with Asian examples of SC development is a direction for future research. Data availability also has a limitation on the research. The annual distribution of observed activities is adequately balanced across years. Further extension of the dataset, by adding more records, or further restricting the years of observation, included in the analysis, by increasing the requirement of a minimum number of activities could be options for strengthening its validity.

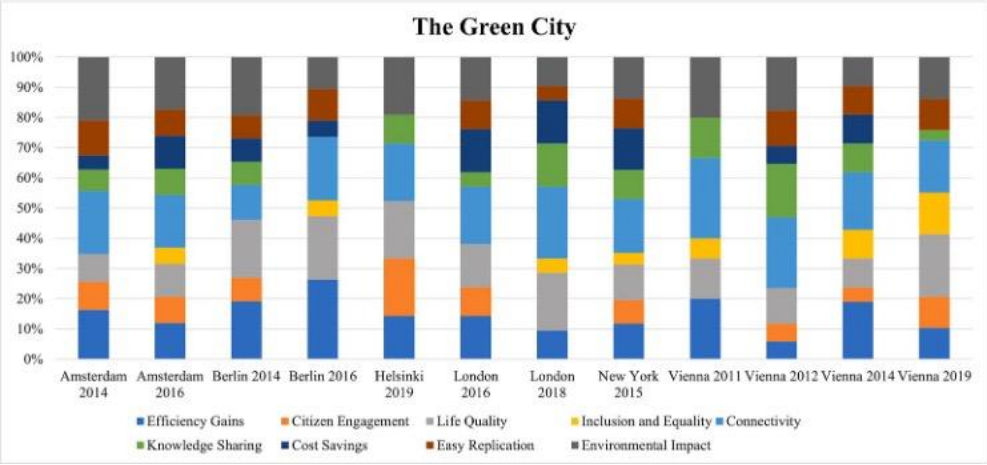


Figure 19 Cities across years focusing on environmental sustainability goals

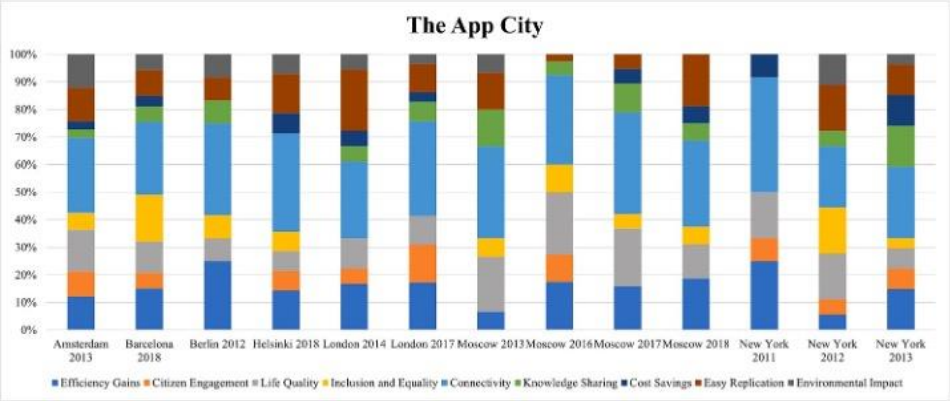


Figure 20 Cities across years focusing on QoL applications

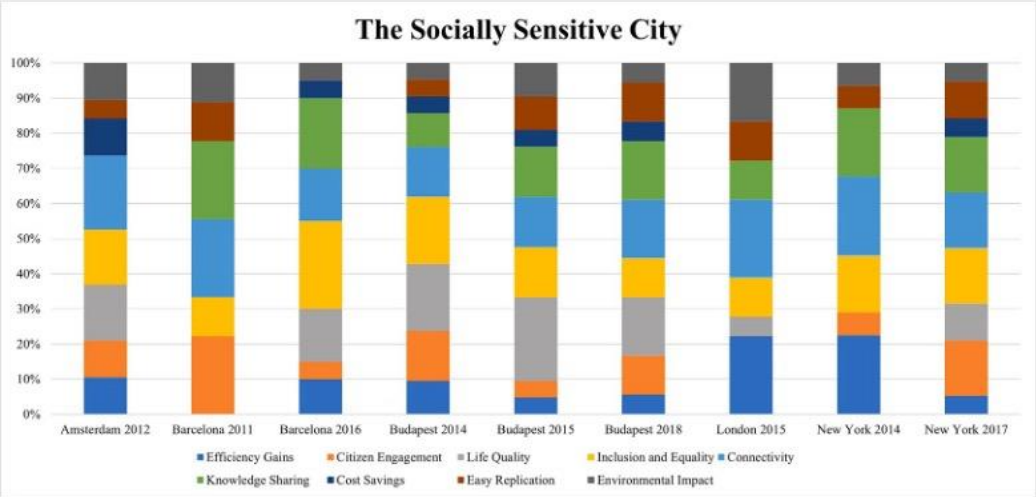


Figure 21 Cities across years focusing on social impacts.

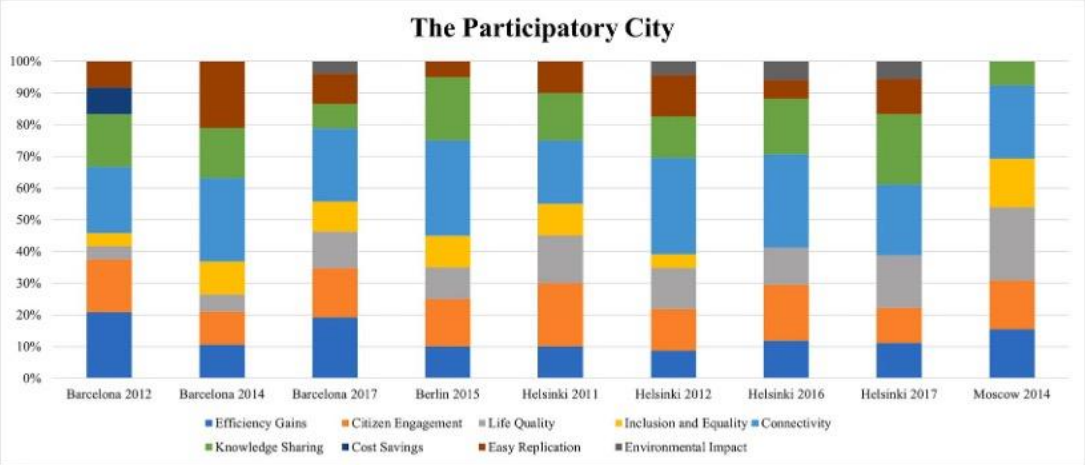


Figure 22 Cities across years focusing on citizen engagement

The studied value proposition components in the observed activities are barely showing their presence in each activity, and do not consider their weight. Furthermore, the weight of each activity is also not considered. These limitations could be managed by considering the main, as well as side effects of anticipated benefits, by introducing a weighting

procedure, together with the investment size of each activity. However, these aspects were out of the scope of this research.

Although we examined the anticipated benefits of SC activities, our research did not consider the actual impacts, they realized. It is advisable to study, did cities achieve what they have planned? What was planned, and what was not achieved? What else did they achieve?

Table 13 Literature review across anticipated SC benefits

Reference	B1	B2	B3	B4	B5	B6	B7	B8	B9
Angelidou (2014)	X	X	X						
Angelidou (2015)	X					X			
Angelidou (2017)									X
Anttiroiko (2016)		X	X						
Anttiroiko, Valkama, & Bailey (2014)				X					
Bakici et al. (2013)	X	X	X				X		
Ballas (2013)			X				X		
Barrionuevo et al. (2012)	X	X							
Batty et al. (2012)	X	X		X	X				
Belanche et al. (2016)	X		X						
Ben Letaifa (2015)									X
Beretta (2018)				X					
Bibri and Krogstie (2017)	X								X
Bolívar (2016)		X							
Borsboom-van Beurden et al. (2019)								X	
Caragliu et al. (2011)	X	X	X	X		X			X
Chen (2010)			X						
Chourabi et al. (2012)	X	X	X						X
Dameri and Rosenthal-Sabroux (2014)	X								X
Deakin and Reid (2018)	X								
Debnath et al. (2014)	X								
Deloitte (2015)								X	
Desdemoustier et al. (2019)	X					X			
Dezi et al. (2018)		X			X				
Dirks and Keeling (2009)	X		X		X		X		
Dirks et al. (2010)	X		X						
Dodgson and Gann (2011)	X								X
Eger (2003)			X						
European Commission (2020)				X		X			
SCIS (2018)								X	
Fernandez-Anez et al. (2018)	X	X							
Ferrer et al. (2017)								X	
Fietkiewicz and Stock (2015)			X						
Giffinger et al. (2007)	X	X	X		X				X
Gil-Garcia et al. (2015)		X							
Hall et al. (2000)	X								X
Hao et al. (2012)	X								
Harrison and Donelly (2010)					X				
Harvey (2000)				X					
Heaton and Parlikad (2019)						X			
Hollands (2008)	X	X		X	X				
Hollands (2015)			X						
Hunter et al. (2018)							X		X
Komninos (2002)					X				
Komninos (2006)	X						X		
Komninos (2011)		X	X	X		X	X		
Kourtit and Nijkamp (2012)	X								

Kummitha and Crutzen (2017)						X			
Lam & Ma (2019)		X							
Lazaroiu and Roscia (2012)	X				X				X
Lee et al. (2013)					X		X		
Lombardi et al. (2012)	X	X							X
Mahizhnan (1999)	X		X		X		X		
Manville et al. (2014)				X					X
Marsal-Llacuna et al. (2015)						X			
McNeill (2015)							X		
Mora et al. (2018)	X	X							X
Mora, Deakin, and Reid (2019)			X						X
Nam and Pardo (2011a)	X	X		X			X		
Nam and Pardo (2011b)									
Naphade et al. (2011)	X								X
Neirotti et al. (2014)	X		X	X					X
Pam & Ma (2018)					X				
Pham (2014)									X
Porter (1997)		X							
Rajakallio et al. (2018)		X							
Robinson (2014)			X						
Ruhlandt (2018)						X			
Schuurman et al. (2012)					X				
Sepasgozar et al. (2019)						X			
Shapiro (2006)			X						
So¨derstro¨m et al. (2014)	X								
Taylor Buck and While (2017)								X	
Thomas et al. (2016)			X						
Thuzar (2011)			X						
Trencher (2019)		X							
van den Buuse and Kolk (2019)							X		
van der Graaf and Ballon (2019)		X							
Winden & Buuse, 2017								X	
Winden et al. (2016)								X	
Vanolo (2014)	X								
Washburn et al. (2010)	X	X					X		
World Bank (2016)				X					
Yigitcanlar and Velibeyoglu (2008)						X			
Zygiaris (2013)					X				9

9 B1: efficiency gains; B2: citizen engagement;B3: quality of life; B4: social inclusion and equality; B5: connectivity; B6: knowledge creation and sharing;B7: cost reduction; B8: scalability and transferability; B9: environmental impact.

4.9 Chapter takeaway for the dissertation argument

This chapter advances the dissertation argument by showing that smart city development must be understood not only through barriers, organizational arrangements, or governance structures, but also through the **anticipated benefits and value propositions** embedded in the concrete activity portfolios of cities. If Chapters 2 and 3 established why smart city development is difficult and how organizational design may enable or constrain urban digitalization, the present chapter adds a further essential dimension: cities also differ in what they understand smart development to be for. In the context of the dissertation, this is a major step forward, because it links the institutional conditions of smart city transition to its strategic substance. The chapter shows that smart city trajectories are shaped not only by capacity and coordination, but also by the kinds of urban benefits city actors seek to produce and prioritize in practice.

The chapter's central contribution to the dissertation lies in its treatment of smart city development as an **activity portfolio with a discernible benefit structure**. Rather than relying on abstract labels or general strategic statements, the study analyses a large set of smart city activities across nine cities and identifies the anticipated value propositions embedded in them. These include efficiency, stakeholder engagement, quality of life, social inclusion and equality, connectivity, knowledge creation and sharing, cost reduction, scalability and transferability, and environmental sustainability. This is highly important for the dissertation because it provides a concrete analytical language for examining what cities are actually trying to achieve through smart city development. It therefore helps move the dissertation beyond the binary distinction between successful and unsuccessful cities, or between more and less digitalized urban systems, toward a richer understanding of the kinds of smartness cities pursue.

At the dissertation level, this has two major implications. First, it supports the argument that smart city development is **strategically differentiated**. Cities do not simply implement more or fewer smart projects; they assemble portfolios that reflect different priorities and benefit logics. Some cities emphasize quality of life and stakeholder engagement, others place stronger weight on efficiency, connectivity, or environmental impacts, while still others show more mixed or transitional portfolio structures. This means that the analysis of smart city development cannot stop at identifying the presence of smart initiatives. It must also ask how those initiatives are distributed, what expected outcomes they embody, and what type of urban development logic they collectively

represent. The chapter thus strengthens the dissertation's broader claim that smart city development is a strategic and organizational process, not just a technological one.

Second, the chapter helps clarify the dissertation's concern with **public value orientation**. Throughout the thesis, one of the key questions is how cities translate smart city ambitions into publicly meaningful development trajectories. This article contributes directly to that question by showing that value propositions can be reconstructed systematically from activity portfolios and used to compare cities. The significance of this is considerable. It means that the dissertation can later interpret governance models and stakeholder structures not in the abstract, but in relation to the benefit orientations they support or constrain. A city with a highly centralized governance structure, for example, may still pursue a relatively broad benefit portfolio, but the distribution of anticipated public value may differ markedly from that of a city with stronger participatory and collaborative arrangements. The chapter therefore provides one of the key conceptual bridges between strategy and implementation in the overall dissertation.

The chapter is also important because it introduces a **comparative perspective** that broadens the dissertation beyond the Hungarian cases without abandoning its central concerns. Chapters 2 and 3 addressed barriers and organizational design in a more general or medium-sized-city-oriented frame. Chapter 4, by contrast, compares nine cities and demonstrates that smart city development can be analysed across cases through a common framework of value propositions. This gives the dissertation stronger comparative depth. It shows that the strategic and benefit-oriented interpretation of smart city development is not limited to a single national or regional context, but can be applied more broadly. At the same time, the chapter does not dissolve the dissertation into an overly broad comparative exercise. Instead, it provides a conceptual comparative background that makes the later Hungarian case studies more analytically meaningful. Budapest and Debrecen can then be interpreted not only in terms of governance and strategy, but also in relation to the broader patterns of benefit orientation and activity portfolio composition identified here.

Another key contribution of the chapter is that it shows the **empirical usefulness of portfolio-based analysis**. This is relevant for the dissertation as a whole because one of its recurring objectives is to move beyond rhetorical descriptions of smart city development. The portfolio approach makes it possible to examine how smart city strategy is enacted through actual interventions rather than inferred solely from policy

documents or branding language. In this respect, the chapter reinforces a methodological principle that also becomes important in the Budapest and Debrecen studies: cities should be analysed through what they do, not only through what they say. This strengthens the empirical grounding of the dissertation and supports its cumulative movement toward more fine-grained city-level analysis.

The study also matters because it complicates any simplistic understanding of smart city excellence. By comparing cities through the benefit structures of their portfolios, the chapter suggests that smart city development is not unidimensional. Cities may appear advanced according to one logic while remaining relatively narrow according to another. A city that is active in many domains may still privilege efficiency and connectivity over inclusion or participation; another may display strong stakeholder-oriented value propositions but less breadth or scalability. This finding supports the dissertation's wider resistance to linear and ranking-based interpretations of smartness. It further reinforces the argument that smart city development should be treated as a differentiated trajectory shaped by multiple strategic choices and institutional conditions.

In relation to the preceding chapters, this article broadens rather than replaces the earlier arguments. Chapter 2 showed that medium-sized cities face structural barriers. Chapter 3 demonstrated that organizational models can reproduce or alleviate such barriers. Chapter 4 adds that even when cities are active and organizationally capable, the substance of their smart city trajectory still depends on the benefit orientations embedded in their activity portfolios. This means that the dissertation argument now has three cumulative layers in place: **barrier environment**, **organizational response**, and **portfolio-level public value orientation**. These layers are essential preparation for the later case-study chapters, where the dissertation turns from general and comparative arguments to the detailed diagnosis of specific Hungarian cities.

The link to Chapter 5 is especially direct. The present chapter provides the conceptual and methodological background for reading a city's smart developments as a strategic pattern rather than as a random collection of projects. Chapter 5 builds on this logic by analysing Budapest through the four strategic dichotomies and examining the conditions under which a Central and Eastern European capital attempts to become smart. The transition is therefore clear: once the dissertation has shown that smart city portfolios differ in their anticipated benefits, it becomes possible to ask how a specific city's strategic orientation can be diagnosed more systematically. In that sense, Chapter 4

prepares the way for Chapter 5 by supplying a richer understanding of what city activities signify and why their internal composition matters.

In sum, this chapter advances the dissertation argument by demonstrating that smart city development is not only constrained and organized differently across cities, but also **imagined and enacted through different value propositions**. Its main contribution is to introduce the portfolio-based and benefit-oriented dimension of the dissertation, thereby linking strategy to concrete urban activities and clarifying the public-value content of smart city trajectories. With this, the dissertation is ready to move from comparative portfolio analysis to focused city-level strategic diagnosis in the Hungarian context.

5. What Are the Conditions to Become Smart? A Systematic Analysis of the Smart City Strategy and Development Activities of Budapest

5.1 Chapter preface

This chapter appears at this point in the dissertation because it marks the transition from the earlier **barrier-oriented, organizational, and comparative** analyses to a **focused city-level strategic diagnosis** in the Hungarian context. Chapters 2 and 3 established that smart city development is constrained by structural and organizational barriers, while Chapter 4 showed that cities also differ in the value propositions embedded in their activity portfolios. The present chapter takes the next logical step by examining how the smart city transition of a specific city can be analysed systematically through a validated strategic framework. It therefore turns from general and comparative arguments to the case of **Budapest**, a Central and Eastern European capital whose smart city trajectory is analytically important precisely because it is not generally treated as an outstanding smart city success case.

The study is particularly important here because it is the first article in the dissertation to operationalize the **four smart city dichotomies** as a diagnostic framework for a Hungarian city. In the article, Budapest is analysed through the tensions between technology-led and holistic development, top-down and bottom-up governance, double- and quadruple-helix collaboration, and mono-dimensional and integrated intervention logic. This makes the chapter pivotal in the overall dissertation architecture. It brings together several of the themes already developed in the earlier chapters, but now in a concrete city case. The chapter shows that the previous arguments about barriers, organizational conditions, and value-proposition differences are not abstract observations; they can be traced in the actual strategy and development activities of a specific city.

The placement of the chapter is also justified by its role as a **bridge** between the broader comparative and conceptual chapters and the dissertation's final, most integrative case study on Debrecen. Budapest serves here as a capital-city case within the Hungarian and Central and Eastern European setting. This provides an important internal contrast for the dissertation. Whereas Debrecen in the next chapter represents a medium-sized city under more typical European scaling conditions, Budapest offers the capital-city perspective within the same national environment. The chapter therefore strengthens the dissertation's within-country comparative logic: it allows the later Debrecen analysis to

be interpreted not in isolation, but against the background of a city with different scale, institutional complexity, and governance conditions.

Substantively, the study contributes to the dissertation by showing that Budapest's smart city strategy is characterized by a relatively **technology-led**, partly **top-down**, and largely **double-helix** collaborative orientation, while its activity portfolio remains more **integrated** across urban domains. At the same time, the article argues that the framework conditions of implementation, such as organizational background, authority, management capacity, and platforms for cooperation, remain underdeveloped. In this way, the chapter deepens the dissertation's central claim that becoming smart depends not merely on the presence of technological projects, but on the strategic and governance principles through which cities organize and interpret smart development.

The chapter also connects directly to what follows. If this Budapest study demonstrates how a Hungarian city's smart city trajectory can be diagnosed through the dichotomous model, the next chapter extends and deepens that same logic in the case of Debrecen. Chapter 6 not only applies the strategic framework again, but also adds project-level coding and stakeholder-network analysis to a medium-sized city. For this reason, Chapter 5 should be read as the dissertation's **pilot city-level strategic diagnosis chapter**, and Chapter 6 as the more integrative extension of that approach in a medium-sized-city context. The present chapter thus plays a critical bridging role in the dissertation: it localizes the broader theoretical debates in a Hungarian case and prepares the methodological and substantive ground for the final empirical chapter.

5.2 Bibliographic record and author contribution

Full citation	Csukás, Máté and Szabó, Roland Zs. (2022) 'What are the conditions to become smart? A systematic analysis of the smart city strategy and smart city development activities of Budapest', *Információs Társadalom*, 22(2), pp. 9-26. https://dx.doi.org/10.22503/inftars.XXII.2022.2.1.
Publication status / outlet	Published journal article in *Információs Társadalom*, Volume XXII, Issue 2, 2022.
Co-authors	Máté Csukás and Roland Zs. Szabó.

Doctoral candidate contribution	The doctoral candidate was the lead author of the study and contributed substantially to the conceptualization of the research problem, the adaptation of the dichotomous smart city framework to the Budapest case, the collection and coding of the dataset on Budapest's smart city development activities, the interpretation of the results, and the drafting of the manuscript. The article also relies on the doctoral candidate's own unpublished database of activities and organizations involved in the Smart City Strategy of Budapest, indicating a central role in the underlying empirical work.
Relation to dissertation research question	This article addresses the dissertation's overarching research question by analysing how a Central and Eastern European capital city attempts to become smart in practice, and by showing how strategic orientation, governance arrangements, and collaboration structures shape that process. It contributes to the dissertation by operationalizing the four smart city dichotomies in a Hungarian case and by demonstrating that smart city development must be interpreted not only through the presence of projects, but through the strategic principles embedded in the city's development activities and governance model.
Editorial adaptation note	The full text of the published article is reproduced in this dissertation as a core chapter of the article-based thesis. Only minor editorial adaptations have been made for dissertation integration, including formatting, chapter and figure numbering, citation harmonization, and alignment with the unified bibliography. No substantive changes have been made to the original scholarly argument, methodology, or findings.

5.3 Introduction

Despite words about the declining popularity and diminishing hype of smart cities (SCs) (Trapp 2018), having climate-neutral SCs became one of the five main mission areas of the European Union's large-scale research and development programme Horizon Europe (European Commission 2021). However, the widespread uptake of the concept is still far from its potential in Hungary and the Central Eastern Euro-pean region, which is further challenged by the social and economic impact of the COVID-19 pandemic. Some particularities make it especially challenging for scientists and practitioners to engage with the vision of SCs.

Ever since fundamental controversies were reported by Hollands (2008) in the SC research, studies aiming to untangle the contradictory nature of the literature have been gaining ground in the scientific community. Mora and Bolici (2017), Mora, Deakin and Reid (2018) and Komninos and Mora (2018) unveiled the significant differences among SC research streams by capturing four distinct dichotomies that are present in scientific publications. Mora et al. (2019) introduced a rigorous case-study-based methodology to analyse SC developments. With their proposed research methodology, they tested the four dichotomies as divergent strategic principles of SC development, using leading cities as examples (Mora, Deakin and Reid 2019).

The implementation of SC developments ought to be realised with strategic methods (Komninos 2014; Angelidou 2015; Mora and Bolici 2016, 2017). The particularities of how these strategic principles should be considered are relatively well researched; however, there are only a few publications available on empirical research relating to Eastern European, especially Hungarian cases of SC development. In this paper, we replicate this validated scientific method and systematically analyse the SC strategy and development activities of one Hungarian example, the capital city, Budapest.

When researching SC developments, most of the available publications focus on either a specific technology solution or urban subsystems, including components of SC models. The comparability and replicability of these researches are limited. On the other hand, papers analysing the overall city-wide context, or multiple cities, with comparable results are usually measuring the 'smart' performance of cities. These works primarily use existing or newly designed indicator systems, based on already available regional or urban data. As Z. Karvalics (2016) points out, a myriad of these indicator frameworks, with their city rankings, are available. However, they are more likely to create confusion and divergent understandings of the concept. Besides SC performance measurement and monitoring, Lukács and Csomós (2020) systematically analyse the presence of SC domains in the strategic documents of 21 Hungarian cities, based on the model of Giffinger et al. (2007). They point out that only three cities have a dedicated SC strategy, and the overall significance of the SC concept in the medium-term strategy of Hungarian cities is very low (15%). Lados (2016) analysed the SC attitudes of Hungarian cities and found various levels of maturity.

This paper aims to establish better linkages between the Hungarian and the international research into SC strategies and smart development activities. The differing definitions

and numerous models cause inconvenience for both researchers and practitioners in adopting the SC concept in a localised context. A standardised methodology and its application to an Eastern European example of SC development will hopefully be inspiring and create cohesion among the various research pathways. Furthermore, this paper will help practitioners in the least developed cities to create their own SC strategy and design meaningful development activity portfolios.

This paper may be useful to policymakers and urban managers as well as SC specialists involved in strategic planning processes, and mainly when they are designing portfolios of SC solutions for a city, undertaking benchmarking and peer learning activities. It could also be interesting to scientists who are engaged with systematic research into SC development activities, SC strategies and SC governance. In the following, we give a detailed description of the divergent principles of strategic SC developments (dichotomies), identified by Komninos and Mora (2018), which will provide the research framework for the case-study analysis of Budapest. Then, in the methodology section, we give a transparent description of how we collected and analysed the data, followed by the results of the four dichotomies studied. In the discussion, we point out the similarities and the differences among cities that demonstrated SC excellence (especially Vienna). Afterwards, we make conclusions, define future research directions and draw attention to the limitations and validity of our research.

The Dichotomous Nature of Smart City Research

There are four different dichotomies identified by Komninos and Mora (2018) in the research of SCs. These strategic principles in each of the four cases not only differ from each other but are directly opposed. The existence of such phenomena makes it challenging for scientists to research strategies since there is no consensus on which way is best for the development of SCs. There is robust evidence available on the existence of such dichotomies in the literature (Mora et al. 2019).

Table 14 The four dichotomies of SC research and the divergent strategic principles

Dichotomies	Strategic principles	Definition
Dichotomy 1: Technology-led or holistic	**Hypothesis 1.1:** Technology-led strategy	SC development must be driven by information and communication technology (ICT) solutions.
	Hypothesis 1.2: Holistic strategy	SC development should rather consider all other conditions for urban environments, built for human habitats.

Dichotomy 2: Top-down or bottom-up approach	**Hypothesis 2.1:** Top-down approach	Local governments must take the leading (governance) role in SC developments and provide strategic directions for all stakeholders.
	Hypothesis 2.2: Bottom-up approach	The civil society and key stakeholders other than the local government must build up SC developments, unbound by central regulation.
Dichotomy 3: Double or quadruple-helix model of collaboration	**Hypothesis 3.1: Double-helix model**	SC development must be built on the cooperation between local governments and industry actors, in a public–private model of collaboration.
	Hypothesis 3.2: Quadruple-helix model	SC development must be built on the collaboration of government, industry, academia and civil society, engaging all four spheres as co-producers of development.
Dichotomy 4: Mono-dimensional or integrated intervention logic	Hypothesis 4.1: Mono-dimensional approach	SC development should concentrate interventions on a single urban domain or dimension, typically ICT infrastructure.
	Hypothesis 4.2: Integrated approach	SC development should align and combine interventions across multiple urban domains within an integrated logic of development.

5.4 Methodology

The present study applies a case-study methodology to analyse the SC strategy of one city. The purpose of the study is to analyse a Central Eastern European case that has not been researched yet and is not regarded as an example of excellence. Considering the purpose of this study, we used a non-probability sampling type, convenience sampling, where the sample was drawn from the part of the population that was closest to hand. As the study is a sort of pilot testing for this type of population, it is the most useful one. The aim was to select a case-study city in which the transition process has proven to be unsuccessful yet. The sampling process considered the following criteria: (1) larger cities

(at a European level), with between 500,000 and 2,000,000 inhabitants, that (2) have an existing SC strategy.

We did a comparative analysis of the SC rankings which showed whether each candidate was an example of an unsuccessful case. Budapest has a resident population of 1,750,216 and has had an SC strategy since 2019, which makes it a late adopter of the concept. However, SC developments were already underway there in the last decade. The city ranked lower (77th) than its region's average ; only Bucharest ranked worse in 2020 (Csécsei 2020). The collection of data was conducted in multiple phases, to find online sources where digital records are available for the city of Budapest and its SC development activities. The main sources identified were: (1) Budapest Portál, the official online information system of the local government (Budapest Főváros Önkormányzata 2021), and (2) the Lechner Knowledge Centre's SC project repository (Lechner Tudásközpont 2021). Using these main sources, we identified and collected digital records, including press releases, web pages, policy documents, local government acts and so on. All the identified activities were collected in an Excel spreadsheet, where duplications were removed and the data was described with a pre-defined template. The processing and analysis of the qualitative data were carried out in the QCA Map website's service. Besides the digital records for each activity, the coding procedure produced quantitative data on the SC domain it belongs to, the year of the activity, the type of activity (A: Com-munity Building, B: Strategic Framework, C: Services and Applications (the type of service or application), D: Digital Infrastructure), the spatial level (City, District, Building, Home) and the organisations participating in the implementation. In the case of organisations, their type and administrative level were also determined. With the coding process, 111 activities (Annex 1) and 337 organisations (Annex 2) were identified. The annexes are accessible in an external file due to their size (Csukás 2022).

5.5 Results

5.5.1 Dichotomy 1: Technology-Led or Holistic Strategies

Budapest's SC development strategy gives much more weight to (1) deploying technological solutions ('Services and Applications'; 'Digital Infrastructure') than to managing urban sustainability issues. The city's strategy implements activities that use ICT components. In contrast with the technology-led focus, the city's strategic activities

have a lesser focus on (2) the development of activities aimed at community building and the necessary strategic framework that supports the roll-out of those technological solutions. This strategy is therefore based on the services and application-focussed vision of SCs, with a high emphasis on technology, particularly ICT. Therefore, we do not consider it a holistic type that is more engaged with the development of socio-technical systems in which technology is a means, not an end itself. Figure 23 illustrates the distribution of SC development activities among the four categories, which ultimately determines the type of strategy.

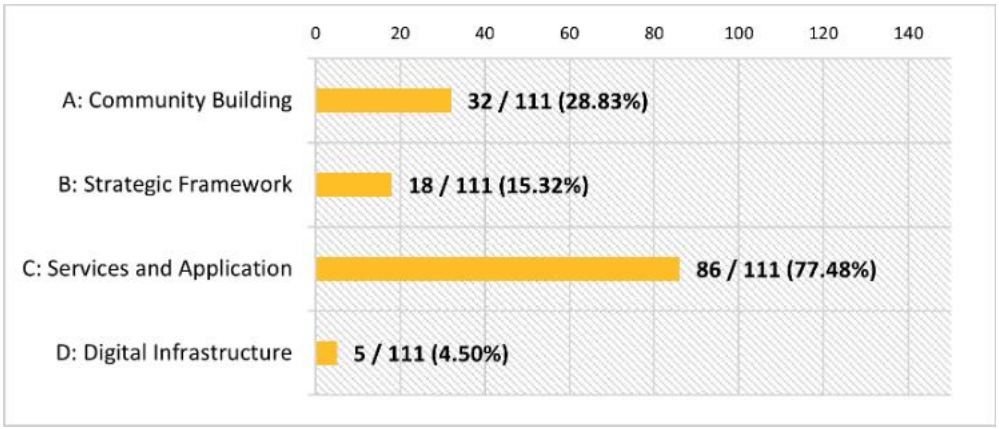


Figure 23 Budapest's SC development strategy: Number of activities by category (own edition)

The details of the statement above are further elaborated in Figure 24, which splits the categories according to their percentage and nominal share of activities. The first group includes those activities belonging to at least one of the first two categories – 'Community Building' and 'Strategic Framework' – both of which focus attention on the non-technological factors of SC development. In the comparison of the two groups, we identify that they are non-balanced – Group 2 has almost twice the number of activities of Group 1.

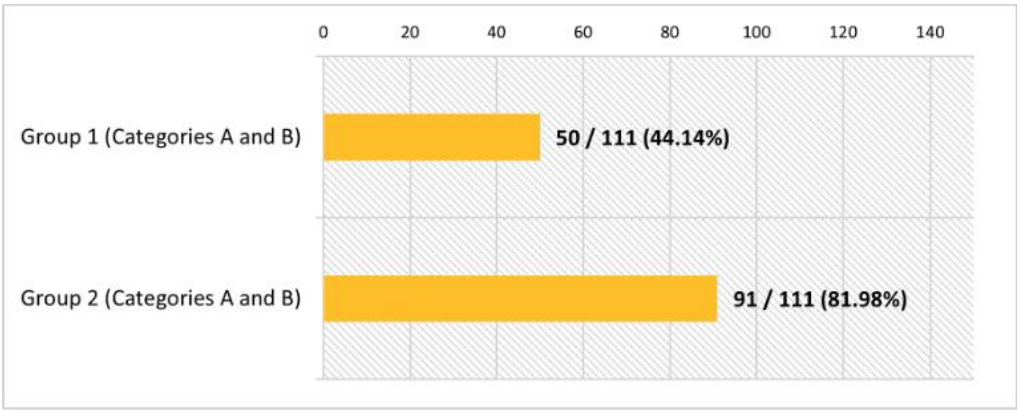


Figure 24 SC development activities of Budapest: Distribution of activities by groups of categories (own edition)

In Group 2, activities are concerned with technological developments. In the smart government domain, examples include integrations with electronic documentation systems, secondary data portals, connection to ASP application services or the Budapest GIS Portal. Many other activities are linked to the smart mobility domain, including the BKK Futár application, smart parking solutions, e-car charging infrastructure and sharing systems, and smart lampposts. There are also examples of electronic card systems in various districts and application-based solutions for tourists.

As an example of Group 1 activities, the CH4LLENGE project, co-funded by the Intelligent Energy Europe Programme of the European Union, with the participation of BKK Budapesti Közlekedési Központ Ltd, improved the capacities and knowledge of Budapest. The objective of the activity was to develop quality Sustainable Urban Mobility Plans, considering the most pressing challenges of participation, cooperation, measure selection, monitoring and evaluation. The final report of the project emphasised the role of institutional cooperation and strategic frameworks (CH4LLENGE Project 2021). The overall strategic framework for SC developments in Budapest is defined in the 'Smart Budapest Framework Strategy' approved by the Budapest City Council in 2019 (Budapest Főváros Önkormányzata 2019). On the other hand, there are various strategic frameworks aligned with it: the climate strategy of Budapest (2018), the Budapest 2030 urban development plan (2013), the Balázs Mór Plan for transport development strategy for the 2014–30 period. An example of the [A] Community Building activities is the establishment of a climate-change platform in Budapest, with 33 member organisations. The objective of the platform is to expand the knowledge of the capital's decision-makers and the public about climate change, to ensure the long-term coordination of the activities related to this topic at the capital level and the conditions of professional communication related to climate change, as well as to define its framework effectively.

5.5.2 Dichotomy 2: Top-Down or Bottom-Up Approach

This section provides an overview of the activities of the Budapest municipality in the governance of the SC as well as defining its objectives and characteristics. The municipality's strategy is defined in the document 'SMART BUDAPEST: The Smart City Vision of Budapest', which also details the dedicated role of each partner and the overall nature of the strategy. The strategy states that it is based on a new approach, which – in contrast with the traditional method of urban development documents – does not emphasise the necessary interventions in all the particular urban domains. It rather

collects a criteria framework for ‘smartness’, which horizontally aligns with all urban domains and harmonises them. It eventually acts as a complex guide to achieving the long-term goals. It could be used in the preparation and decision phase of projects. On the other hand, it may also be used in embedding smartness into the integrated urban development strategies (Smart ITS). The final focus areas are (1) Initiator Urban Governance, (2) Smart People, (3) Smart Economy, (4) Sustainable Resources, (5) Smart Mobility and (6) Urban Quality of Life.

Budapest’s SC development strategy shows a mixed picture of top-down and bottom-up approaches, mainly due to its special view on the strategic framework, as explained above. The local government of the capital of Budapest is a key driver and participant in SC development activities. Public companies and district municipalities related to the capital were involved in 62% of all activities. Those activities that happened without the participation of local public administration took up a rather lower share of 38%, which means that the bottom-up approach of the city’s strategy is less significant. The framework strategy describes the role of different stakeholders in the implementation process. The actors are explicitly called (1) local governments and central government administration, (2) inhabitants and civil society and (3) market-oriented enterprises. Local government tasks are described as adopting SC principles into existing operations and executing new projects, with special emphasis on incentives and legislation. Civil society is encouraged to take on responsibilities and enforce smart principles in individual decisions. Members of the civil society are also expected to monitor, validate and provide feedback on planning and implementation of smart projects. The market-oriented enterprises’ task is to engage with urban challenges by developing products and services.

The document defines its role as a guiding mechanism for all the stakeholders to support their cooperation and harmonise project activities. On the other hand, the strategy emphasises the special structure of Budapest’s public administration, the two-tier system of local governments. This makes the city services more complex; additionally, the Hungarian government implements several projects, within its jurisdiction, while key government services – where SC developments are common in excellent cases – are nationally centralised, leaving little space for the city to plan and implement actions. Taking into consideration the relatively high level of engagement of the city, one may expect strong leadership and a straightforward vision. However, the fragmentation of authority, the diverse interests of the various public bodies, the centralised service

provision and the horizontal nature of the framework strategy make it challenging to classify it as a purely top-down approach. Figure 25 shows that, while the Budapest municipalities take the lead, the central government's role is relatively high in the SC development activities of Budapest.

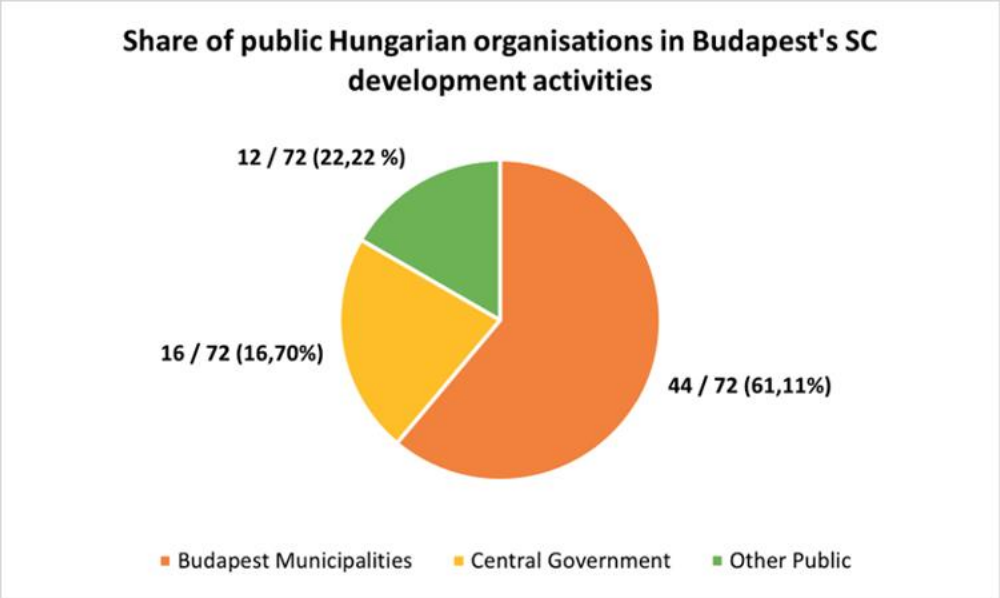


Figure 25 Share of public Hungarian organisations, based on their spatial level (own edition)

Budapest's SC framework strategy outlines a four-step planning process that begins with the (1) definition of SC, its focus areas and principles, based on the city's vision, and a review of international practices; continues with (2) assessment of the situation in each focus area, covering already implemented and ongoing SC projects, local and national sectoral plans, and identification of key stakeholders; is followed by (3) determination of objectives and intervention areas in the focus areas; and concludes with (4) preparation of mechanisms to enforce smart principles in the development areas.

Different target groups were engaged, using various methods. The working group responsible for developing the strategy consisted of personnel from the Mayor's Office and external experts, which determined it as a centralised development process. Urban challenges and good practices were identified by conducting workshops with the participation of district local governments, where they also disseminated the methodology of the planning process. Another key stakeholder group, where similar workshops were conducted, was public service provider organisations (e.g., utility companies). In these cases, the working group also used the interview technique with representatives of the organisations, to enquire in depth about their opinions and recommendations. Despite these efforts to make the strategy creation process an open and inclusive one, there is no

publicly available evidence found on these workshops and interviews; furthermore, activities related to gathering the opinions of the wider population are also missing.

Despite the thorough description of monitoring systems, measurement and indicators to evaluate the interventions in each focus areas, there are no responsibilities assigned to any organisations. Being a horizontal methodology to enforce smart principles in urban development, the strategy has no central organisations, where the necessary capacities and competencies are assigned. The strategy refers to the role and central role of Lechner Non-profit Ltd, which is a professional organisation that supports architectural and construction work and performs other professional information technology (IT) tasks. It created a Smart City Development Model – Methodological Guide TÉMOR, a City Evaluation and Monitoring System for Hungarian cities. However, this organisation has national jurisdiction and is directly linked with the Prime Minister's Office and therefore the Hungarian government. Another key organisation mentioned is related to the Digital Welfare Program 2.0 (the Hungarian government's digitalisation strategy), which is similarly linked to the central government. There is no specific local government organisation with the role of coordination, internal and external stakeholder management, project initiation, communication, etc. Nevertheless, the framework dedicates a central, leadership role to district local governments. There are also mentions of the pivotal role of knowledge generation and knowledge sharing (know-how) among members of communities, and institutional experience sharing. However, the strategy does not describe the mechanisms, sources or any particulars about such activities, for instance, organising cooperation events, stimulating the ecosystem and involving new stakeholders. The legislated environment and the regulations are also not sufficiently developed.

5.5.3 Dichotomy 3: Double or Quadruple-Helix Model of Collaboration

Budapest's SC ecosystem for collaboration in development activities is analysed and visualised using the freeware Gephi software. The participating organisations are classified based on their affiliation in the quadruple-helix model. As Figure 26 shows, the most active organisations are within the 'Government' category, with 133 organisations (39.47%), while the second most active sphere is 'Industry', with only two fewer participants, 131 organisations (38.86%). The third one is 'Research', which comprises the higher-education institutions, with 41 organisations (12.17%). The fourth most active sphere is 'Civil Society', with 32 organisations (9.50%). This data suggests that Budapest

uses a double-helix collaborative model, with the main participation coming from government and industry, as an engine behind the city's strategy for SC development activities.

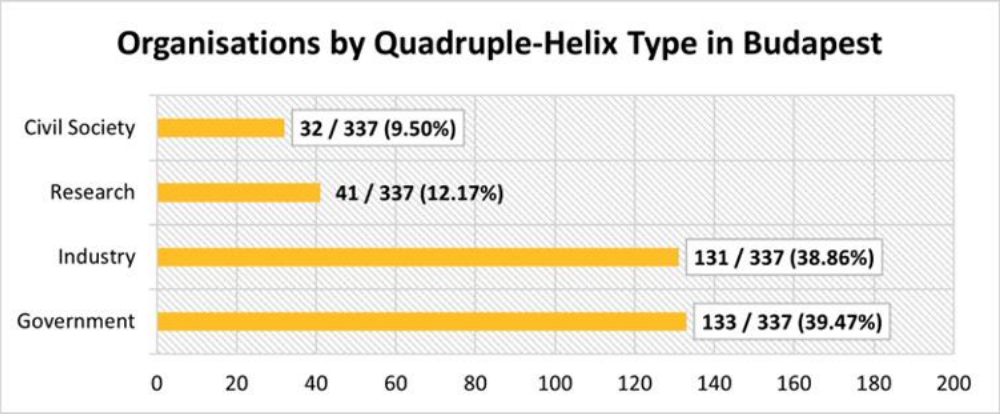


Figure 26 Organisations by quadruple-helix type in Budapest's SC development activities (own edition)

Figure 27 shows the network graph of the participating organisations in the ecosystem. The organisations mapped during the coding process are represented as nodes with a diameter that is directly proportional to the number of activities they participated in. Every edge connects the organisations that have collaborated in implementing at least one activity. Some organisations carried out activities on their own, and these cases are defined as self-loops in the software. The stronger the degree of collaboration between two organisations, the thicker the edge connecting them. The graph uses the Fruchterman Reingold layout, which is a classical one, developed in 1984 (used in Gephi software). For the sake of managing duplicate collaborations between two organisations, we used the simple 'sum' method for weighting. The edges are all 'undirected' ones. Colours are assigned according to the organisation types, as the legend on the right side illustrates.

The data suggests that Budapest's SC strategy holds onto the belief that SC developments can be efficiently realised within the narrow margin of traditional public–private relationships. Therefore, the collaboration's model is a double-he-lix structure. In this specific case, this means that the roles of the research organisations and universities are underappreciated; there are great opportunities for municipalities to engage with research actors on the topic of SC development activities. The potential for various instances of mutually beneficial cooperation is currently underexploited. The city's framework strategy declares that the road to smartness could be achieved through validation of 11 horizontal principles, which might be interpreted in any level of planning. The 'cooperative' principle describes that one of the most important indicators for measuring

the smartness of Budapest is the degree of interconnectedness of its urban actors. With regards to the status of a central institution, the strategy states that the municipalities play a pivotal role in urban governance. It is the public sphere's (e.g., local governments') responsibility to build partnerships, be proactive and coordinate urban actors. A key practical challenge is the management of activities that affect several administrative boundaries.

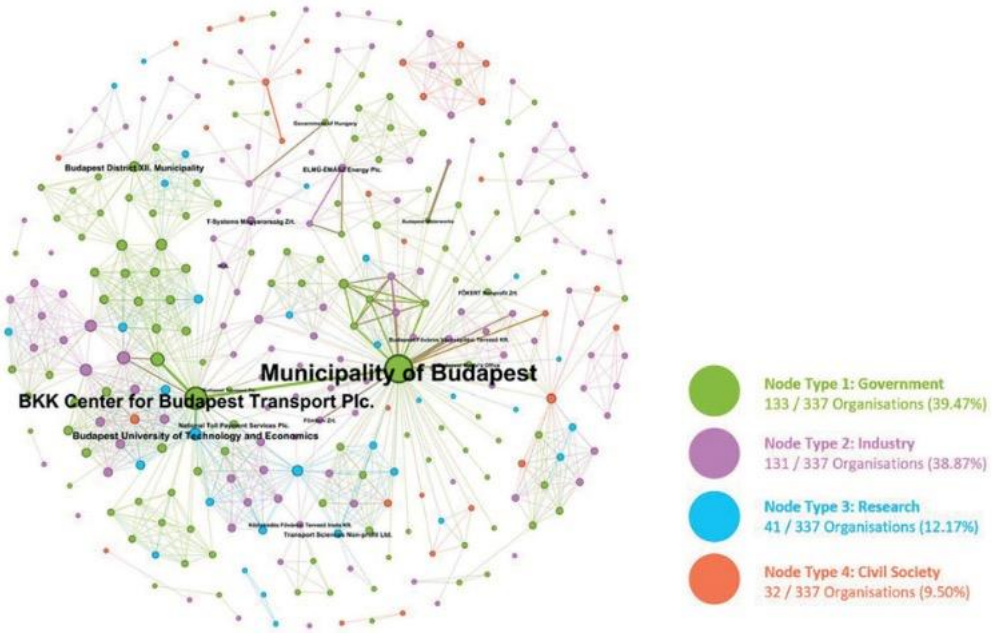


Figure 27 The SC development ecosystem of Budapest's strategy (own edition)

Civil society, being the least represented organisation type, holds a rather high share, compared to the international examples of excellent cases. As an example, Budapest's local government and several local district governments introduced the institution of participatory budgeting, which had dedicated to it an important role in empowering citizens and incentivising their engagement with local urban development activities. However, this significant participation is to be interpreted not only as a consequence of the city's intention to strengthen the role of the civil society but as proof of the existence of notable grassroots activities.

5.5.4 Dichotomy 4: Mono-dimensional or Integrated Intervention Logic

The available data in the analysis shows in Figure 28 that in the activity category of 'Services and Applications' Budapest's SC strategy has an integrated approach, which means that SC development activities cover most urban domains, in an integrated manner. It focusses on various domains of applications, not solely on the implementation of environmentally friendly solutions. Most of the activities are connected to 'E-

Government' (25/86, 29.07%), 'Mobility and Transport' (23/86, 26,74%), 'Health and Social Inclusion' (20/86, 23,26%), 'Education' (18/86, 20.93%) and 'Air' (17/86, 19.77%).

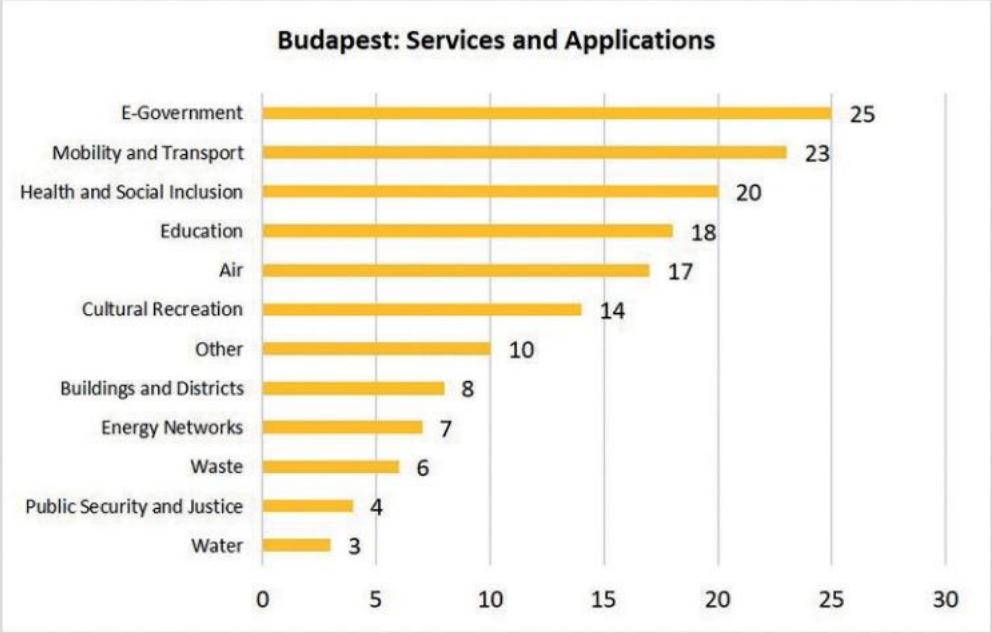


Figure 28 Budapest's SC development strategy: Activities by application domain (own edition)

Considering this data, the activity portfolio of the city fits well with the Euro-pean understanding of SCs. This aligns with the current city management's policy focus of a climate strategy that aims to address the environmental sustainability issues that are pressuring the needs of the citizens. Among the services and applications, we find a variety of solutions – e.g., dynamic simulation models to optimise the operational and maintenance conditions of the city's waterworks, development of geographical information systems (GIS), e-mobility and micro-mobility solutions, open data utilisation portals to share public data assets with the general public and make use of them, community food sharing platforms, an online platform for the management of citizen reports about public space problems and sharing these items with the competent authorities, deployment of UV-B radiation sensors, providing citizens with real-time information on public transport, and a smart grid pilot project with the extensive engagement of households with smart metering solutions.

5.6 Discussion

For researchers and the general public, it would seem inappropriate, or at least irrelevant in contrast to other pressing issues, to discuss the current situation of SCs in Hungary or the Central Eastern European region. In many cases, the COVID-19 pandemic further

marginalised the SC development activities of less-well-performing cities since some of them reported having challenges with operating even the very basic urban services such as public transportation. Nevertheless, we should remind ourselves that SCs are fundamentally not only all about fancy multi-million-dollar ICT projects. The concept emerged as a comprehensive framework to minimise the contemporary inefficiencies of urban systems and maximise the quality of life for citizens. Amid the challenges of this new pandemic, the resilience of urban systems is being tested, and the need for smartness is becoming even more urgent than before. As mentioned in the introduction, to embrace smartness, local governments are provided with directives, and financial incentives in the European Union, to plan smart activities. However, the unpreparedness of municipalities prevents them from accessing additional resources to develop urban services, and they decline even further in competitiveness. Lukács and Csomós (2020) reported that 15% of Hungarian cities with at least 10,000 inhabitants (140 cities) barely mention 'smartness' in their most important medium-term development programme. Are these results generalisable among Eastern European peers and the EU-15 countries, or is it only a Hungarian phenomenon? Cities need more support in tools and capacities to embed the concept into their mid-term plans. Showing the characteristics of Budapest, the supposedly most advanced case in the country, we find the findings of the analysis to be more informative if we compare them with the case of Vienna, which is already reported in the international literature as an example of excellence. The comparison between the neighbouring countries is otherwise an often-used benchmark in public media. In contrast to Budapest, Vienna uses a holistic SC strategy approach, which means that technological development is aligned with human, social, cultural, economic and environmental factors. Furthermore, Vienna keeps a balance between top-down and bottom-up approaches, and the city government promotes a bottom-up development process. There is another sharp difference between the two cities. Regarding the models of cooperation, Budapest uses a double-helix approach, while Vienna uses a triple-he-lix one. The share of academia in Budapest's SC development activities is lower (12.17%) compared to its peer (19.61/%). Another key difference is the share of government organisations: 39.47% in the case of Budapest and 19.61% in the case of Vienna. The dominance of government organisations also means a lower share of industry organisations in Budapest (38.87%, in contrast to Vienna's 56.47%). Yet another interesting finding is that the share of the civil society is almost double in Budapest what it is in the other city. The composition of services and applications (C) is quite similar in the two cases. All this data suggests that, compared to

an excellent case, Budapest's SC development activity uses different strategic principles in Dichotomies 1, 2 and 3. This suggests that the differences in performance might

be originating from the adaptation of these different principles, because the activity portfolio of the two cities is much alike in terms of the applied domain. The question arises, then, do cities like Budapest want to compare themselves to Vienna, if such fundamentally different approaches are present in the SC strategy? Or, rather, is the performance in smartness correlated with the type of strategic principles that cities adopt? This is a future direction for research.

Looking at the SC development activities of Budapest, we can state that the current European partnerships created benefits and challenges as well. One special example of failure originates from an international cooperation project, funded by the European Commission, called Cities-4-People (Cities-4-People, 2021). Within the project, the local government and the BKK (competence centre for transport) worked together with several shared mobility solution companies, such as the Lime Lime Network B.V. which operates shared electric scooters. The service provider proved to be inadequate in terms of taxation, generated huge tension in urban mobility, and, parallelly, mainly served the needs of tourists, instead of the residents. The service has even been banned in various districts by the local governments.

Considering the very low engagement of the medium-term strategies of Hungarian cities with the SC concept, it is vital to provide easy-to-understand and standardised methodologies for researchers and practitioners. Besides the fundamental differences we found in the different strategic approaches of an excellent and less successful city, there are other key issues to be considered that are not at all technological or ICT related in their nature but, rather, involve strategic management, institutional challenges and planning problems, which are hindering the transition to smartness. A key difference is that the Urban Innovation Labs is missing. Every city is unique, and adaptation of novel technological solutions requires special skill and knowledge; otherwise, the 'boxed' products of the industry create tension and lead to further unsuccessful cases. The observation of excellence cases suggests that specialised competence centres are established, separately – e.g., Forum Virium Helsin-ki speeds up innovation in Helsinki, with pioneer work in the field of open data and SC development (Forum Virium Helsinki 2021). It uses the 'agile smart city development' concept (which originate from business and management science) to make Helsinki the most functional SC in the world. As

another example, Urban Innovation Vienna was established as a competence centre for future urban issues in Vienna. It contributes the knowledge gained there to open discourse with local experts so that proactive and creative strategies can be drawn up for Vienna.

Therefore, this paper proposes, the key enabling factors to support the transition to smartness are not only technological ones but, in most cases, management, organisational and planning issues. If we accept that the local governments take the leading role in the transition, they must acquire the necessary organisational mechanisms to absorb and diffuse innovation. Unless a dedicated organisation with the necessary skills, expertise, competence and authority exists, the transition to smartness will be more likely to create problems than to solve existing urban challenges. As a new initiative, the Budapest Public Foundation for Enterprise Development's' Smart Budapest Idea Competition' has the potential to fill in such a gap in the future in Budapest.

As mentioned before, in the COVID-19 pandemic cities have been struggling to operate basic services; however, their resilience is being tested in these times, and the capacity of the city management is evaluated in terms of success or failure to recover quickly from difficulties, saving as many lives as possible. The capabilities of local governments to improve their efficiency and make more use of existing resources embodies smartness. Installation of fancy gadgets, and participation in low impact and unjustified, purely monetarily attractive international projects are not the way forward. However, the capability of making smart decisions is not a commodity that can be bought from industry; rather, the transition to an SC fundamentally carries within itself radical change, which might trigger resistance from those it affects.

Another key issue raised by this paper is connected to SC rankings and their indicator systems. It is important to measure the performance of cities in the framework of the SC concept. However, researchers should not be solely engaged with the development of such indicator systems unless they are directly linked with SC development activities, and those activities are clearly with the change of status range of certain performance areas (Bukovszki et al. 2019). In most cases, these rankings are indistinguishable from other competitiveness rankings. Attention needs to be focussed on what cities actually do within the SC context.

5.7 Conclusions and Future Research Directions

In this paper, we analysed the SC strategy of the Hungarian capital Budapest, which is considered to be an example of a less-well-performing city. Budapest's SC development strategy focusses on technological solutions. This means that the framework conditions for implementing the strategy – organisational background, authority, management, platforms for cooperation and so on – are rather neglected. The strategy uses a top-down approach; however, the two-tier administrative system and the key role of the central government make it a special case where the two approaches are mixed. In the case of the model for cooperation, Budapest adopts early on a double-helix model of collaboration: the most active organisations are government and industry ones, while the share of research is rather low. The presence of the civil society is relatively high compared to Vienna; however, in absolute terms, it is still low. Additionally, SC development activities cover most urban domains in an integrated manner; the city fits well with the European understanding of SCs, focussing on environmentally friendly solutions. The strategic principles used in Budapest's approach to SC transition are significantly different from a number of excellent cases such as Vienna, which might be the reason for the difference in performance. However, the correlation between a set of strategic principles used in cities and their performance is a future direction for research. Budapest lacks a specialised organisation, with the necessary skills, authority and capacities to engage with urban innovation, which on the other hand is present in various excellent cases. This might be another explanatory factor in the search for the different performance, which needs further investigation, too.

5.8 Limitation and Validity

It is important to note that the multiple-case-study selection process and the number of replications always determine the external validity of the study and the extent to which the results are generalisable. The extent of iteration is highly dependent on the confidence the researcher wants to achieve; 'the greater certainty lies with the larger number of cases' (Yin 2012, 58). Besides, analytical generalisation is also affected by two contextual conditions: the geographical distribution of the selected cases and their size. A more heterogeneous sample would determine a broader generalisation of the results. Budapest, as one case in the Central Eastern European region, is good for a pilot to assess the capability of the methodology that has proved to be working well for excellent cases. For further generalisation, other cases need to be tested in the region. Data availability also

has a limitation on the research. Furthermore, the weight of each activity is not considered.

5.9 Chapter takeaway for the dissertation argument

This chapter advances the dissertation argument by showing how the broader conceptual claims developed in the earlier chapters can be translated into a structured diagnosis of a specific city's smart development trajectory. If Chapters 2 and 3 established that smart city transition is constrained by structural and organizational barriers, and Chapter 4 demonstrated that cities also differ in the value propositions embedded in their activity portfolios, the present chapter adds a further level of precision by showing how a city's smart city trajectory can be interpreted through a coherent strategic framework. In the logic of the dissertation, this is a decisive step. The dissertation does not only argue that smart city development is context-dependent and governance-sensitive; it also seeks to show how these characteristics become empirically visible in an actual urban case. The Budapest chapter provides that demonstration.

The main dissertation-level contribution of this study is that it operationalizes the four strategic smart city dichotomies in a Hungarian and Central and Eastern European context. By analysing Budapest through the tensions between technology-led and holistic development, top-down and bottom-up governance, double- and quadruple-helix collaboration, and mono-dimensional and integrated intervention logic, the chapter provides a structured language for interpreting the city's pathway toward smartness. This is important because it allows the dissertation to move beyond generic statements about success, failure, or maturity. Instead of asking only whether Budapest is smart, the chapter asks what kind of smart development it is pursuing and under what strategic and institutional conditions. This directly supports the dissertation's overarching argument that becoming smart is not a binary condition, but a patterned urban trajectory shaped by strategic choices, governance arrangements, and implementation practices.

A second important contribution is that the chapter grounds the dissertation's Central and Eastern European and Hungarian orientation more explicitly. Earlier chapters established that this regional context is underrepresented in the international smart city literature and that Hungarian cases are especially valuable for testing whether dominant smart city frameworks travel effectively beyond flagship Western examples. The Budapest study responds directly to that need. It applies an internationally established analytical model

to a city that has an explicit smart city strategy, a visible portfolio of smart developments, and a complex metropolitan setting, yet is not typically cited as a smart city benchmark in the international canon. This matters for the dissertation because it strengthens its claim that context matters not only at the level of city size, but also at the level of region, governance tradition, institutional capacity, and strategic implementation culture. Budapest is not used here as a representative case of all cities, but as a revealing case that helps locate the dissertation more firmly in the Hungarian and Central and Eastern European debate.

The empirical findings of the chapter also deepen the dissertation argument in a substantive way. The study shows that Budapest's smart city development can be characterized as relatively technology-led, partly top-down, and largely based on double-helix collaboration, while at the same time exhibiting a relatively integrated portfolio across urban domains. This combination is analytically significant. It suggests that a city may display a broad and multi-domain set of smart development activities without necessarily achieving a governance model that is equally broad in terms of actor inclusion or participatory depth. In other words, portfolio integration does not automatically imply participatory governance or quadruple-helix collaboration. This is an important lesson for the dissertation as a whole, because it complicates any overly simple equation between the breadth of smart city activity and the quality of smart city governance. A city may be active, relatively integrated, and strategically ambitious, while still remaining organizationally underdeveloped and governance-wise selective.

This finding also connects closely to the earlier chapters. Chapter 2 identified barriers such as weak standards, uneven knowledge, and dependency structures. Chapter 3 showed that organizational design and collaborative capacity are central to whether smart city transition becomes workable in practice. The present chapter demonstrates how those more general problems may manifest at the level of a specific city trajectory. Budapest's relative weakness in bottom-up engagement, stronger dependence on public-private rather than broader quadruple-helix collaboration, and the underdeveloped organizational background of strategy implementation all echo the concerns raised earlier in the dissertation. This makes the Budapest chapter more than an isolated case study. It becomes a city-level expression of the broader dissertation argument that the key constraints of smart city development lie not only in the technological sphere, but in the institutional and organizational architecture through which technology is embedded.

Another major contribution of the chapter is methodological. It shows that the dichotomous framework is not merely a conceptual scheme for theoretical discussion, but a usable tool for the structured interpretation of city-level smart city development. This is highly relevant for the dissertation because one of its broader aims is to bridge abstract smart city theory and empirical urban analysis. The Budapest study advances that aim by showing how strategic orientation can be reconstructed from strategy documents, activity portfolios, and actor involvement patterns. It thus helps establish a methodological path that is later extended and refined in the Debrecen chapter. In this sense, the Budapest study is both a substantive contribution in its own right and a methodological precursor to the dissertation's final empirical chapter.

The chapter is also important because it highlights the gap between strategic framing and implementation conditions. Budapest appears in the study as a city whose activity portfolio is relatively broad and integrated, yet whose implementation environment remains constrained by insufficient organizational authority, incomplete management structures, and limited platforms for broader cooperation. This supports one of the dissertation's most consistent claims: smart city development cannot be assessed solely on the basis of visible initiatives or strategy documents. It must also be judged in relation to the institutional capacity and governance architecture that support or limit those initiatives. In this regard, the chapter reinforces the dissertation's integrative conceptual framework, in which strategy, barriers, governance, and implementation are treated as interdependent dimensions rather than separate research themes.

In relation to the dissertation's overall trajectory, the Budapest chapter performs an essential bridging function. It stands between the broader comparative discussion of value propositions in Chapter 4 and the more deeply integrated medium-sized-city governance analysis in Chapter 6. This position is analytically productive. Chapter 4 showed that cities differ in the benefit structures of their activity portfolios. Chapter 5 now shows how one city's trajectory can be diagnosed strategically through a structured framework. Chapter 6 will take that same framework into a medium-sized-city context and deepen it further through project-level and stakeholder-network analysis. Budapest therefore serves as an intermediate step between comparative portfolio analysis and full governance-network synthesis. It confirms the value of the dichotomous diagnostic approach while also revealing the kinds of limitations that make a deeper medium-sized-city case study necessary.

This link to Chapter 6 is especially important for the dissertation argument. Budapest, as a capital city, offers a valuable case of strategic smart city diagnosis in the Hungarian setting, but it does not fully capture the medium-sized-city problem that is central to the dissertation as a whole. The next chapter addresses this by turning to Debrecen, where the dissertation's core themes converge more fully: medium-sized-city context, strategic orientation, concrete project portfolio, governance structure, and stakeholder-network relations. In that sense, Chapter 5 prepares the ground for Chapter 6 by demonstrating the usefulness of the strategic framework and by revealing the need to analyse smart city development not only through a city's declared strategy and activity portfolio, but also through the underlying network of actors that shapes implementation. The move from Budapest to Debrecen is therefore not merely a shift of case. It is an analytical deepening of the dissertation's central concern with how cities become smart in practice.

In sum, this chapter advances the dissertation argument in four main ways. First, it localizes the dissertation's conceptual framework in a Hungarian and Central and Eastern European city case. Second, it operationalizes the four smart city dichotomies as a tool for diagnosing strategic orientation. Third, it shows that a city may be relatively integrated in its activities while still remaining selective or constrained in governance and collaboration. Fourth, it prepares the transition to the dissertation's culminating empirical chapter by establishing a city-level strategic diagnosis that Chapter 6 can extend into a medium-sized-city governance and stakeholder-network analysis. Its main contribution is therefore to demonstrate that smart city development can be interpreted systematically as a strategic trajectory shaped by organizational and governance conditions, rather than merely described as a collection of projects or policy ambitions.

6. Smart City Governance in a Medium-Sized European City: Strategic Dichotomies and Stakeholder Networks in Debrecen (Hungary)

6.1 Chapter preface

This chapter appears at the culmination of the article-based core of the dissertation because it brings together, in a single empirical study, the main analytical dimensions developed across the preceding chapters. Chapter 2 identified the structural barriers hindering smart city development in medium-sized cities. Chapter 3 showed that many of these barriers are reproduced or alleviated through organizational design. Chapter 4 demonstrated that smart city trajectories also differ in the value propositions embedded in their activity portfolios. Chapter 5 then operationalized the four strategic smart city dichotomies in the case of Budapest and showed how a city's smart development can be diagnosed systematically through its strategy and projects. The present chapter extends and integrates these lines of inquiry in the case of Debrecen, a medium-sized Central European city, by combining project-level strategic diagnosis with stakeholder-network analysis. It is therefore placed here as the dissertation's most comprehensive empirical chapter.

The chapter is especially important because it returns the dissertation to one of its central concerns: the under-examined role of **medium-sized cities** in smart city research. The article explicitly positions Debrecen as an analytically informative case because medium-sized cities are a more typical European implementation setting than capital-city or flagship cases, yet they remain less thoroughly studied in the literature. The study therefore responds directly to the dissertation's effort to move beyond capital-city bias and to understand how smart city governance unfolds under more ordinary scaling conditions, with thinner organizational capacity, more limited in-house data and analytics capabilities, and greater dependence on external programmes and partnerships.

This chapter also occupies a pivotal position because it is the first study in the dissertation to combine the **strategic dichotomy framework** with a full **stakeholder-network perspective**. The article analyses Debrecen's portfolio along the four key dichotomies already introduced in Chapter 5, technology-driven versus holistic development, top-down versus bottom-up governance, double-helix versus quadruple-helix collaboration, and mono-dimensional versus integrated logic, but it goes further by constructing a contributor network from co-participation data. In this way, the chapter not only diagnoses the city's strategic orientation, but also reveals how that orientation is

embedded in a concrete governance structure of organizations, partnerships, and central actors. This makes the chapter especially valuable for the dissertation, because it turns the earlier conceptual claim about governance and stakeholder relations into a directly observable empirical pattern.

Substantively, the chapter deepens the dissertation's main argument by showing that Debrecen's smart city trajectory is predominantly technology-led, municipally orchestrated, and grounded in government–industry collaboration, while at the same time achieving broad coverage across smart city domains. This combination is analytically significant. It suggests that in medium-sized cities, strong top-down coordination may support multi-domain breadth and implementation coherence, yet the same governance bundle may also reinforce a relatively narrow collaboration structure and limit participatory depth and knowledge-sector inclusion. This is one of the dissertation's most important cumulative insights, and it becomes clearest in this chapter.

The chapter also connects directly to the dissertation's final integrative conclusion. Unlike the earlier article chapters, which each emphasized one dominant dimension, barriers, organizational design, value propositions, or capital-city strategy, this study brings together context, strategy, implementation portfolio, and governance network in a single case. It therefore functions as the empirical culmination of the dissertation. The following and final chapter will synthesize the findings of all five studies, but many of the dissertation's core conclusions are already visible here in concentrated form: medium-sized cities matter analytically; governance structure shapes smart city trajectory; broad project coverage does not automatically imply inclusive collaboration; and smart city development must be evaluated through both strategic logic and stakeholder architecture.

6.2 Bibliographic record and author contribution

Full citation	Csukás, M. S. and Szabó, R. Zs. (2026) 'Smart city governance in a medium-sized European city: Strategic dichotomies and stakeholder networks in Debrecen (Hungary)', *Open Research Europe*, 6, 206. https://doi.org/10.12688/openreseurope.23465.1
Publication status / outlet	Peer-reviewed article published in *Open Research Europe*, Volume 6, Article 206, on 17 June 2026 (version 1; peer review: 3 approved with reservations).

	Open Research Europe is the European Commission's open-access publishing platform for research funded under Horizon Europe and Horizon 2020.
Co-authors	Máté Szilárd Csukás and **Roland Zsolt Szabó**.
Doctoral candidate contribution	The doctoral candidate led the study and was primarily responsible for the conception of the research, the development of the analytical framework, the compilation and validation of the Debrecen project dataset, the coding of initiatives along the strategic dichotomies, the construction and interpretation of the stakeholder collaboration network, and the drafting of the manuscript. The co-author contributed through scholarly consultation, conceptual feedback, and manuscript development support.
Relation to dissertation research question	This article addresses the dissertation's overarching research question by examining how a **medium-sized Central European city** becomes smart in practice, and by showing how strategic orientation, municipal coordination, and stakeholder-network structure shape that process. It contributes directly to the dissertation by integrating the medium-sized-city focus, the dichotomous strategy framework, and the governance-network perspective into one empirical case, thereby offering the dissertation's strongest combined evidence on how smart city ambitions are translated into concrete project portfolios and collaboration structures.
Editorial adaptation note	The full text of the published article is reproduced in this dissertation as a core chapter of the article-based thesis. Only minor editorial adaptations have been made for integration into the dissertation, including formatting, chapter and figure numbering, citation harmonization, and alignment with the unified bibliography. No substantive changes have been made to the argument, methodology, or findings of the published article.

6.3 Introduction

The smart-city has become a widely adopted paradigm for urban development (Almulhim and Yigitcanlar, 2025; Bibri, 2019; Colding et al., 2019; Dabeedooal et al., 2019; Malandrino et al., 2019; Schipper and Silvius, 2018; Tobey et al., 2019), that has diffused globally beyond pilot discourse, with evidence of >1000 implemented projects worldwide (Csukás and Szabó, 2021; Hajek et al., 2022) and large-scale public and city investment commitments (Cui et al., 2024; Kim, 2022), alongside institutionalization in major policy programmes such as the EU's Cities Mission targeting 100 climate-neutral and smart

cities by 2030 (“Climate-neutral and smart cities - Research and innovation,” 2026; Prieto, n.d.), encompassing applications of advanced technology (Allam and Newman, 2018) and data-driven solutions to improve sustainability, governance, and quality of life (Bokolo, 2023; Csukás and Szabó, 2021; Kaluarachchi, 2022; Kitchin, 2014). Early implementations of smart cities were often technology-driven, emphasizing ICT infrastructure and smart services as ends in themselves (Hu et al., 2023; Kummitha and Crutzen, 2017; Liu and Wu, 2023; Myeong et al., 2021; Ramaprasad et al., 2017). This techno-centric approach, exemplified by many flagship projects, has invited critiques for neglecting human and social dimensions of urban innovation (Cook and Karvonen, 2024; Hollands, 2015; Kitchin, 2016, 2015; Kummitha and Crutzen, 2017; Marvin et al., 2015; McFarlane and Söderström, 2017). In response, scholars and practitioners have called for more holistic strategies that treat technology as a means to broader urban goals – integrating community needs, sustainability, and institutional change (Ahvenniemi et al., 2017; Angelidou et al., 2018; Castelnovo et al., 2016; Gracias et al., 2023; Hollands, 2008; Shelton et al., 2015). Likewise, the governance of smart city initiatives can range from top-down – led by government with centralized planning – to bottom-up, where grassroots actors, civic tech communities, and other stakeholders drive innovation (Meijer and Bolivar, 2016; Mora and Bolici, 2017; Myeong et al., 2021; Ruhlandt, 2018). The breadth of stakeholder collaboration is another key axis (Clement et al., 2022; Dabeedooal et al., 2019; Dezi et al., 2018; Esteban-Narro et al., 2025; José and Rodrigues, 2024; Lopez-Carreiro et al., 2023): Smart-city delivery is frequently organized through public–private arrangements (city authorities working with firms), sometimes framed as a double-helix governance mode (Ju et al., 2024; Quan and Solheim, 2023), while the quadruple-helix perspective explicitly broadens smart-city innovation to include academia and civil society in co-creation (Angelidou, 2017; Carayannis et al., 2022; Csukás and Zs. Szabó, 2022; Csukás and Szabó, 2021; Mora et al., 2019a; Mora and Bolici, 2017).

Finally, Smart City efforts may pursue a mono-dimensional logic - concentrating on a single domain or a set of isolated projects - or an integrated logic that aligns multiple urban domains and policies under a unified smart city framework. Empirical evidence shows substantial variation in how broadly cities spread “smart” initiatives across domains: Neirotti et al. operationalize this using a domain “coverage ratio” (i.e., the ratio of domains addressed by a city’s smart initiatives relative to the set of potential domains), demonstrating that some cities concentrate on a narrow subset while others adopt broader,

cross-domain portfolios (Neirotti et al., 2014). At the same time, the smart city concept is described as evolving "from a sector-based approach to a more comprehensive view," yet implementation often requires "lowering the scale from the strategy to the project level," so the capacity of initiatives to deliver an "integrated and systematic" response is contested in practice (Fernandez-Anez et al., 2018). Correspondingly, the literature contrasts cases of integrated smart city strategies (explicitly discussed as "toward an integrated approach" and illustrated through citywide strategy examples) with contexts where piecemeal initiatives predominate and smart-city making emerges through a mix of ad hoc initiatives and later "post hoc" strategizing (Neirotti et al., 2014).

These dichotomies - technology-driven vs. holistic, top-down vs. bottom-up, double- vs. quadruple-helix, and mono-dimensional vs. integrated - capture strategic choices and tensions frequently observed in smart city development (Csukás and Zs. Szabó, 2022; Mora et al., 2019b). Balancing these tendencies is widely regarded as important for effective smart city governance. Yet, the empirical base used to theorize and benchmark them remains uneven: much of the most visible evidence and many comparative syntheses draw disproportionately on global cities and capital regions, i.e., contexts characterized by high administrative capacity, dense innovation ecosystems, large procurement markets, and strong international visibility. This raises a risk of selection bias in smart city research (Dashkevych and Portnov, 2022; Shi and Shi, 2023), whereby governance arrangements and strategic logics observed in "flagship" cities are implicitly treated as generalizable, even though they are produced under atypical institutional and resource conditions. (Del-Real et al., 2023; Kitchin, 2015).

Medium-sized cities constitute a different - and in Europe, more common - implementation setting (Desdemoustier et al., 2019). They often operate with thinner organizational capacity (Lafioune et al., 2023; Tejedo-Romero et al., 2022), more constrained fiscal space (Blanck and Ribeiro, 2021; Caselli et al., 2022), higher dependence on external funding programmes (Caselli et al., 2022), and more limited in-house data and analytics capabilities (Csukás and Szabó, 2018; Nowaczyk et al., 2022). These conditions can systematically shape whether smart city development becomes technology-led or holistic, top-down or participatory, and predominantly double-helix or more broadly collaborative in practice (Borghys et al., 2020; Fernandez-Anez et al., 2018; Kummitha, 2025; Lee et al., 2023; Nguyen et al., 2022; Quan and Solheim, 2023; Voorwinden, 2021). This matters not only for theory but also for policy: European

programmes increasingly expect cities beyond capitals to deliver integrated digital and climate transitions (Salvia et al., 2023; Shabb and McCormick, 2023; Ulpiani et al., 2023), yet the smart-city literature still provides only limited, fine-grained empirical analysis of how city-level strategic framings are translated into concrete project choices, governance arrangements, and implementation practices, particularly in small and medium-sized, non-flagship contexts (Anschütz et al., 2024; Fernandez-Anez et al., 2018; Giffinger et al., 2007; Mu et al., 2022; Zhao et al., 2021).

Accordingly, this study positions Debrecen (Hungary) as an analytically informative case of a medium-sized regional centre where smart city development is pursued under typical European "scaling" conditions (Varró and Szalai, 2022). Debrecen has experienced rapid economic restructuring alongside major infrastructure investment, and it has articulated explicit smart city priorities (Smart Mobility, Sustainable Energy, and Digital Debrecen), supported by cross-cutting aims related to citizen engagement, data-informed decision-making, and external collaboration. In such settings, governance networks and capacity constraints are not background conditions; they are plausible causal drivers of observed strategic orientations.

Methodologically, we operationalize the four dichotomies as an empirical diagnostic using a newly curated and validated dataset of 120 smart city initiatives in Debrecen, complemented with a stakeholder collaboration network derived from co-participation data. We assess whether strategic intent is reflected in practice by: (1) mapping initiatives across smart city domains and application areas; (2) coding projects along the four dichotomies; and (3) analysing the collaboration network to identify central actors, bridging roles, and the extent of multi-helix participation. The approach builds on a pilot methodology and aligns with a recent Budapest case analysis to improve within-country comparability while extending empirical evidence to a non-capital, medium-city context.

The remainder of the paper is structured as follows. The Methodology section describes our data collection, coding process, and analytical framework, including the operationalization of the dichotomous model and construction of the stakeholder network. In the Results, we present findings on Debrecen's strategic orientation: (1) a mapping of its smart city strategy along the four dichotomy dimensions, (2) a typology of projects by type and domain, (3) the roles and participation of different actor types, and (4) the structure of the smart city collaboration network visualized from the data. The Discussion reflects on the implications of these findings – comparing Debrecen's approach to

patterns observed in larger cities (e.g. Budapest) and discussing what the Debrecen case reveals about the opportunities and limitations for medium-sized cities in smart city development. Finally, the Conclusions summarize key insights and provide recommendations for policymakers and researchers, highlighting the significance of medium-sized cities in the broader smart cities discourse.

6.4 Materials and Methods

6.4.1 Data Collection and Study Context

This study is based on a comprehensive dataset of Debrecen's smart city initiatives compiled and validated in 2025. The dataset includes 120 projects and initiatives implemented roughly between 2007 and 2025 in Debrecen. These were identified through multiple sources: municipal project documentation, the official Debrecen Smart City Strategy document, press releases, and contributions from local stakeholders (as recorded in the project database). Each initiative record was cross-checked against at least two independent sources where possible, and uncertain classifications were resolved through iterative review of original documentation. Each entry in the dataset contains details such as the project name, year, associated smart city domain, a description, and a list of participating organizations (cooperating partners). The domains are categorized according to the standard European smart city dimensions – in Smart Governance, Smart Mobility, Smart Economy, Smart Society/People, Smart Environment, and Smart Living. This classification is consistent with the Giffinger model of smart city domains and was directly annotated in the dataset for each project(Giffinger et al., 2007). In Debrecen's case, the official strategy prioritized three focus areas (mobility, energy, digital) , but our dataset shows that initiatives actually span all six domains, allowing an analysis of the city's multidimensional smart city development.

Additionally, for each project, the dataset captures whether the City was involved (as initiator or partner) and the list of up to 15 partner organizations (public agencies, companies, NGOs, etc.). A separate "network edges" file was generated from this, listing every pair of organizations that appeared together in at least one project (with a weight indicating the number of co-occurrences). This serves as the input for our network analysis of Debrecen's smart city ecosystem.

6.4.2 Coding Approach: Dichotomous Strategy Dimensions

To analyse Debrecen's strategic governance logic, we adopted a coding scheme based on the dichotomous model proposed by Mora et al. (2019) and further applied by Csukás and Szabó in their Budapest case study (Csukás and Zs. Szabó, 2022; Mora et al., 2019b). Each project was coded along several axes corresponding to the hypothesized dichotomies:

- **Tech-driven vs. Holistic**: We assessed whether the project had a primarily technological focus (e.g., implementing ICT solutions, smart infrastructure, digital services) or a broader holistic focus (e.g., community development, policy or institutional frameworks, non-technical interventions). Following the methodology of Mora et al. (2019), we introduced four activity-type categories to capture this: (A) Community Building, (B) Strategic Framework, (C) Services and Applications, and (D) Digital Infrastructure . Categories A and B represent non-technical, social or organizational activities (such as citizen engagement programs, strategy formulation, training, etc.), whereas C and D represent technology-oriented activities (deployment of smart services, mobile apps, sensors, Wi-Fi, hardware, etc.). Each initiative in Debrecen's dataset was coded with one or more of these categories as applicable. This allows us to quantify the balance between tech-centric and community-centric efforts. In line with prior studies, we then grouped A+B vs. C+D to determine the overall strategy leaning.
- **Top-Down vs. Bottom-Up**: We examined the governance mode of each initiative. An initiative was classified as top-down if it was initiated by the municipal government or a public authority and aligned with official strategy (for example, projects where Debrecen City Hall or a city-owned enterprise is a driving actor). Conversely, it was classified as bottom-up if it emerged from outside the municipal government – for instance, a project led by a startup, community organization, or corporate actor without direct city planning involvement. In practice, we used the "City involvement" field as a proxy: if the Municipality of Debrecen (or its agencies) was involved in an initiative, we consider it top-down or at least guided by the city, whereas if the city was not a participant, the initiative is treated as externally or bottom-up driven. This binary classification aligns with the dichotomy definitions where Hypothesis 2.1 posits that local governments lead smart city development (top-down) and H2.2 posits that other stakeholders

drive it independently (bottom-up). We recognize that reality can be nuanced (some projects are co-created), but this provides a clear criterion for analysis.

- **Double Helix vs. Quadruple Helix Collaboration**: We identified the stakeholder composition of each project to see whether Debrecen's smart city development relies mainly on the double-helix of government–industry collaboration or expands to a quadruple-helix model including academia (research institutions) and civil society (NGOs, citizen groups). To do this, we classified every participating organization in the dataset into one of four categories: Government (municipal departments, city-owned companies, national agencies, local authorities), Industry (private sector firms, startups, utilities if privately run), Research (universities, research institutes, schools), or Civil Society (non-profits, associations, community groups). The categorization was informed by organization type and name (for example, "Önkormányzat" denotes a municipality, indicating a government actor; "Egyetem" denotes a university, etc.). We computed the share and number of actors from each sphere involved in Debrecen's initiatives, as well as examined specific major projects for the diversity of partners. This allows us to judge whether Debrecen's smart city development model is closer to a closed public–private partnership core (double-helix) or an open collaborative network (quadruple-helix) involving knowledge institutions and the public.
- **Mono-dimensional vs. Integrated Logic**: Finally, we assessed whether Debrecen's smart city activities concentrate on a single dimension or pursue an integrated approach across multiple domains. The breadth of smart city domains covered by the city's projects is one indicator: a mono-dimensional strategy might focus overwhelmingly on, say, ICT infrastructure or one sector like transportation, whereas an integrated strategy would include projects in mobility, environment, governance, economy, people, living, etc., reflecting a balanced urban development vision. Using the domain labels in the dataset, we tallied projects per domain and identified the level of cross-domain integration. Another indicator is the horizontal ("cross-cutting") initiatives that tie multiple domains together (for example, a climate strategy that involves environment, mobility, and community engagement simultaneously, or a digital education program that connects governance, people, and living domains). We flagged such integrative initiatives where applicable. Debrecen's own strategy document suggests an integrated

perspective by linking focus areas with horizontal principles . Our analysis examines to what extent this is reflected in the actual portfolio of projects.

Because several initiatives span multiple domains and activity types, coding was conducted iteratively, with repeated checks of borderline cases to ensure consistent application of the dichotomy definitions across the dataset.

6.4.3 Network Construction and Analysis

To visualize and analyse the ecosystem of actors in Debrecen's smart city initiatives, we used the contributor data to build a collaboration network graph. In this undirected graph, each node represents an organization (stakeholder) that has participated in at least one smart city project in Debrecen, and each edge represents a collaboration between two organizations, defined by co-participation in one or more projects. If two entities worked together on multiple projects, the edge between them is assigned a higher weight (equal to the number of shared projects). For example, the City of Debrecen and the EDC Debrecen Economic Development Centre co-appear in 12 projects, so there is a weighted edge of 12 between them in the network. We extracted 476 such collaboration links among 161 unique organizations, and the network was analysed using Python/NetworkX and visualized with a force-directed layout (spring algorithm).

We applied visual encoding to highlight the quadruple-helix roles of actors . In the network visualization (see Figure 30), node colours indicate the actor type (e.g., red for government, green for industry, blue for research, orange for civil society), and node size corresponds to the number of projects that actor is involved in (degree centrality, with larger nodes for more active participants) . We also draw edges with a thickness proportional to collaboration strength (common projects) to spotlight strong partnerships . This network representation allows us to identify key hubs, clusters of collaboration, and the overall structure of Debrecen's smart city stakeholder ecosystem. Basic network metrics such as degree centrality were computed to rank the influence of actors, and connected components were examined to see if any sub-networks operate relatively disconnected from the main cluster (e.g., exclusively bottom-up project clusters).

By combining the qualitative dichotomy coding with quantitative network analysis, our methodology provides a multidimensional view of Debrecen's smart city strategy: not only classifying the nature of initiatives but also mapping who drives and connects these

initiatives. This mixed-methods approach was crucial for drawing nuanced conclusions about strategic governance logic, as recommended by prior research on overcoming dichotomous perspectives in smart city analysis .

6.5 Results

6.5.1 Strategic Orientation: Tech-Driven vs. Holistic Balance

Our analysis finds that Debrecen's smart city portfolio is predominantly technology-driven, though not without holistic elements. Out of the 120 documented initiatives, a large majority involve tangible technological solutions – for instance, deploying new digital services, smart infrastructure, or data platforms – whereas a smaller subset focus on community engagement or strategic planning without a tech component. Using the category coding, we observed 100 initiatives (83%) include "Services & Applications" or "Digital Infrastructure" elements, compared to 46 initiatives (41%) that include "Community Building" or "Strategic Framework" elements (many projects contain both types) . In other words, there are roughly twice as many tech-oriented activities as socially-oriented ones in Debrecen, a ratio very much in line with Budapest's case where Group 2 (tech-driven) had almost double the number of activities of Group 1 (holistic support). Figure 24 in the Budapest study (Chapter 5) illustrated this imbalance clearly; our findings indicate a similar non-balanced distribution for Debrecen.

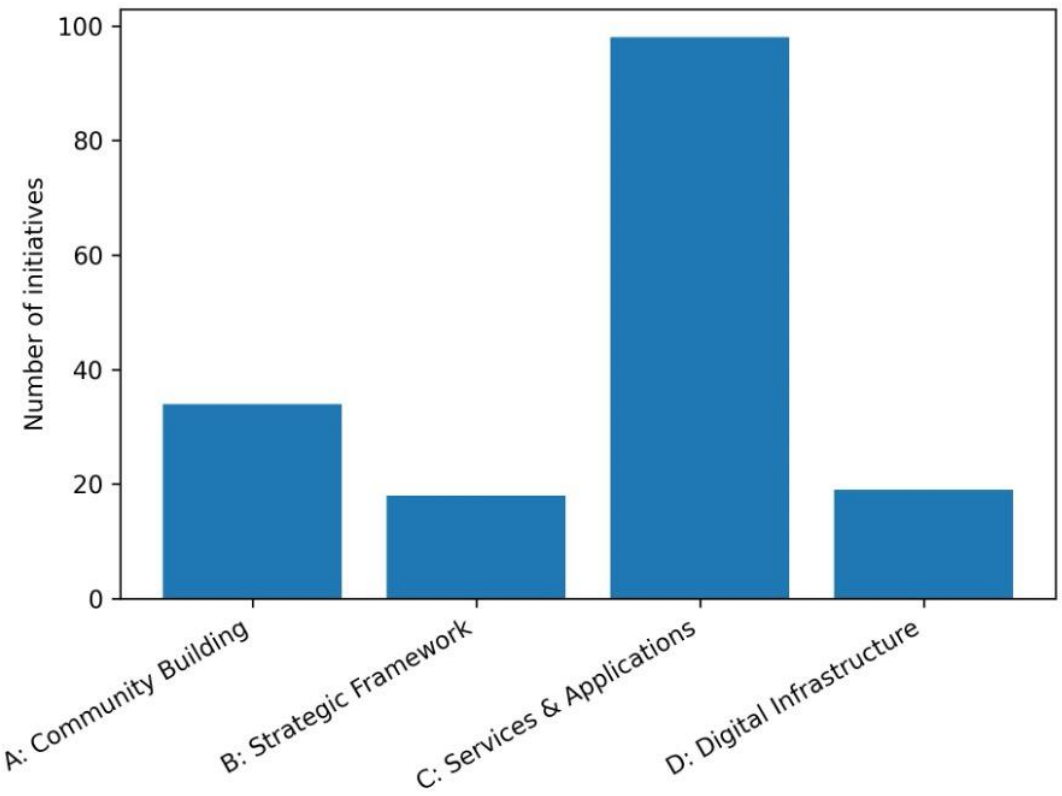


Figure 29 Debrecen's smart city development strategy: number of initiatives by category (A–D)

Percentages indicate the share of initiatives coded in each category; categories are not mutually exclusive (initiatives may be assigned to multiple categories

This skew toward technology is underscored by the nature of Debrecen's flagship projects. Many initiatives target smart infrastructure in urban mobility and energy. For example, the city installed smart traffic solutions ("intelligent crosswalks", smart traffic lights), rolled out city-wide free Wi-Fi hotspots, implemented smart parking and e-ticketing systems, launched an open data portal, and participated in EU pilots for electric buses and charging infrastructure. These typically fall under the "Digital Infrastructure" or "Service/Application" categories in our coding. In contrast, comparatively fewer projects were devoted to community-centric programs or soft measures. Notable holistic efforts include the "Debrecen Smart City Meetup" series (a community-building and knowledge-sharing event) , the establishment of a "Smart City Round Table" for stakeholder dialogue (strategic framework activity), and certain education programs like coding workshops for youth (Logiscool, NI Mentor Program). Debrecen also developed strategy documents such as a Sustainable Energy and Climate Action Plan (SECAP) and a local climate strategy (both categorized as Strategic Framework initiatives). However,

these holistic or strategic initiatives are fewer and often run in parallel to the main tech deployments rather than fully integrating with them.

Overall, Debrecen's strategy can be characterized as technology-led rather than fully holistic. Similar to the conclusion drawn for Budapest , Debrecen's smart city approach puts high emphasis on implementing ICT and smart solutions (technology as a driving force), and relatively less emphasis on activities aimed at community empowerment or deep institutional change. The city's philosophy appears to view technology as a primary tool to achieve urban improvements, while citizen engagement and policy innovation are supportive but secondary. As a result, Debrecen's strategy cannot be considered holistic in the stronger sense of fundamentally reshaping socio-technical systems – instead, it aligns more with a service-and-application-focused vision of smart cities . Nonetheless, the fact that about 40% of initiatives did involve some community or planning dimension indicates that Debrecen has not entirely ignored holistic principles; it has some awareness of the need for strategic frameworks and public buy-in (for example, the strategy's emphasis on "bringing society on board"). In practice, though, these aspects play a supporting role to the technology deployments, rather than guiding the overall program.

6.5.2 Governance Mode: Top-Down City Leadership vs. Bottom-Up Initiatives

Debrecen's smart city development has been overwhelmingly top-down in governance. We found that the Municipality of Debrecen (city government) is a participant in 106 out of 120 projects (88%), often as the leading or coordinating entity. Many projects were directly initiated by the Mayor's Office or city departments, frequently in partnership with the city's own companies (e.g., DKV – the public transport company, Debreceni Vagyonkezelő – the asset management holding) or the city-backed Economic Development Center (EDC Debrecen). This indicates a strong central steering of the smart city agenda: the local government has been the key actor setting strategic priorities and mobilizing resources for implementation. This top-down pattern aligns with Hypothesis 2.1, that local government provides strategic direction and leadership for smart city developments .

Bottom-up or externally driven initiatives exist but are relatively rare outliers. Only ~12% of the projects lacked direct city involvement. These include, for example, a few private sector-led projects such as the "NI Mentor Program" (an education initiative by National Instruments, a multinational company with a Debrecen presence), and certain startup

pilots (e.g., a contactless parking payment app by a local startup). Another small set of projects were led by research consortia or NGOs without the city's lead – for instance, Debrecen's participation in the LIFE IP HungAIRy program was coordinated by national environmental agencies and involved many cities, with Debrecen more of a beneficiary partner than the leader. Even in such cases, however, Debrecen's municipality typically had at least a nominal role (as seen in LIFE IP HungAIRy, the city signed on as a partner).

The dominance of top-down initiatives in Debrecen underscores the city's proactive stance: the local government took on the responsibility to "build partnerships, be proactive and coordinate urban actors", which is consistent with its strategy documents and the general expectation for municipalities in smart city governance. Interviews and strategy texts emphasize that Debrecen's leadership sees itself as the orchestrator of the smart city program, aligning with the notion that the public sector must coordinate and drive these efforts for success. This has advantages in terms of coherence – Debrecen's projects largely fit into the city's strategic focus areas, suggesting that the top-down approach ensured alignment with mobility, energy, and digital priorities. However, the flip side is that bottom-up innovation has been limited. We do not observe strong evidence of citizen-initiated "smart" projects or independent local tech community projects feeding into the city strategy. The smart city meetup events are a positive step to involve the community, but they were also organized by the city (EDC). Compared to some Western cities where hackathons, civic tech groups, or grassroots movements have influenced smart city development, Debrecen's model remains more centralized.

Debrecen exemplifies a top-down governance model of smart city development, where the city hall and its affiliated organizations are the primary decision-makers and implementers. Bottom-up contributions, while present in a few cases, have not been a major driving force. This mirrors the situation in Budapest, where the city's smart initiatives were also found to be chiefly driven by municipal leadership and not by bottom-up forces . The implication is that Debrecen's smart city strategy has the benefit of clear leadership and potential for unified vision, but it may risk under-utilizing the creativity and engagement of civic society unless more avenues for bottom-up participation are introduced.

6.5.3 Collaboration Model: Stakeholder Participation and Quadruple-Helix Analysis

Debrecen's smart city ecosystem involves a variety of stakeholders, but the distribution is heavily skewed toward government and industry actors, reflecting a double-helix collaboration pattern. We identified a total of 161 distinct organizations participating across the 113 initiatives. Figure 30 below visualizes the network of these actors and their collaborations (each link indicating co-implementation of a project).

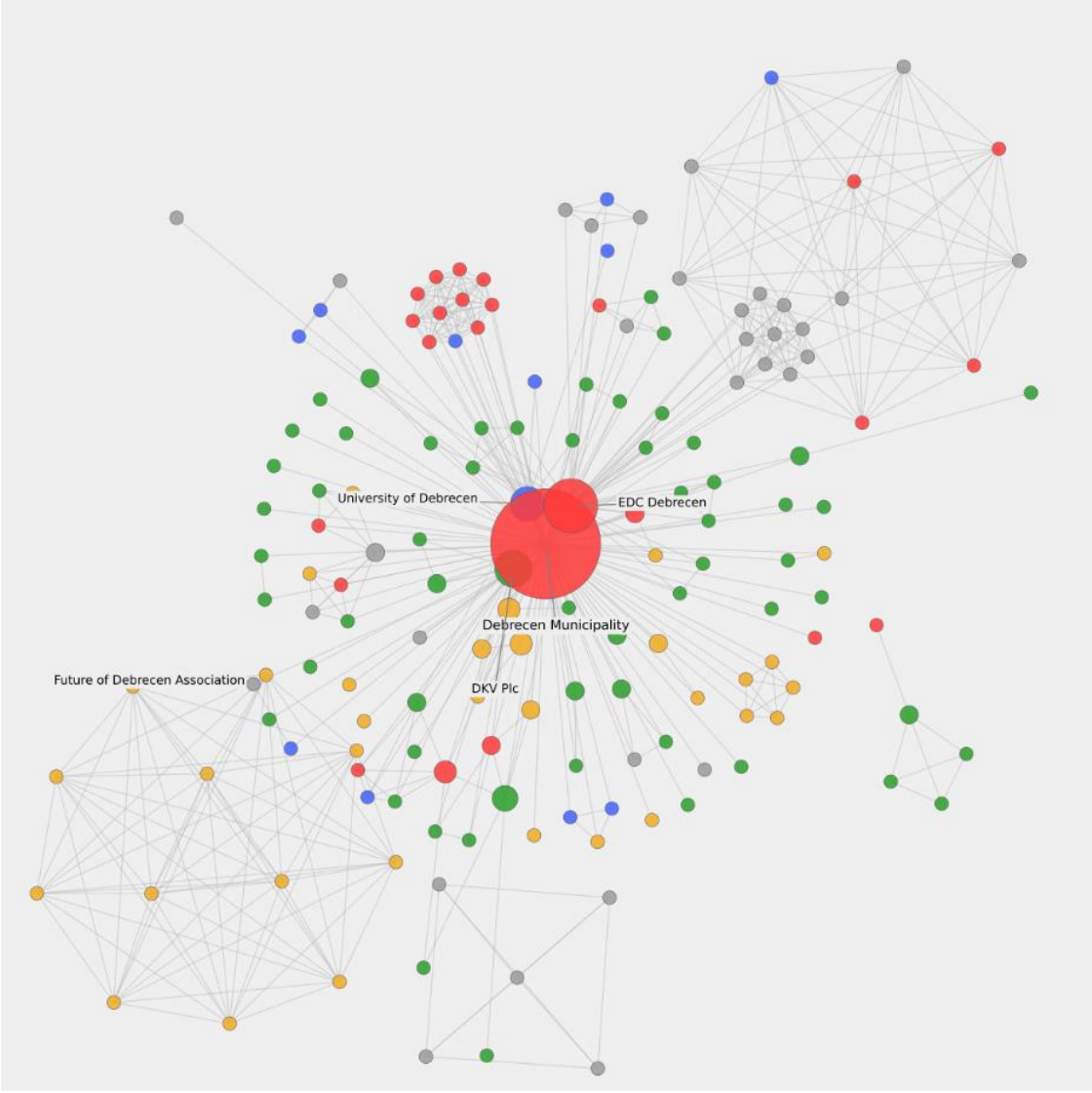


Figure 30 Collaboration network of Debrecen's smart city actors (nodes coloured by type: red = government, green = industry, blue = research, orange = civil; node size proportional to number of projects; edge thickness proportional to number of shared projects).

In Debrecen, the government sphere – which includes the municipal government and other public authorities – and the industry sphere – comprising private companies and investors – together account for the vast majority of participants. By our classification, roughly three-quarters of all involved entities are companies or industry partners, and

about 15% are government or public-sector bodies. The remaining share is split between academia (universities, research institutes) and civil society organizations, which together make up less than 15% of actors. This breakdown is very much in line with what was observed in Budapest's smart city projects: there, 39% of participating organizations were government and 39% industry, with only ~12% research and ~9% civil . Debrecen's proportions are comparable, confirming that the core partnership is essentially between the city and businesses (a double-helix).

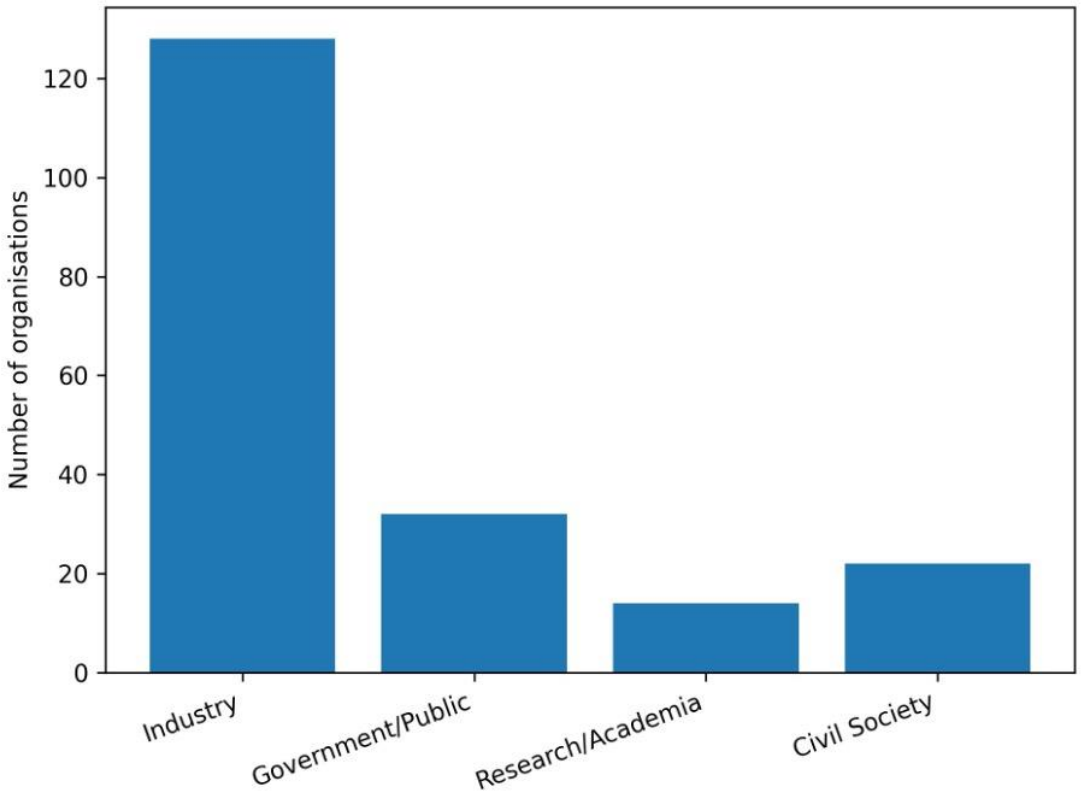


Figure 31 Debrecen Smart City Ecosystem – Organisations by Helix Category

By our classification, roughly three-quarters of all involved entities are companies or industry partners, and about 15% are government or public-sector bodies. The remaining share is split between academia (universities, research institutes) and civil

The City of Debrecen itself (Debrecen Megyei Jogú Város Önkormányzata) is by far the most central actor in the network. It participated in 97 collaboration links (edges) with other stakeholders, meaning it has worked directly with roughly 97 different organizations on various projects. This makes the city a dominant hub – visually the large red node in Figure 30 – connecting to almost every other cluster of activity. The weighted degree of the city node is 124, indicating it has been involved in that many total partnership instances (some organizations multiple times) across all projects. Such

centrality underscores that the municipality is the linchpin of Debrecen's smart city ecosystem, consistent with its top-down role. It is noteworthy that no other node approaches this level of connectivity.

The next most prominent actor is EDC Debrecen, the city's Economic Development Center (shown in red in the figure, as it is a city-established nonprofit company). EDC acted as a key implementing agency for the smart city program – co-leading 12 projects with the city and participating in many others. EDC Debrecen appears as a hub linking the city to external partners, especially in projects that have an innovation or economic development angle (startup support, open data, etc.). Its high centrality reflects its function as an intermediary between the local government and businesses or academia.

Among industry actors, several local technology companies and utilities stand out with multiple connections: for example, DKV Zrt (Debrecen's public transport company, technically a city-owned enterprise but here counted in the industry/utility sphere) collaborated with the city on numerous mobility projects and has degree 15 in the network. Other firms like Pearl Enterprises Kft (involved in smart crosswalk and e-parking solutions), National Instruments (NI) Hungary, and a few construction and IT firms (e.g., AppCorner Kft, HC Linear Kft) show up as nodes linked to the city in specific domains. However, these companies typically have edges of weight 1 or 2 – indicating their involvement in one or two projects each, often in a vendor or pilot partner role.

The University of Debrecen (Debreceni Egyetem) is the major academic actor in the city and does feature in the network – it partnered in a handful of projects (degree 11, including a smart bike-sharing initiative UniBike and joint research pilots). But notably, the university's involvement is limited compared to the city or key companies. There is also a student organization (the University's Student Union) that co-initiated one project, and some external research collaborations (e.g., the Hungarian Transport Science Institute in one transport pilot) – these contribute to the "Research" category share. Academia's relatively small node sizes and low degree in Figure 30 indicate that the knowledge sector is underrepresented in Debrecen's smart city program. This mirrors Budapest's finding that universities and research institutes played a minor role, which was interpreted as a missed opportunity in building a more innovative, knowledge-driven approach .

Similarly, civil society involvement in Debrecen's smart projects has been modest. A few NGOs and community groups are present – for instance, the Future of Debrecen Association (an environmental NGO), some neighbourhood and youth associations, and

thematic NGOs (like cycling advocacy groups or environmental organizations) participated in consultative roles in certain projects (especially those with environmental or social impact). In one notable initiative, Debrecen's climate strategy development, the process intentionally included local civil organizations and residents as partners . In the network, these appear as orange nodes often labelled "…Egyesület" (association). However, their connections are typically only with the city (and maybe one other partner), reflecting one-off inclusion rather than sustained multi-project involvement. No dominant civil society hub emerges; rather, each NGO tends to be tied to a specific project's context. This suggests that while Debrecen has involved civic stakeholders in consultations (e.g., for climate action, community programs), there isn't a strong civil society driver for smart city projects as an independent force.

Considering the collaboration model, we conclude that Debrecen's smart city development fits the double-helix pattern, where the engine of collaboration is the city government working with industry partners . Government–industry ties are the thickest edges in Figure 30 (for example, City–EDC, City–DKV, City–various tech firms). The other two helices of the quadruple model – academia and civil society – are present but peripheral. This outcome is consistent with studies that many smart city initiatives default to public–private partnerships and that extra helix engagement needs deliberate effort . Debrecen has not yet fully leveraged the quadruple-helix model; the roles of universities and community groups remain underdeveloped, which implies potential for broadening collaboration in the future.

It is worth noting that some network substructures exist. Apart from the main cluster cantered on Debrecen City, we identified a few smaller clusters of actors collaborating without direct city involvement. For example, an international pilot project in 2020 connected actors like Zone Cluster (a Hungarian mobility cluster), AMB (Barcelona Metropolitan Area), and several European startups (Ciclogreen, Moven, Lobelia Earth) in a bike-sharing data initiative – Debrecen was a test site, but the city government did not lead, resulting in those partners linking to each other (forming a component) rather than through Debrecen City. Another cluster was the LIFE IP HungAIRy consortium, linking multiple Hungarian city municipalities (Budapest, Pécs, Miskolc, etc.) and an environmental institute . In our network, those cities all connected to each other via that project, creating a fully interconnected subgraph (each pair of city municipalities has an edge of weight 1 from co-participation in HungAIRy). This appears as a clique of nodes

(Budapest, Békéscsaba, Eger, etc., and the Herman Ottó Institute) densely connected. Debrecen's node is also part of that sub-network and in fact bridges it to the main cluster. These examples show Debrecen's involvement in broader networks and EU collaborations, which is one aspect of its strategy to gain knowledge and funding (as emphasized by the strategy's focus on international relations). However, aside from adding a few extra nodes, these collaborations did not alter the overall centrality hierarchy: Debrecen's city government is still the primary bridge into those networks.

In summary, the network analysis confirms that Debrecen's smart city ecosystem is centrally orchestrated by the local government (consistent with top-down governance) and primarily involves government–business collaborations (consistent with a double-helix model). Academia and civil society actors, while present, play secondary or supporting roles, indicating that the quadruple-helix ideal is not yet realized – an observation in line with similar research on other cities . The implication is that Debrecen could enhance its smart city innovation capacity by more actively engaging the university and citizen groups as equal partners, rather than as occasional contributors.

6.5.4 Multidimensional Project Portfolio: Domains and Integration

One research question was whether Debrecen's smart city development follows a mono-dimensional or an integrated, multidimensional logic. Our findings show that Debrecen's approach is relatively broad and multi-domain, albeit with some domains emphasized over others. Every one of the six major smart city domains is represented in the project portfolio . Figure 32 (below) summarizes the distribution of initiatives across these domains:

- **Smart Environment**: 38 projects (about 33% of the total), making it the largest category. This includes initiatives related to sustainable energy, climate action, green infrastructure, and environmental monitoring. The high count is partly due to the city's focus on energy efficiency (e.g., building retrofits, solar panel installations, electric garbage trucks) and participation in national programs like the climate strategy and the "Zöld Busz" (Green Bus) Program for low-emission buses.
- **Smart Living**: 25 projects (~22%). These involve projects aimed at improving quality of life, healthcare, culture, and community well-being. Examples are the modernization of cultural institutions (e.g., smart library systems with QR code

info kiosks , community-supported agriculture like “Debrecen Szatyor” local produce initiative), and various e-health or safety pilots. Smart Living overlaps with social aspects and often includes some citizen engagement.

- **Smart Mobility**: 25 projects (~18%). Debrecen’s strong focus on mobility is evident – projects range from intelligent traffic systems and traffic data platforms (e.g., using Waze data for traffic management), to promoting cycling (smart bike storage, “Bike to Work” campaigns), to the aforementioned electric buses and charging infrastructure. Mobility initiatives tend to be tech-heavy (sensors, IoT, vehicles) but some also have behavioural components (campaigns to encourage cycling).
- **Smart Society/People**: 13 projects (~12%). These are initiatives cantered on human capital, education, inclusion, and community. Debrecen’s examples include digital skills education (Logiscool coding school for kids), talent programs, and efforts to involve citizens in co-creating solutions. While smaller in number, such projects indicate attention to the “people” aspect of smart cities.
- **Smart Governance**: 12 projects (~10%). This domain covers e-government services, transparency, and data-driven governance. Debrecen launched an open data portal and internal IT developments for city management and hosted Smart City forums. The relatively lower count here might reflect that governance improvements often happen as part of broader projects rather than standalone (for example, integrating city systems with national e-administration platforms).
- **Smart Economy**: 7 projects (~6%). This domain has the fewest entries, encompassing initiatives that directly aim to boost innovation, startups, and the digital economy. Debrecen’s efforts in this area include the Startup Debrecen program (Startup Round Table events , incubator support) and collaborations with large employers (like the NI mentoring program, which also touches education). The low count is partly because many economy-related benefits (like attracting investment, job creation) are seen as outcomes of other smart projects (mobility, digital infrastructure) rather than separate “economic” projects.

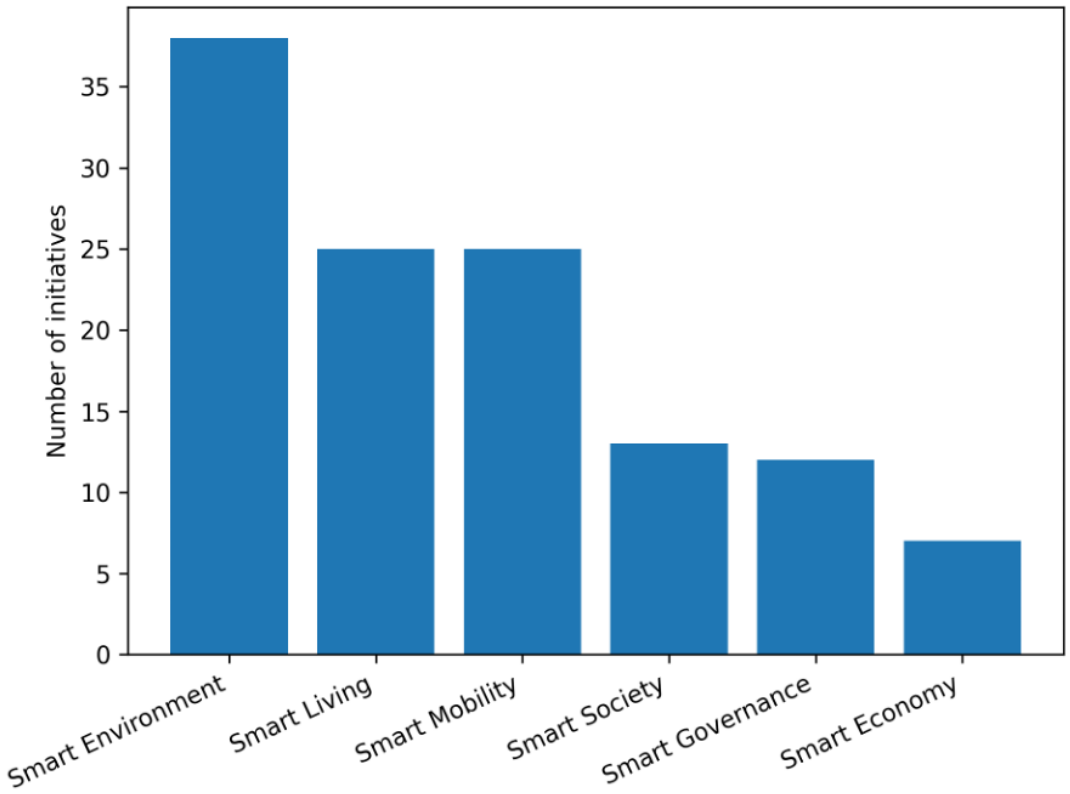


Figure 32 Debrecen smart city initiatives by domain

Smart Environment projects constitute about one-third of all initiatives, followed by Smart Living (~22%) and Smart Mobility (~18%). Smart Society (~12%), Governance (~10%), and Economy (~6%) are less represented

This domain distribution suggests that Debrecen's strategy is indeed multidimensional – not confined to a single aspect like IT or transport, but tackling a range of urban challenges (transport, environment, social, etc.). In that sense, the city exhibits an integrated logic at least in scope: it is addressing multiple "smarts" concurrently rather than, say, only pursuing a tech-city image or only focusing on green energy. Debrecen's objective tree explicitly aimed to link mobility, energy, and digital development to overall quality of life , and the data shows concrete projects in each area supporting that.

However, integration can also be interpreted as cross-sectoral integration – how well do these domains and projects interrelate in a unified strategy? On that front, Debrecen has taken some steps, such as ensuring horizontal principles (citizen inclusion, data use) are applied across domains . For example, many mobility projects have an environmental angle (reducing air pollution, which ties to environment goals), and digital projects like open data support governance and economic innovation. Some projects explicitly span domains: the "Debreceniek Háza" project (House of Debreceners) was a complex

initiative combining smart living, community space, and digital services in one new urban facility . Another example is the climate action plan which, though classified under environment, involved society and governance aspects (public awareness, inter-agency planning). These indicate efforts at integrated planning.

Nonetheless, the existence of separate domain silos (with environment getting a lot of standalone projects, for instance) also suggests that many initiatives were handled within their sectoral domain primarily. Debrecen's focus areas (mobility, energy, digital) could potentially lead to silos if not coordinated – the strategy's inclusion of cross-domain "Data-Driven Decision Making" and "Cooperation Opportunities" hints at an intent to integrate them . Our observation is that integration is partial: Debrecen achieved breadth by covering all domains and did have some unifying frameworks (like the Smart City Strategy itself, and a central coordination by EDC), but on-the-ground projects often remained within one domain's purview. For example, mobility projects were largely implemented by the transport company and city transport department, while energy projects were handled by the city energy agency and utilities, etc., with less interaction between those groups except at the high level of strategy monitoring.

A lot of technological activities in various domains, but fewer integrative, participatory planning activities tying them together . Debrecen seems to mirror that: technology deployment in multiple domains is evident (a positive for multi-dimensionality), yet a holistic integration – in terms of truly blending tech, governance, and social innovation – remains limited (as discussed, the approach is more tech-led than socio-technical). We categorize Debrecen's logic as integrated in breadth but not deeply holistic in process. It is not "mono-dimensional" because it does not focus on just one urban system; it clearly acknowledges the interplay of several (transport, energy, etc.). But it also doesn't fully realize a holistic integration where solutions are co-designed with citizens across domains – that would require stronger quadruple-helix engagement and strategic coherence beyond individual projects.

6.5.5 Application-domain profiles

The dataset distinguishes "Services and Applications" initiatives (Category C) and assigns them to one or more application domains (C.01–C.12). In Debrecen, 98 of 120 initiatives (81.7%) are coded as Category C, and application domains are non-mutually exclusive (i.e., a single initiative may cover multiple C.01–C.12 domains). Across the 98 Category C initiatives, the most frequently addressed application domains are C.06

Buildings and districts (36 initiatives; 36.7%) and C.05 Mobility and transport (28; 28.6%), indicating that Debrecen's smart city service portfolio is strongly anchored in the built environment and urban mobility systems. A second tier of application domains includes C.08 Cultural heritage (17; 17.3%), C.07 Health and Social Inclusion (14; 14.3%), and C.09 Education (11; 11.2%), pointing to a meaningful, though smaller set of initiatives that extend smart city services into cultural, social, and human-capital fields. Safety- and administration-related services appear at moderate levels (C.10 Public safety and security: 8; 8.2%, C.11 E-government: 6; 6.1%). In contrast, environment-monitoring and utilities-related application services are relatively less prevalent (C.01 Energy networks: 6; 6.1%, C.02 Air: 4; 4.1%, C.03 Water: 3; 3.1%, C.04 Waste: 4; 4.1%, C.12 Other: 3; 3.1%). Overall, the C.01–C.12 distribution suggests that Debrecen's service/application layer is dominated by place-based operational domains (buildings/districts and transport), while environmental applications (air/water/waste) are present but constitute a smaller share of digitally delivered smart services in the portfolio.

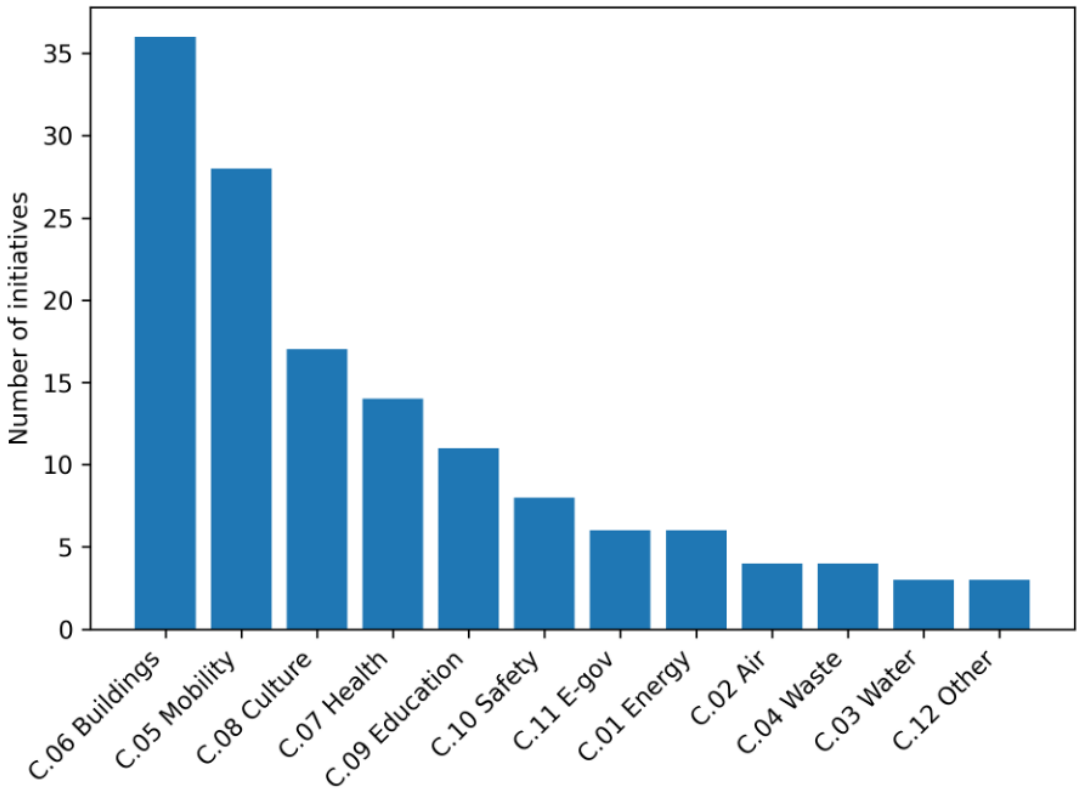


Figure 33 Debrecen Category C ("Services and Applications") initiatives by application domain (C.01–C.12).

Counts and percentages are calculated over Category C initiatives (n = 98). Application-domain coding is non-mutually exclusive

6.5.6 Spatial scale of initiatives (City, District, Building, Home)

Spatial coding indicates that Debrecen's initiatives are primarily oriented toward public-space and city-system scales, again with non-mutually exclusive assignments. Out of 120 initiatives, 61 (50.8%) are coded as city-level interventions, 45 (37.5%) as district-level, and 37 (30.8%) as building-level. Only 1 initiative (0.8%) targets the home/household scale, implying that Debrecen's smart city development is largely implemented through municipal infrastructure, public services, and institutional sites rather than consumer-facing "smart home" deployments. In terms of multi-scalar design, 100 initiatives (83.3%) operate at exactly one spatial level, while 16 (13.3%) span two levels and 4 (3.3%) span three levels. The most common single-scale patterns are city-only (45 initiatives; 37.5%), building-only (29; 24.2%), and district-only (26; 21.7%), whereas cross-scale initiatives most frequently combine city + district (12; 10.0%). This profile indicates that Debrecen's smart city portfolio is dominated by single-scale interventions with selective multi-scalar integration, and that integration, when present, tends to connect city systems and districts rather than extending down to household-level applications.

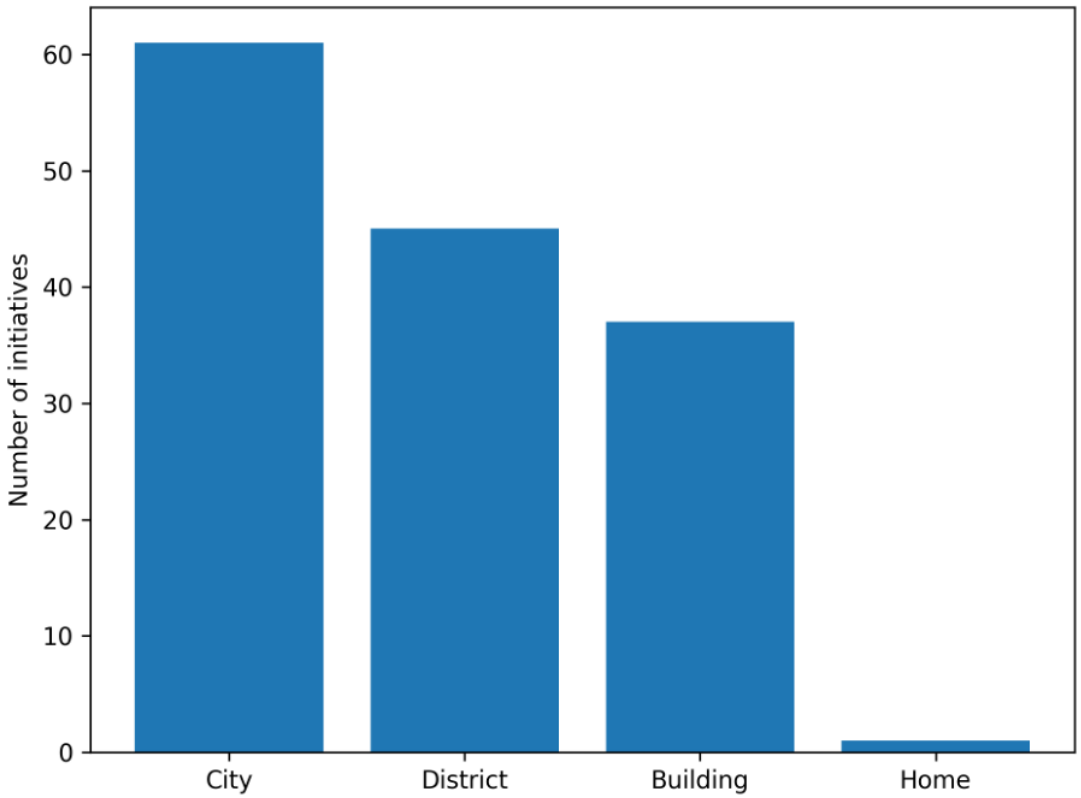


Figure 34 Debrecen smart city initiatives by spatial level (n = 120).[10]

In conclusion, Debrecen's smart city development can be summarized along the four dichotomy dimensions as follows:

- **Tech-driven vs Holistic**: Largely tech-driven, with extensive ICT and smart infrastructure deployments, and only moderate holistic/community-oriented support. Debrecen is closer to the "technology-led" end of this spectrum , although it has some holistic intentions in strategy.
- **Top-down vs Bottom-up**: Predominantly top-down. The city leads the way on almost all initiatives, confirming Hypothesis 2.1 (top-down governance) . Bottom-up initiatives exist but have not significantly shaped the overall strategy.
- **Double-helix vs Quadruple-helix**: Effectively double-helix. Government and industry partnership is the backbone, while academic and civil actors are marginal. Thus, Debrecen's collaboration model is not fully inclusive (quadruple) but rather focused on the traditional public-private axis .

[10] Spatial coding is non-mutually exclusive; a single initiative may be assigned to multiple spatial levels.

- **Mono-dimensional vs Integrated**: Debrecen leans integrated in terms of addressing multiple smart city dimensions simultaneously (no single-dimension focus). However, the integration is more at the strategic level (covering various domains) than in each project's implementation. We place Debrecen closer to the "integrated" hypothesis (H4.2) in intent, given its spread of domains and horizontal principles, but with room for stronger cross-domain synergy.

These results provide a nuanced picture of Debrecen's strategic governance logic in its smart city journey. We next discuss what these findings imply for medium-sized cities and how Debrecen's approach compares to broader trends.

6.6 Discussion

Debrecen's smart city development illustrates a governance pathway that is increasingly common among medium-sized European cities: a broad, multi-domain portfolio delivered through centrally coordinated, technology-led projects and predominantly public–private collaboration. By combining project-level coding with stakeholder network analysis, this study makes visible not only "what" a city implements (domains, applications, spatial scale), but also "how" it is governed (who initiates, who collaborates, and which actors remain peripheral). The discussion interprets these patterns through the four dichotomies applied in the Results and highlights implications for medium-sized cities operating under capacity constraints and strong dependence on external programmes and procurement-led implementation.

1. Technology-led modernization and the "public value gap"

The portfolio shows a pronounced emphasis on services/applications and digital infrastructure relative to community-building and strategic framework activities. This aligns with a modernization logic in which smart city progress is measured through deployable systems - traffic management, smart mobility assets, public Wi-Fi, digitized services - rather than through institutional and social innovation. Such an orientation can deliver tangible operational benefits, particularly in mobility and the built environment, where Debrecen's application profile is strongest (e.g., buildings/districts and mobility/transport as dominant application areas). However, the smart city literature has repeatedly warned that technology-driven approaches can produce a "smartness" that is highly visible but weakly anchored in citizen capabilities, inclusion, and public value

creation (e.g., the critique of techno-centric smart city narratives in Hollands, 2008 (Hollands, 2008)).

In Debrecen, the imbalance is not that community-oriented initiatives are absent; rather, they appear as a secondary layer that rarely drives the direction of technological investments. This is where the risk of a public value gap emerges: if engagement, digital inclusion, and problem framing are not integrated upstream, cities may experience low adoption rates, uneven distribution of benefits, and limited legitimacy - especially for data-driven solutions that touch mobility behaviour, public space, and service access. For medium-sized cities, this gap can be narrowed without abandoning technological modernization by treating community-building as an enabling infrastructure. Concretely, this can include (i) embedding co-design into pilot phases, (ii) integrating digital inclusion measures into service rollouts (targeted training and support for vulnerable groups), and (iii) instituting routine post-implementation evaluation focused on user uptake and distributional outcomes rather than only technical deployment. Living-lab approaches are particularly relevant here, because they create a structured channel for iterative feedback between city systems and everyday use contexts (Nguyen et al., 2022).

2. Municipal centrality: capacity, coherence, and the participation trade-off

Debrecen's governance mode is predominantly top-down: the municipality appears as an implementing partner in the overwhelming majority of initiatives and occupies the central hub position in the stakeholder network. In a medium-sized city, such centrality can be understood as a capacity-substitution mechanism. When administrative and analytical resources are limited, strong municipal steering can ensure coherence, secure external funding, and reduce fragmentation across departments and contractors. The presence of a development agency functioning as a key intermediary further supports this orchestration by translating strategic priorities into implementable projects and managing partner relations.

At the same time, central steering brings a well-known participation trade-off. A portfolio dominated by municipally initiated projects risks crowding out bottom-up experimentation and narrowing the problem agenda to what fits procurement procedures, programme requirements, and institutional routines. Over time, this may reduce the city's sensitivity to "street-level" problems and limit the diversity of solutions entering the pipeline. The governance literature suggests that citizen engagement is not simply normative; it can also improve solution fit, legitimacy, and long-term sustainability of

smart city interventions (Meijer and Bolivar, 2016; Ruhlandt, 2018). A practical way forward is not to "replace" top-down governance, but to add structured bottom-up channels that are compatible with municipal coordination. These can include open innovation calls, civic challenge programmes, participatory budgeting for small-scale digital projects, and formal pathways for civic tech groups to propose prototypes for municipal adoption. The key is designing these channels as recurring mechanisms rather than one-off events, thereby allowing bottom-up contributions to accumulate into an innovation stream that complements the core municipal portfolio.

3. From double-helix default to quadruple-helix capacity building

The stakeholder network confirms a collaboration model dominated by government–industry ties, with academia and civil society present but peripheral. This pattern is consistent with a broader tendency for smart city delivery to default to public–private partnership arrangements, which can be effective for deployment but may also reinforce vendor-driven solutionism and reduce openness (Quan and Solheim, 2023; Voorwinden, 2021). The limited participation of the knowledge sector and civic actors is consequential because, in quadruple-helix terms, these groups often provide the capabilities needed for (i) data analysis and evaluation, (ii) experimentation and learning, and (iii) legitimacy through co-creation and public deliberation (Borghys et al., 2020; Carayannis et al., 2022).

Debrecen's configuration suggests that the city's collaborative capacity currently relies more on contractual delivery than on knowledge co-production. Strengthening quadruple-helix engagement does not require radical institutional change; it can be approached through "boundary infrastructures" that make collaboration routine and resource-efficient. Examples include: (i) a city–university data lab that supports analytics, evaluation, and open-data use cases; (ii) a campus or district living lab where pilots can be tested in real conditions with structured feedback loops; and (iii) a standing citizen panel or deliberative forum linked to the smart city portfolio, ensuring that social priorities and concerns (e.g., privacy, accessibility, equity) are systematically represented. Such mechanisms can shift academia and civil society from occasional partners to recurring contributors, improving both innovation quality and legitimacy.

4. Integration by coverage versus integration by coupling

A key finding is that Debrecen is not mono-dimensional: initiatives span all six smart city domains, with particularly strong activity in environment, mobility, and living. This

supports the claim of an integrated development logic in terms of portfolio breadth. However, the spatial and application profiles also suggest that integration is often achieved by parallel domain pipelines rather than by deeply coupled cross-sector solutions. Most initiatives operate at a single spatial level (city, district, or building), and household-scale interventions are nearly absent. This reinforces an interpretation of "public-space and asset-based smartness", where integration is framed through municipal infrastructure and institutional sites rather than through demand-side adoption and everyday behavioural change.

For medium-sized cities, the challenge is to move from integration-by-coverage (multiple domains represented) to integration-by-design (projects explicitly structured to deliver multi-domain outcomes). A practical route is to establish cross-departmental programme governance (a joint steering group for mobility–energy–digital themes) and a shared measurement framework that evaluates projects against integrated outcomes (e.g., mobility efficiency + emissions + inclusion). Another high-leverage step is connecting digital governance tools (open data, dashboards, shared platforms) to operational domains (transport, buildings, environment) so that data becomes a coordinating mechanism rather than a standalone initiative. Where possible, designing projects to "stack" benefits across domains, e.g., energy-efficient buildings linked to indoor health outcomes and social inclusion programming, can deliver higher returns on investment and strengthen the argument that smart city initiatives address public value rather than only technological novelty.

5. Implications for medium-sized cities and for smart city governance theory

Two broader implications follow. First, Debrecen supports the argument that medium-sized cities can build wide smart city portfolios even under constrained capacity, especially when municipal leadership is strong and external programmes are effectively leveraged. Second, the case illustrates that the four dichotomies are not independent. In Debrecen, strong top-down steering appears compatible with multi-domain coverage, but it coincides with a technology-led orientation and a narrow (double-helix) collaboration structure. This suggests a governance "bundle" in which orchestration enables scale and coherence but can also reduce participatory depth and knowledge-sector integration.

From a theoretical standpoint, the study reinforces the usefulness of dichotomies as a diagnostic lens, while also showing the value of adding network structure to the analysis. The network reveals not just actor categories but relational positions, especially the role

of intermediary organizations that connect municipal priorities with external partners. For comparative research, this points to a promising analytical direction: examining how the presence (or absence) of boundary organizations and recurring co-creation mechanisms mediates the relationship between top-down governance and inclusive, holistic smart city outcomes.

6.7 Limitations and future research directions

Several limitations should be noted. First, the initiative dataset was compiled from municipal documentation, strategy materials, press releases, and stakeholder inputs; this approach may under-represent informal, short-lived, or purely grassroots initiatives that leave limited documentary traces. Second, the operationalization of top-down versus bottom-up governance relies on municipal involvement as a proxy, which simplifies mixed governance arrangements where co-creation may occur even with municipal participation. Third, network ties are derived from co-participation in projects and do not capture the quality, intensity, or direction of collaboration (e.g., contractual delivery versus genuine co-production). Finally, the analysis is primarily diagnostic and descriptive; it identifies governance patterns but does not establish causal relationships between governance configurations and measurable urban outcomes.

Future research can build on this by (i) comparing multiple medium-sized cities to test whether the "orchestrated, domain-broad, helix-narrow" bundle recurs across contexts; (ii) incorporating longitudinal network analysis to examine how collaboration structures evolve over time; and (iii) integrating outcome metrics and citizen perspectives (surveys, interviews, usage analytics) to evaluate how governance modes translate into adoption, equity, and sustainability impacts.

6.8 Conclusions

This paper assessed Debrecen's smart city development through a project-level diagnostic of four strategic governance dichotomies and a stakeholder collaboration network derived from co-participation in initiatives. The evidence indicates that Debrecen's smart city trajectory is predominantly technology-led, municipally orchestrated, and grounded in government–industry collaboration, while simultaneously achieving broad coverage across smart city domains.

Three empirical conclusions stand out. First, the activity portfolio emphasizes deployable technologies and infrastructure over community-building and institutional innovation, suggesting that "smartness" is pursued primarily through modernization of services, mobility systems, and the built environment. Second, municipal leadership is structurally central: the municipality and its affiliated organizations function as the main coordinators linking diverse partners, which supports coherence and implementation capacity but limits bottom-up agenda-setting. Third, the collaboration model approximates a double-helix configuration, with academia and civil society playing secondary and often project-specific roles rather than serving as sustained co-producers of knowledge and legitimacy.

The study contributes to smart city scholarship in three ways. It expands the empirical evidence base beyond capital-city and flagship-city bias by providing a systematic account of a medium-sized Central European city. It demonstrates a replicable mixed-method approach that combines dichotomy-based coding with network analysis to map both project characteristics and governance structure. Finally, it highlights how governance bundles can emerge in medium-sized cities: top-down steering can support multi-domain breadth, while simultaneously reinforce technology-led priorities and limit quadruple-helix inclusiveness.

For policy and practice in Debrecen and similar medium-sized cities, the findings suggest four actionable priorities for the next phase of smart city development: (i) institutionalize participatory mechanisms that complement municipal steering (e.g., recurring open innovation calls, small-scale civic digital grants, or deliberative panels); (ii) build durable quadruple-helix capacity through boundary infrastructures such as a city–university data lab and living-lab sites; (iii) shift from integration-by-coverage to integration-by-design by aligning projects to shared cross-domain outcomes and cross-departmental governance; and (iv) strengthen evaluation by systematically measuring adoption, equity, and public value outcomes alongside technical performance.

Overall, Debrecen demonstrates that medium-sized cities can implement ambitious and multi-domain smart city programmes through strong coordination and public–private partnerships. Sustaining and deepening these achievements, however, will likely depend on increasing participatory depth and knowledge-sector engagement so that smart city investments deliver not only technological modernization but also inclusive and widely shared urban benefits.

6.9 Chapter takeaway for the dissertation argument

This chapter advances the dissertation argument by providing the most integrated empirical demonstration of how smart city development unfolds in practice in a medium-sized Central European city. While the preceding chapters each developed one major dimension of the overall research problem, this study brings those dimensions together in a single case. Chapter 2 identified the structural barriers hindering smart city development in medium-sized cities. Chapter 3 showed that organizational design and collaborative capacity are central to whether such barriers can be addressed. Chapter 4 demonstrated that smart city development also differs according to the value propositions embedded in cities' activity portfolios. Chapter 5 then operationalized the strategic dichotomy framework in the Budapest case. The present chapter extends that trajectory by combining strategic diagnosis with stakeholder-network analysis in Debrecen, thereby offering the dissertation's strongest empirical synthesis of context, governance, implementation, and actor structure.

At the dissertation level, the chapter's main contribution is that it demonstrates how the smart city trajectory of a medium-sized city can be understood as a **governance bundle** rather than as a loose collection of projects. The study shows that Debrecen's development path is characterized by a predominantly technology-driven orientation, strong top-down coordination, a collaboration model centred mainly on government and industry, and broad project coverage across smart city domains. These findings are analytically important because they show that medium-sized-city smartness is not reducible either to infrastructural modernization or to simple institutional weakness. Instead, Debrecen illustrates that a city may achieve considerable breadth and strategic coherence in its smart city activities through strong municipal orchestration, while still relying on a relatively selective governance structure in which broader quadruple-helix participation remains limited. This is one of the dissertation's central cumulative insights: smart city development may be broad and active without necessarily being participatory or deeply inclusive in governance terms.

This finding matters because it sharpens the dissertation's wider argument about the relationship between **integration** and **inclusiveness**. Earlier chapters already suggested that these should not be conflated. Chapter 4 showed that cities differ in the anticipated benefits embedded in their activity portfolios, while Chapter 5 demonstrated that a city such as Budapest may appear relatively integrated across domains while remaining more

selective in governance and stakeholder participation. The Debrecen case confirms and deepens this point. The chapter shows that integration at the level of project coverage can coexist with a governance model dominated by municipal leadership and a narrower set of central actors. In dissertation terms, this is a crucial contribution because it moves the argument beyond the assumption that smart city maturity necessarily implies broad collaborative inclusion. The Debrecen case instead suggests that, in medium-sized cities, the pathway to smart development may be shaped by a distinct trade-off: stronger central coordination may support implementation breadth and strategic coherence, yet at the cost of weaker participatory depth and narrower stakeholder pluralism.

The chapter also contributes decisively to the dissertation's **medium-sized-city focus**. One of the dissertation's main premises has been that medium-sized cities deserve specific analytical attention because they represent a typical European urban condition, but are often overshadowed in the literature by capitals and flagship smart city leaders. The Debrecen study operationalizes that claim empirically. It shows that medium-sized cities are not merely constrained or lagging versions of larger cities. Rather, they may develop distinctive governance arrangements that reflect their scale, administrative structure, development history, and resource environment. Debrecen's smart city governance appears shaped by a strong municipal centre, selective but effective public–private collaboration, and project portfolios that span multiple domains. This confirms the dissertation's broader contention that medium-sized cities should be studied in their own right, because they reveal smart city dynamics under conditions that are more ordinary, and in many respects more policy-relevant, than the exceptional settings of global flagship cities.

A further major contribution of the chapter is methodological. It extends the dichotomous strategic framework used in Chapter 5 by embedding it in a **stakeholder-network perspective**. This matters greatly for the dissertation as a whole. Earlier chapters argued that governance and organizational design are central to how smart city development is translated into practice. The Debrecen chapter makes this claim empirically observable by moving from actor categories and strategic labels to the relational structure of collaboration itself. Through the project-based network analysis, the chapter identifies which actors are central, which organizations bridge across domains, and how the governance ecosystem is structured around municipal leadership and selected partners. This is a substantial advance in the dissertation argument because it shows that

governance is not just a matter of formal strategy or institutional rhetoric. It is also a matter of relational architecture. The chapter therefore strengthens the dissertation's claim that stakeholder networks are not peripheral to smart city development, but part of its explanatory core.

This relational perspective also helps reinterpret the findings of the earlier chapters. Chapter 2 identified vendor dependence, knowledge gaps, and institutional asymmetries as barriers of smart city development in medium-sized cities. Chapter 3 showed that urban digitalization is often hindered by closed organizational forms, weak collaboration, and fragmented coordination. In the Debrecen case, these problems do not disappear, but they become more concretely structured. The stakeholder-network analysis suggests how knowledge, influence, and coordination may become concentrated in a narrower set of actors, even within a broad smart city portfolio. This gives the dissertation a more refined explanatory language. Rather than speaking in general terms about governance problems, it becomes possible to show how such problems are embedded in actual patterns of collaboration, centrality, and actor positioning. Debrecen thus functions as the chapter in which several earlier theoretical claims are transformed into concrete relational findings.

The chapter is also highly significant because it strengthens the dissertation's claim that smart city development should be understood as a **trajectory** rather than a status. Debrecen is not portrayed as either fully smart or not smart. Instead, the chapter shows that its smart city development is taking shape through a specific combination of strategic and organizational features: technology-oriented modernization, strong municipal guidance, broad multi-domain activity, and relatively selective collaboration patterns. This is precisely the kind of patterned development trajectory the dissertation set out to identify. The contribution of the chapter is therefore not to classify Debrecen normatively, but to explain the logic of its ongoing smart city formation. In doing so, it gives the dissertation one of its most concrete answers to the overarching research question of how cities become smart in practice.

Another important dissertation-level contribution of this study is that it clarifies the relationship between **public value ambitions** and **governance capacity**. Chapter 4 showed that city portfolios can be read through the anticipated benefits they embed. The Debrecen chapter adds that the realization of such value propositions depends on who is structurally positioned to define priorities and deliver projects. A city may pursue broad domain coverage and visible technological modernization, but the extent to which this

translates into wider civic inclusion, knowledge-sharing, or participatory benefit depends on the governance network through which projects are organized. This reinforces a core dissertation claim: smart city development cannot be evaluated by project quantity or technological sophistication alone. It must be assessed through the interaction of portfolio breadth, strategic logic, and governance architecture.

In the structure of the dissertation, this chapter therefore serves as the **empirical culmination** of the article portfolio. It does not replace the contributions of the earlier studies, but gathers many of their strands into one case. From Chapter 2 it inherits the medium-sized-city problem orientation. From Chapter 3 it carries forward the focus on governance and organizational design. From Chapter 4 it retains sensitivity to the significance of actual project portfolios. From Chapter 5 it adopts and extends the dichotomous strategic framework. Its distinctive added value is that it combines all of these with stakeholder-network analysis, thereby giving the dissertation its most complete empirical account of how a city's smart development is structured.

The link to the next chapter is therefore straightforward but important. Chapter 7, the integrative conclusion, will move from the findings of the individual studies back to the dissertation level. The Debrecen chapter provides especially strong material for that synthesis because it concentrates many of the dissertation's major themes in one place. The final chapter can now compare the barrier environment identified in Chapter 2, the organizational implications developed in Chapter 3, the value-proposition logic explored in Chapter 4, the Budapest strategic diagnosis in Chapter 5, and the Debrecen governance-network findings presented here. In this way, the transition from Chapter 6 to Chapter 7 is not simply the move from one more case to a conclusion. It is the move from the dissertation's most comprehensive empirical demonstration to its final theoretical and integrative synthesis.

In sum, this chapter advances the dissertation argument in four main ways. First, it demonstrates that the smart city trajectory of a medium-sized city can be explained through a combined analysis of strategic dichotomies and stakeholder networks. Second, it shows that broad activity portfolios may coexist with relatively selective governance structures, thereby distinguishing integration from inclusiveness. Third, it provides the dissertation's strongest empirical support for treating medium-sized cities as analytically important cases in their own right. Fourth, it functions as the culminating bridge to the final chapter by concentrating the dissertation's central concerns, context, strategy,

governance, organization, portfolio structure, and stakeholder relations, into one integrated case. Its main contribution is therefore to show, in the clearest empirical form within the dissertation, how cities become smart in practice through the interaction of strategic choices and governance structures rather than through technology alone.

7. Integrative Conclusion

7.1 Synthesis of results across the five studies

Taken together, the five studies show that cities do not become smart primarily by acquiring advanced technologies, adopting the smart city label, or accumulating a visible portfolio of digital projects. Rather, the dissertation demonstrates that smart city development is a context-dependent and governance-mediated transition process in which structural conditions, strategic orientation, organizational design, and stakeholder configuration jointly shape what kinds of smart urban development become possible in practice. This is the central integrated answer to the dissertation's overarching research question: **cities, especially medium-sized and Central and Eastern European cities, become smart through the interaction of contextual constraints, strategic choices, governance arrangements, and implementation portfolios, not through technology alone.**

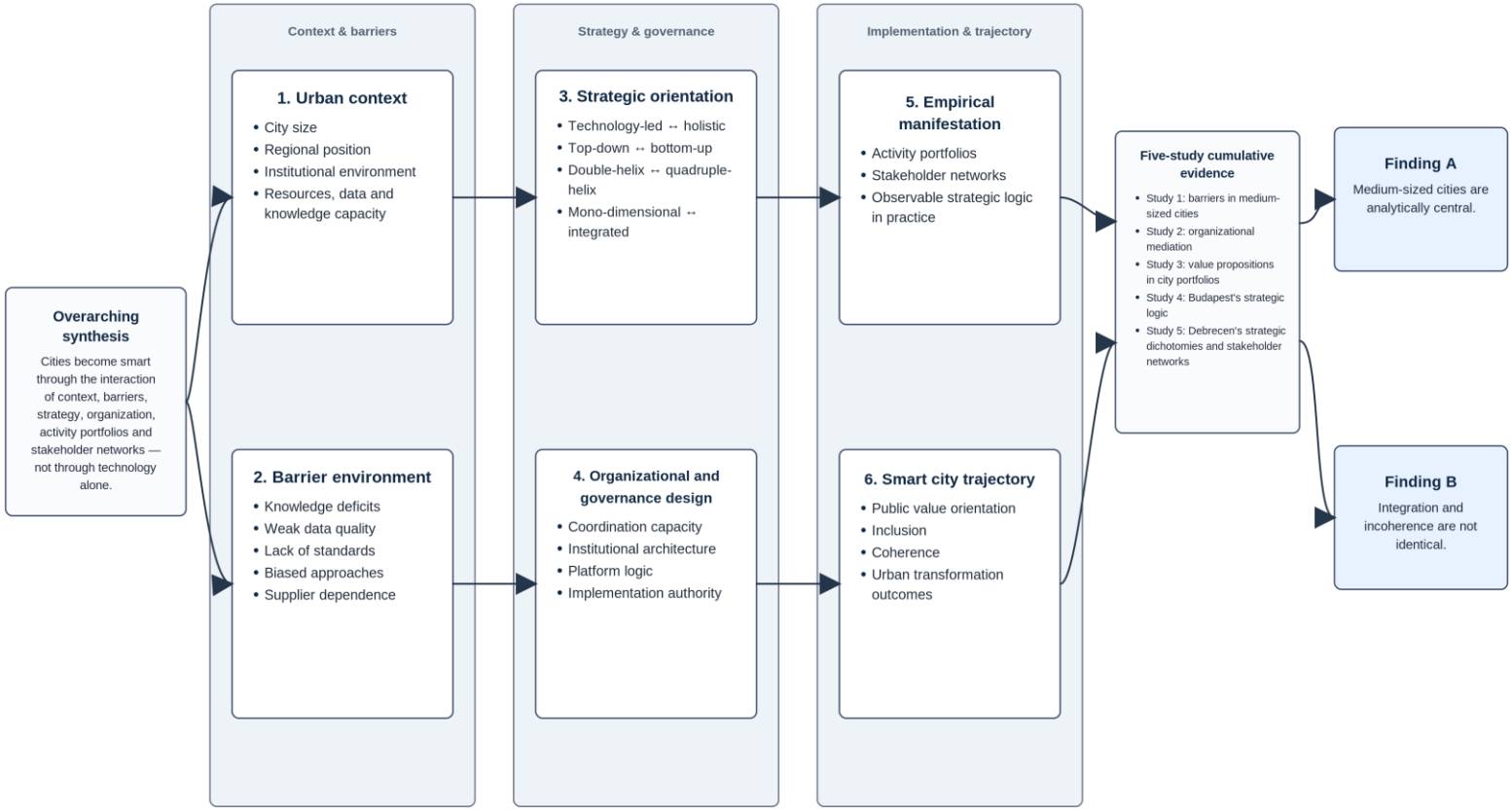


Figure 35 Integrated layers of the dissertation's results[11]

[11] The figure summarizes the cumulative explanatory logic developed across the five studies, showing how urban context and barri
responses, which become visible in activity portfolios and stakeholder networks and ultimately produce distinct smart city develop
outcomes.

The first layer of this answer concerns the **conditions under which smart city development starts and unfolds**. The opening study on medium-sized cities shows that smart city transition is hindered by a set of structural barriers that are only partly technological. Knowledge deficits, weak data quality, lack of standards, biased approaches, and dependence on large external suppliers all constrain the strategic room for manoeuvre of cities that seek to develop smart urban solutions. The significance of this finding at dissertation level is that it shifts the explanatory focus away from the availability of digital tools toward the institutional and strategic environment in which cities operate. Medium-sized cities do not begin the smart transition from a neutral baseline; they enter it under asymmetric conditions that shape both what they can do and what kinds of models are likely to be imposed on them. This establishes the dissertation's first major proposition: smart city development is conditioned by a barrier environment that is especially visible in medium-sized urban settings.

The second layer of the integrated answer concerns the **organizational mechanisms through which such barriers are either reproduced or mitigated**. The second study shows that many of the recurring problems of smart city development are embedded in conventional organizational models themselves. Public-sector silos, weak coordination mechanisms, closed organizational design, underperforming collaborative arrangements, and the difficulty of managing heterogeneous actors all make smart city transition harder to realize. The study's contribution to the synthesis is decisive: it demonstrates that the smart city is not only a matter of strategy or technological adoption, but also of organizational architecture. If the first study identifies the problem environment, the second shows why that environment remains difficult to overcome even when cities attempt to act. At the same time, it offers a constructive dissertation-level implication through the SmartCEPS platform logic: more open, collaborative, and platform-based organizational forms are better suited to support urban digitalization under conditions of sociotechnical complexity. The dissertation therefore advances a second core proposition: organizational design is a central mediator between smart city ambition and smart city implementation.

The third layer concerns the **substantive direction of smart city development**, that is, what cities actually seek to achieve through their smart city activities. The comparative portfolio study broadens the dissertation's explanatory model by showing that smart city development is not only constrained differently and organized differently across cities,

but also imagined differently. Cities embed different anticipated benefits into their activity portfolios, including efficiency, stakeholder engagement, quality of life, inclusion, connectivity, knowledge creation, cost reduction, scalability, and environmental sustainability. This is important for the overall synthesis because it clarifies that smart city development is not a single pathway with a uniform endpoint. Different cities pursue different value configurations, and these value propositions are visible in the composition of actual project portfolios rather than only in abstract strategy documents. In dissertation terms, this means that the meaning of smartness must be reconstructed empirically from what cities do, not simply inferred from how they describe themselves. The third proposition of the dissertation is therefore that smart city development is a differentiated public-value trajectory, and activity portfolios are one of its clearest empirical expressions.

The fourth and fifth studies then bring these earlier insights into **structured city-level diagnosis** in the Hungarian and Central European context. The Budapest study shows that a city may have a broad and active smart city portfolio while still displaying a relatively technology-led, partly top-down, and predominantly double-helix collaborative orientation. Just as importantly, the study shows that framework conditions for implementation, such as organizational authority, management capacity, and cooperation platforms, may remain underdeveloped even where visible smart city activity exists. This adds a crucial synthesis point: a city's smartness cannot be inferred from the existence of projects alone. It must be interpreted through the strategic and governance principles that organize those projects. The Budapest case thus confirms the relevance of the dissertation's earlier findings: the barrier environment and organizational weaknesses identified in the first two studies are not abstract concerns, but recur concretely in a city-level strategic trajectory.

The Debrecen study then provides the dissertation's most integrated empirical answer. It shows that a medium-sized Central European city can build a broad and ambitious smart city programme through strong municipal orchestration and public–private collaboration, while remaining predominantly technology-led, top-down, and relatively narrow in helix composition. The stakeholder-network analysis deepens the dissertation substantially because it reveals that smart city governance is not just a matter of declared strategy, but also of relational structure: who is central, who bridges, and who remains peripheral in the ecosystem affects how smart city development is realized. Debrecen's case

demonstrates that multi-domain breadth and implementation coherence can coexist with limited participatory depth and weaker knowledge-sector inclusion. This is a highly important synthesis finding, because it resolves one of the dissertation's core concerns: **integration and inclusiveness are not the same thing**. A city may be integrated in the sense of covering many domains and coordinating many projects, while still remaining governance-wise selective and collaboration-wise narrow

Across the five studies, a common explanatory pattern emerges. Smart city development can be understood as a sequence and interaction of six elements. First, cities face a specific **urban context**, including city size, regional position, institutional environment, resource endowment, and data and knowledge capacity. Second, this context shapes the **barriers and enabling conditions** of smart city transition. Third, cities respond through a particular **strategic orientation**, which may be more technology-led or holistic, more top-down or bottom-up, more double-helix or quadruple-helix, and more mono-dimensional or integrated. Fourth, this orientation is operationalized through a particular **organizational and governance design**, which may either support or hinder collaborative and adaptive implementation. Fifth, the resulting logic becomes visible in the city's **activity portfolio** and **stakeholder network**. Sixth, these together produce a distinct **smart city development trajectory**, with particular implications for public value, inclusion, and urban transformation. This synthesized explanatory chain directly reflects the integrative conceptual framework proposed in Chapter 1 and is now empirically substantiated across the article portfolio.

A second major synthesis concerns the role of **medium-sized cities**. The dissertation consistently shows that medium-sized cities are not peripheral to smart city research, but central to it. They are analytically important because they reveal smart city dynamics under more typical European conditions than capital-city and flagship cases. In medium-sized cities, capacity constraints, dependence on external actors, thinner knowledge infrastructures, and stronger sensitivity to organizational design are not secondary variables; they are part of the explanation of why certain strategic and governance models emerge. Debrecen illustrates that strong local orchestration can support breadth and coherence, while the first article shows that medium-sized cities are also especially exposed to knowledge asymmetries, weak standards, and supplier dependence. The dissertation therefore argues that medium-sized cities should not be treated as scaled-

down versions of smart capitals. They constitute a distinct setting in which the strategic and governance logic of smart development is especially visible.

A third synthesis point concerns the **Central and Eastern European and Hungarian context**. The Budapest and Debrecen studies show that the region's relevance lies not simply in geographic underrepresentation, but in the fact that it exposes the dependence of smart city development on institutional capability, strategic coordination, and governance architecture. The Hungarian cases suggest that smart city uptake may remain technology-led and selectively collaborative unless dedicated organizational mechanisms, stronger knowledge-sector engagement, and more durable participatory infrastructures are created. This does not mean that Hungarian cities are uniquely deficient. Rather, it means that the region makes especially visible a general lesson of the dissertation: smart city development is fragile when technological modernization is not matched by institutional and governance development.

The dissertation's integrated answer to the overarching research question can therefore be stated clearly. **Cities become smart in practice when they are able to translate contextual constraints into coherent strategic choices, support those choices through effective organizational and governance arrangements, and realize them in activity portfolios and stakeholder networks that generate publicly meaningful outcomes.** Where this translation is weak, smart city development becomes fragmented, supplier-driven, or rhetorically ambitious but institutionally shallow. Where it is stronger, cities can build broad and coordinated portfolios, although not necessarily fully inclusive ones. The five studies jointly show that the decisive issue is not whether smart city development exists, but what strategic and governance logic it follows, under what conditions, and toward what kinds of public value.

This synthesis also clarifies the dissertation's overall contribution. The article portfolio does not merely document five related smart city topics. It builds a single cumulative argument: **smart city development is best explained as a context-sensitive governance process in which barriers, organizational design, strategic orientation, value propositions, and stakeholder structures interact**. The novelty of the dissertation lies precisely in this integration. It brings together a medium-sized-city perspective, an organizational-design perspective, a portfolio-based value perspective, a dichotomy-based strategy perspective, and a network-governance perspective into one explanatory

framework. For that reason, the five studies collectively provide a stronger answer to the dissertation question than any single article could have produced alone.

7.2 Consistency, differences and interpretation of results

The five studies included in this dissertation produce a broadly consistent overall picture of smart city development, but they do not do so by generating identical findings. Their consistency lies in their shared conclusion that smart city development is shaped by organizational, strategic, and governance conditions rather than by technology alone. Their differences lie in what part of that broader process each study makes most visible. These differences are not contradictions in any simple sense. Rather, they reflect the fact that the dissertation examines a complex and multi-layered phenomenon through different theoretical lenses, methods, empirical settings, and moments of observation. Interpreting these similarities and differences carefully is therefore essential to the dissertation's final contribution.

At the most general level, the findings are highly consistent on one central point: **techno-centric interpretations of the smart city are insufficient**. The first study shows that medium-sized cities are hindered not merely by lack of digital tools, but by knowledge deficits, data problems, weak standards, and supplier dependence. The second study demonstrates that organizational design and collaborative capability are decisive for whether urban digitalization can be realized. The third study reveals that cities differ in the benefit structures embedded in their smart city portfolios, implying that smartness is defined through strategic choices, not only through infrastructures. The Budapest and Debrecen studies both show that the character of smart city development depends on how projects are organized through governance models, actor constellations, and strategic orientations. In this sense, the article portfolio is strongly coherent: across all five studies, the smart city emerges as a socio-technical and governance process rather than as a purely technological condition.

A second area of consistency concerns the importance of **governance and organization as mediating mechanisms**. Even where governance is not the sole explicit focus of a study, it repeatedly appears as a decisive explanatory factor. In the first article, barriers arise partly because cities lack the knowledge, standards, and bargaining position needed to govern smart city development effectively. In the second article, governance becomes explicit in the form of organizational barriers, collaborative design problems, and the need

for platform-based coordination. In the fourth and fifth studies, governance is visible through the top-down versus bottom-up and double- versus quadruple-helix dimensions, and in the Debrecen chapter also through the stakeholder network itself. This repeated appearance of governance across otherwise different studies suggests that governance is not simply one variable among many, but a core integrative dimension of smart city development. That consistency gives strong support to the dissertation's conceptual framework.

At the same time, the studies differ in emphasis, and these differences must be explained rather than smoothed over. One important difference concerns the **level at which the problem of smart city development is observed**. The first article works at the level of medium-sized cities as a category and identifies broad structural barriers. The second article moves to the level of organizational arrangements and proposes an alternative collaborative design. The third article operates comparatively across nine cities and focuses on value propositions within activity portfolios. The fourth and fifth articles then shift to focused city-level diagnosis, first in Budapest and then in Debrecen. These different levels of observation naturally generate different types of results. Barrier-focused studies tend to foreground asymmetries, limitations, and institutional weaknesses. Comparative portfolio studies foreground diversity in strategic benefit orientation. City case studies foreground how strategic and governance patterns become concretely structured. The resulting variation is therefore partly methodological and scalar, not substantive contradiction.

A second difference appears in the relationship between **integration and inclusiveness**. The studies do not always depict these in the same way, but the apparent variation is theoretically meaningful. The comparative portfolio chapter suggests that some cities achieve broad and diverse portfolios that embed multiple benefit types. The Budapest study finds that the city is relatively integrated across urban domains, yet remains more technology-led, partly top-down, and largely double-helix in collaboration. The Debrecen study sharpens this even further: the city shows broad domain coverage and coherent implementation, but its governance network remains strongly centred on municipal and selected public–private actors, with weaker quadruple-helix inclusion. At first glance, one might expect an integrated smart city to also be a highly inclusive one. However, the portfolio shows that this does not necessarily follow. The theoretical implication is that **integration of projects and inclusiveness of governance are analytically distinct**

dimensions. A city may be integrated in what it does, while remaining selective in who participates meaningfully in governing it. This is one of the dissertation's most important reconciliations of seemingly divergent findings.

A third difference concerns the relative balance between **technology-led and holistic development**. The literature often presents these as opposing models, and the dissertation uses that dichotomy as a diagnostic tool. Yet the studies show that cities rarely fall neatly at one extreme. The Budapest and Debrecen analyses both identify predominantly technology-led development, but not in a purely reductionist sense. Both cities also show broader multi-domain activity and some effort toward integrated urban development. Similarly, the organizational design article critiques conventional models for being too fragmented and too weakly adapted to complexity, but does not argue that technology is irrelevant. Rather, it argues that technology must be organizationally and strategically embedded. These differences can be resolved theoretically by recognizing that the dichotomies used in the dissertation are **analytical gradients**, not rigid classifications. Cities occupy mixed positions. They may combine technology-led implementation with broader strategic aspirations, or top-down coordination with some limited forms of participation. The dissertation's findings are consistent once the dichotomies are interpreted as dimensions of tendency rather than mutually exclusive types.

The studies also differ in what they reveal about the role of **medium-sized cities**. The first article emphasizes their vulnerability: weaker capacities, greater supplier dependence, and more fragile knowledge infrastructures make smart city development harder. The Debrecen article, however, shows that a medium-sized city can still develop a broad and relatively coherent smart city portfolio under strong municipal coordination. This is not a contradiction. Rather, it indicates that medium-sized-city status does not determine one fixed outcome. The first article identifies the general risk structure of this urban category. The Debrecen article shows that such risks can be partially overcome under certain governance conditions, though not without trade-offs. Interpreted together, the two findings support a more nuanced dissertation claim: medium-sized cities are structurally constrained, but not condemned to weak or fragmented smart city development. Their trajectories depend strongly on how local governance bundles are assembled.

Another set of differences can be explained by **case selection and empirical purpose**. Budapest and Debrecen are not interchangeable cases. Budapest is a capital city with

greater scale, institutional complexity, and broader strategic exposure, but also with fragmented implementation conditions and weaker supporting organizational infrastructure. Debrecen is smaller, more bounded, and in some respects more governable through centralized municipal coordination. These case differences help explain why Budapest appears relatively integrated in activities but underdeveloped in implementation conditions, while Debrecen appears more coherently orchestrated yet narrower in collaboration structure. The divergence is therefore not primarily theoretical inconsistency, but a function of different urban scale, institutional complexity, and empirical role within the dissertation. Budapest serves as a capital-city diagnostic case in the Hungarian setting; Debrecen serves as the more typical medium-sized-city governance case. Together, they broaden rather than undermine the dissertation's conclusions.

Temporal context also matters. The articles were written and published across several years, and the smart city field itself evolved over that period. The first study reflects an earlier phase in which the absence of standards, the novelty of the field, and the dominance of technology-centred narratives were especially salient. The second study responds to the growing recognition that organizational and collaborative barriers were slowing the realization of smart city promises. The third study reflects a maturing interest in comparing what cities actually pursue through their smart city activities. The later Budapest and Debrecen studies apply more structured strategic and governance frameworks to actual city portfolios. Some variation across the studies is thus historically situated. The dissertation should not hide this. On the contrary, it can be interpreted as a strength of the article portfolio: the studies capture the field from different moments and thereby show how the explanatory focus of smart city research shifts from broad barriers to governance architecture and strategic differentiation over time.

Methodological differences also explain part of the variation. Focus-group-based and exploratory studies are more likely to surface perceived barriers, coordination problems, and capability gaps. Comparative portfolio studies reveal variation in benefit structures but are less suited to uncovering deep governance processes unless supplemented by network or interview data. Single-case studies provide more contextual depth, but their findings are more sensitive to the specific institutional profile of the chosen city. Network analysis, as used in the Debrecen study, reveals relational centrality and governance structure more clearly than a portfolio-only approach. These differences mean that the

studies illuminate different slices of the same phenomenon. The dissertation's task is not to force them into artificial uniformity, but to interpret them as complementary methodological windows. When read this way, the differences in findings become expected and productive. They show that smart city development is multi-dimensional enough to require multiple methods and units of analysis.

The portfolio also contains a productive tension between **diagnostic critique** and **constructive possibility**. The first two studies emphasize barriers and organizational inadequacies, which might suggest a relatively pessimistic view of smart city transition. The Debrecen study, by contrast, shows that even under medium-sized-city conditions, a city may still assemble a broad and effective smart city programme. The resolution of this tension lies in the dissertation's overall theoretical stance: structural and organizational barriers are real, but they do not determine outcomes mechanically. Cities still have room for strategic agency, especially when governance is organized coherently. The dissertation thus arrives at a balanced interpretation. It neither treats smart city development as an easy technical upgrade nor depicts it as structurally blocked in all but flagship cases. Instead, it shows that cities operate within real constraints, but that governance bundles and organizational design shape how far and in what direction they can move.

Another apparent divergence lies in the balance between **public value breadth** and **implementation depth**. The many-faces chapter identifies diverse value propositions across cities and suggests a wide spectrum of possible benefit orientations. The later Hungarian studies reveal that achieving such value breadth in practice depends on more than strategic aspiration; it depends on governance arrangements, actor inclusion, and management capacity. This is not a contradiction but a synthesis point. The comparative study shows what cities aim for and how they signal those aims through portfolios. The Budapest and Debrecen studies show what institutional conditions are required for those aims to become coherent and durable. Thus, portfolio-level aspiration and governance-level implementation should be interpreted as different but connected analytical layers.

In summary, the differences across the five studies are explicable in four main ways: by **theoretical lens**, **methodological design**, **case selection**, and **temporal context**. None of these differences undermine the coherence of the dissertation. Instead, they strengthen it by showing that the overarching research question cannot be answered adequately from one angle alone. The studies converge on the claim that smart city development is a

context-sensitive governance process, but they reveal different aspects of that process depending on whether they focus on barriers, organizational design, value propositions, strategic diagnosis, or stakeholder networks. Once interpreted within the common conceptual framework developed in Chapter 1, these variations become part of the dissertation's explanatory strength rather than sources of inconsistency.

7.3 Scientific novelty and theoretical contribution

The scientific novelty of this dissertation lies not in any single article taken in isolation, but in the way the five studies are integrated into a common explanatory framework for understanding how cities become smart in practice. At dissertation level, the central contribution is to show that smart city development is best interpreted as a **context-sensitive governance process** in which structural barriers, strategic orientation, organizational design, activity portfolios, and stakeholder configurations interact. This moves beyond a large part of the smart city literature, which has often remained divided between techno-centric narratives, indicator-based comparisons, normative strategy models, and case descriptions that do not fully connect implementation to governance structure. The dissertation's novelty therefore lies first in **integration**: it brings together analytical dimensions that are often studied separately and demonstrates their cumulative explanatory power.

A first theoretical contribution of the dissertation is that it reframes the smart city from a predominantly technological construct into a **governance-mediated urban transition**. While the literature has increasingly criticized narrow techno-centric interpretations of the smart city, much empirical work still implicitly treats technology adoption, digital infrastructure, or visible innovation activity as the primary markers of smartness. The dissertation contributes to this debate by showing, across five studies, that the decisive explanatory mechanisms lie elsewhere: in the barrier environment facing cities, in the organizational forms through which urban digitalization is managed, in the strategic logic guiding project selection, and in the stakeholder structures that shape implementation. In this sense, the dissertation does not merely repeat the claim that smart cities should be understood more holistically. It provides an empirically grounded model of **how and why** governance and organization become decisive in shaping smart city trajectories.

A second major contribution is the dissertation's theoretical elevation of the **medium-sized city** from a marginal empirical category to a central analytical setting. Much of the

influential smart city literature has relied on capital cities, globally branded cases, or highly visible pioneers, which can distort understanding by generalizing from exceptional urban conditions. This dissertation argues that medium-sized cities are not simply smaller versions of flagship smart cities. They constitute a distinct environment in which capacity constraints, weaker internal knowledge infrastructures, external dependence, and organizational sensitivity become especially visible. The first and fifth studies are particularly important here: the former identifies the structural barriers that medium-sized cities face, while the latter shows how a medium-sized city can still develop a broad and coordinated smart city portfolio through a particular governance bundle. The theoretical contribution is therefore twofold: the dissertation both identifies the vulnerability structure of medium-sized cities and demonstrates their capacity for distinctive smart city trajectories. This adds nuance to the literature by moving beyond both deficit-based and flagship-based interpretations.

A third contribution lies in the dissertation's treatment of **organizational design** as a core explanatory layer of smart city development. In much smart city research, organization is present only implicitly, often folded into broad governance language or mentioned as a practical implementation issue. This dissertation contributes a more precise theoretical claim: organizational design is a mediating mechanism between strategic ambition and realized urban transformation. The organizational design study demonstrates that public-sector silos, weak coordination, limited collaborative capabilities, and closed inter-organizational structures are not incidental obstacles, but recurring features of why smart city initiatives underperform. By linking these findings to the broader dissertation framework, the thesis advances a more disciplined conceptualization of organization in smart city studies. It suggests that the study of smart city development should not stop at governance types or strategic documents, but should examine the concrete institutional architectures through which actors coordinate, learn, and implement.

A fourth theoretical contribution is the introduction of **activity portfolios and value propositions** as a dissertation-level bridge between strategy and implementation. Smart city research often discusses strategy at the level of visions, plans, and domains, but gives less systematic attention to what cities' actual intervention portfolios imply about their development logic. The comparative article on nine cities addresses this directly by reconstructing the anticipated benefits embedded in smart city activities. In the dissertation as a whole, this becomes more than a comparative observation. It becomes a

theoretical proposition: smart city development should be interpreted through the value structures materialized in concrete project portfolios. This helps overcome the gap between rhetoric and practice. It also contributes a more differentiated understanding of smartness by showing that cities pursue different public-value configurations rather than converging on one ideal type. The novelty here lies in connecting benefit orientation to the wider governance framework of the dissertation, so that portfolios become not just outputs, but expressions of strategic and institutional choice.

A fifth and especially important contribution is the dissertation's refinement of the relationship between **integration and inclusiveness**. One of the central findings emerging across the later chapters is that these are analytically distinct dimensions of smart city development. The Budapest and Debrecen studies show that a city may achieve broad coverage across domains and relatively coherent implementation, yet remain limited in participatory depth or in quadruple-helix collaboration. This matters theoretically because smart city literature sometimes treats integrated development as if it were naturally associated with inclusive governance. The dissertation challenges that assumption. It shows that breadth of intervention and breadth of participation do not necessarily move together. This distinction has significant explanatory value: it helps interpret why some cities appear strategically coherent while still exhibiting narrow actor configurations or municipally dominated governance models. The dissertation therefore contributes a more precise conceptual separation between portfolio integration and governance inclusiveness.

A sixth contribution lies in the incorporation of a **stakeholder-network perspective** into smart city governance analysis. Many smart city studies refer to actor groups such as municipalities, firms, universities, or citizens, but far fewer analyse the relational structure among them as an explanatory factor. The Debrecen study advances this by showing that the structure of collaboration itself, centrality, bridging, and concentration, shapes how smart city development is realized. At dissertation level, this produces a broader theoretical contribution: governance should be understood not only as a set of formal arrangements or strategic principles, but also as a relational architecture. This perspective strengthens the dissertation's broader claim that smart city development is conditioned by who coordinates, who connects, and who remains peripheral. It thus adds network structure to the explanatory model alongside barriers, organization, and portfolio logic.

A seventh contribution is methodological-theoretical in nature. The dissertation demonstrates the value of combining **multiple analytical lenses,** strategic management, organizational design, value-proposition analysis, dichotomy-based strategic diagnosis, and stakeholder-network analysis, within one cumulative framework. Each of these has appeared in the literature in some form, but the novelty here lies in their integration around one overarching question. The dissertation shows that none of these perspectives alone is sufficient. Barrier analysis without organizational design remains incomplete. Portfolio analysis without governance analysis risks remaining descriptive. Strategic diagnosis without stakeholder structure misses the relational basis of implementation. By integrating these approaches, the dissertation offers a more comprehensive theoretical model of smart city development than a single-lens study could provide.

The dissertation also contributes specifically to the literature on **Central and Eastern European smart city development**. Here, its novelty lies less in claiming regional exceptionalism and more in showing why this context matters theoretically. The Budapest and Debrecen studies make visible a recurring pattern: smart city development can remain technology-led and selectively collaborative unless institutional capability, organizational support, and broader knowledge-sector involvement are actively developed. The region is important not only because it is underrepresented in the literature, but because it makes especially visible the dependence of smart city trajectories on governance capacity and implementation architecture. In this respect, the dissertation's Hungarian cases contribute to theory by sharpening a general lesson: smart city development remains shallow when technological modernization is not matched by institutional deepening.

Taken together, these contributions allow the dissertation's scientific novelty to be summarized in a disciplined way. The dissertation offers:

- First, an **integrative explanatory framework** for smart city development that links context, barriers, strategic orientation, organizational design, activity portfolios, and stakeholder networks.
- Second, a **repositioning of medium-sized cities** as theoretically important settings for smart city research rather than peripheral cases.
- Third, a **stronger conceptualization of organization and governance** as mediating mechanisms of smart city transition.

- Fourth, a **portfolio-based interpretation of smart city strategy** through anticipated public-value structures.
- Fifth, a **distinction between integration and inclusiveness** as separate dimensions of smart city development.
- Sixth, a **network-governance perspective** that makes stakeholder structure part of the explanation of how cities become smart.

These contributions together constitute the dissertation's theoretical added value. The thesis does not claim to resolve all debates in smart city studies, nor to offer a universally valid model for all cities. Its contribution is more precise and, for that reason, more robust: it provides a cumulative, empirically grounded, and conceptually integrated explanation of how smart city development is structured in practice, especially in medium-sized and Central and Eastern European urban contexts.

7.4 Managerial, policy and urban governance implications

The findings of this dissertation have several implications for city leaders, municipal organizations, and smart city practitioners, especially in medium-sized cities operating under constrained institutional and financial conditions. The most general implication is that smart city development should not be managed primarily as a technology-acquisition agenda. Across the five studies, the evidence consistently shows that the decisive challenges and opportunities of smart city transition lie in governance capacity, organizational design, strategic coherence, and stakeholder coordination. For practitioners, this means that the central managerial question is not only which digital solutions to procure, but how to organize the city so that such solutions are selected, combined, governed, and evaluated in a coherent and publicly meaningful way.

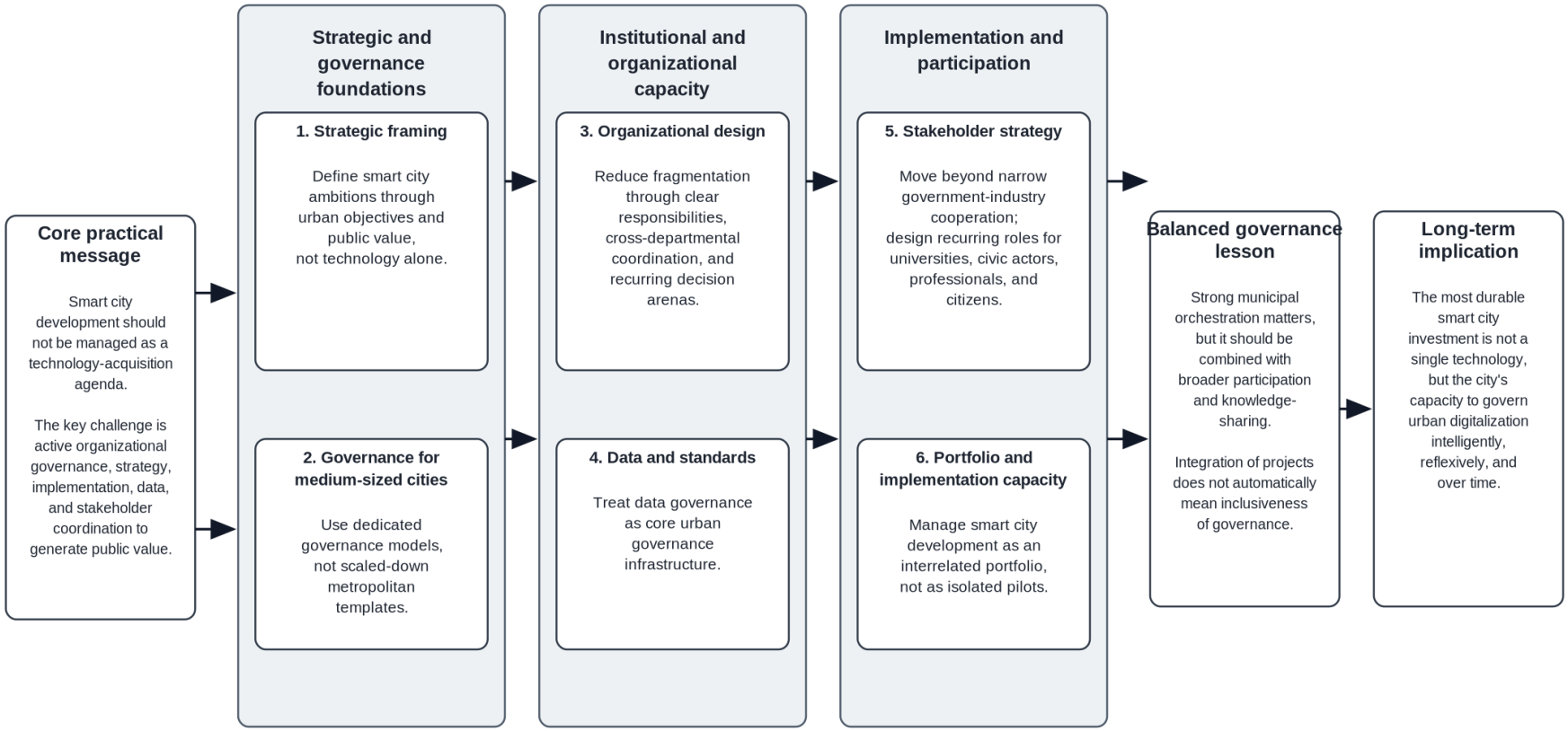

Core practical message
Smart city development should not be managed as a technology-acquisition agenda.
The key challenge is active organizational governance, strategy, implementation, data, and stakeholder coordination to generate public value.
Strategic and governance foundations
1. Strategic framing
Define smart city ambitions through urban objectives and public value, not technology alone.
2. Governance for medium-sized cities
Use dedicated governance models, not scaled-down metropolitan templates.
Institutional and organizational capacity
3. Organizational design
Reduce fragmentation through clear responsibilities, cross-departmental coordination, and recurring decision arenas.
4. Data and standards
Treat data governance as core urban governance infrastructure.
Implementation and participation
5. Stakeholder strategy
Move beyond narrow government-industry cooperation; design recurring roles for universities, civic actors, professionals, and citizens.
6. Portfolio and implementation capacity
Manage smart city development as an interrelated portfolio, not as isolated pilots.
Balanced governance lesson
Strong municipal orchestration matters, but it should be combined with broader participation and knowledge-sharing.
Integration of projects does not automatically mean inclusiveness of governance.
Long-term implication
The most durable smart city investment is not a single technology, but the city's capacity to govern urban digitalization intelligently, reflexively, and over time.

Figure 36 Managerial, policy and urban governance implications of the dissertation

A first implication concerns **strategic framing**. Medium-sized cities should avoid treating the smart city as a catalogue of isolated projects or as a branding label detached from urban development priorities. The dissertation suggests that cities perform better when smart city activities are embedded in a broader strategic logic that clarifies what kinds of public value they are meant to generate. This means that city leaders should define smart city ambitions in terms of concrete urban objectives, such as mobility improvement, energy efficiency, service accessibility, social inclusion, stakeholder engagement, or quality of life, rather than in terms of technology deployment alone. The comparative portfolio study shows that cities differ markedly in the benefit structures embedded in their activity portfolios, which implies that local strategy should explicitly decide which benefits are prioritized and why. For practice, the lesson is that a city should not ask simply "Which smart tools should we adopt?" but rather "What kind of urban value do we want our smart city portfolio to create?"

A second implication is that **medium-sized cities require dedicated governance models**, not scaled-down copies of metropolitan examples. The dissertation repeatedly shows that medium-sized cities face specific vulnerabilities: weaker internal knowledge bases, more limited financial room for experimentation, stronger dependence on external suppliers, and greater exposure to one-sided or biased smart city models. City leaders in these settings should therefore be cautious about adopting off-the-shelf technological packages or externally imposed smart city templates without sufficient strategic translation into local needs. A more appropriate policy approach is to build governance arrangements that compensate for these structural disadvantages through knowledge partnerships, incremental capability-building, and stronger internal coordination. In practical terms, this means investing not only in projects, but also in municipal learning capacity, data management competence, and the ability to critically evaluate vendor offers and consultant frameworks.

A third implication concerns **organizational design inside city government**. The dissertation shows that fragmented internal structures, weak horizontal coordination, and unclear implementation responsibility significantly hinder smart city transition. For municipal managers, this implies that smart city development should not be left to ad hoc project coordination across disconnected departments. Cities need clearer organizational interfaces between strategy, planning, ICT, urban operations, and external stakeholder management. The evidence from the organizational design study suggests that

collaborative and platform-based arrangements are better suited than silo-based administrative routines to handle the complexity of urban digitalization. This does not necessarily require creating entirely new bureaucratic layers in every case, but it does require clear responsibility centres, cross-departmental coordination routines, shared information structures, and recurring decision arenas in which technical, strategic, and urban-planning perspectives can be aligned.

A fourth implication is that cities should treat **data and standards as governance infrastructure**, not merely as technical back-office matters. One of the recurring problems identified in the dissertation is that weak data quality, incomplete data accessibility, and lack of standards limit the ability of cities to plan, evaluate, and integrate smart city activities. For practitioners, this means that urban digitalization should be supported by deliberate investment in data governance: clear data ownership, common standards, interoperable structures, and processes for maintaining data quality over time. This is especially relevant for medium-sized cities, where limited internal analytical capacity can make poor data environments even more constraining. Without a stronger data-governance basis, smart projects remain difficult to compare, integrate, or scale, and cities remain more dependent on external actors for interpretation and implementation.

A fifth implication concerns **stakeholder strategy**. The dissertation suggests that cities should move beyond narrow government–industry cooperation if they want smart city development to become more adaptive, legitimate, and publicly valuable. The Budapest and Debrecen studies both show that broad project activity can coexist with relatively selective collaboration patterns. This means that visible smart city progress does not automatically imply strong civic participation, robust knowledge-sector inclusion, or broader co-creation. For policymakers, the lesson is that stakeholder diversity should be designed intentionally, not assumed to emerge on its own. Universities, civic organizations, professional communities, neighbourhood actors, and citizens should not be included only symbolically or episodically, but through recurring institutional roles. This is especially important where cities aim to move from technology-led modernization toward more holistic and socially embedded smart development.

At the same time, the dissertation also shows that **strong municipal orchestration matters**. The implication is not that city governments should withdraw in favour of loose network governance. On the contrary, the Debrecen case suggests that medium-sized cities may benefit from a relatively strong coordinating municipal centre, particularly

when the goal is to maintain strategic coherence and broad project coverage. The practical lesson is therefore more balanced: city governments should remain capable orchestrators, but they should combine that coordinating role with better-designed participatory and knowledge-sharing mechanisms. In other words, the challenge is not to choose between strong leadership and broad collaboration, but to create governance designs in which strong coordination does not collapse into narrow actor concentration.

A sixth implication concerns **portfolio management**. Cities should manage smart city development as a portfolio of interrelated interventions rather than as a sequence of independent projects. The dissertation shows that the strategic meaning of smart city development becomes visible in the composition of project portfolios: which domains are covered, which benefits are pursued, which actors are involved, and whether interventions reinforce or fragment one another. For city leaders, this means that project approval and monitoring should include portfolio-level questions. Does a new project strengthen an existing strategic direction, or does it add another isolated pilot? Does the portfolio overemphasize efficiency and infrastructure while neglecting participation, inclusion, or quality of life? Does it deepen dependence on one supplier category or create more institutional learning capacity? Such questions help turn smart city management from reactive project accumulation into strategic urban governance.

A seventh implication is that **implementation capacity should be treated as a strategic asset**. The Budapest study is especially clear in showing that even where a city has a relatively integrated and active smart city portfolio, implementation can remain fragile if management authority, institutional background, and cooperation platforms are underdeveloped. For urban policymakers, this means that smart city strategy documents are not enough. Cities need implementation structures with continuity, mandate, and administrative embedding. Dedicated coordination units, project management capacity, formalized partnership channels, and review processes matter because they determine whether a strategy remains aspirational or becomes operational. This is a particularly important lesson for Central and Eastern European contexts, where strategic ambition may outpace implementation architecture.

An eighth implication concerns **vendor relations and procurement intelligence**. The first study highlights supplier dependence and biased approaches as significant barriers, especially in medium-sized cities. For practitioners, this implies that procurement should not be seen merely as an administrative or legal process. It is also a strategic governance

function. Cities should build internal capacity to define needs clearly, compare alternative approaches, avoid lock-in, and require interoperability and data portability where possible. More collaborative pre-procurement consultation, stronger technical due diligence, and independent evaluative expertise may help cities avoid one-sided vendor-defined smart city pathways. This is especially important where internal technical knowledge is limited.

A ninth implication follows from the dissertation's distinction between **integration and inclusiveness**. Urban policymakers should not assume that broad domain coverage or a high number of smart initiatives automatically means that governance is balanced or socially embedded. A city may appear advanced because it has projects in mobility, energy, governance, and public services, while still concentrating agenda-setting and implementation power in a relatively narrow set of organizations. For practice, this means that evaluation frameworks should include both dimensions: the breadth and coherence of the portfolio, and the breadth and quality of stakeholder participation. Cities should assess not only what they are doing, but also who is shaping, steering, and benefiting from that activity.

Finally, the dissertation implies that smart city policy should be approached as a **long-term institutional development process** rather than a short-term innovation programme. Cities become smarter not only by launching projects, but by gradually building the institutional capacity to select, govern, coordinate, evaluate, and revise those projects over time. This is especially relevant for medium-sized cities, where one-off pilots and externally funded initiatives may otherwise create episodic activity without lasting capability formation. The practical recommendation is therefore to design smart city governance in a way that accumulates institutional learning: document projects in consistent formats, evaluate outcomes systematically, retain organizational memory, strengthen internal expertise, and build durable partnerships with universities, utilities, firms, and civic actors. In this sense, the most durable smart city investment may not be a specific technology at all, but the city's capacity to govern urban digitalization intelligently and reflexively.

7.5 Limitations

The dissertation offers a cumulative and multi-perspectival account of smart city development, but its findings should be interpreted in light of several limitations. These

limitations do not invalidate the dissertation's conclusions, but they help define the scope within which its contributions are strongest and the areas in which further validation or extension would be desirable.

A first limitation concerns the **article-based composition of the thesis itself**. The strength of the dissertation lies in the complementarity of the five studies, but the portfolio was not originally designed as a single monographic research project with one unified data collection plan and one fixed methodological protocol from the outset. Instead, the studies were produced over time, with different immediate research purposes, different empirical materials, and different publication contexts. The dissertation has integrated them into a common conceptual framework, but some degree of heterogeneity remains inevitable. This is visible, for example, in the fact that the studies rely on partly different theoretical vocabularies, different scales of analysis, and different empirical objects. The dissertation addresses this through synthesis, but the portfolio format necessarily produces a more layered and reconstructive integration than a single-purpose monograph would.

A second limitation is **methodological heterogeneity**. The portfolio combines focus groups, expert-based exploratory inquiry, literature-driven design research, comparative multiple case study analysis, structured single-case diagnosis, and stakeholder-network analysis. This breadth is one of the dissertation's advantages, but it also means that the studies do not all support the same type of inference. Some are more exploratory and theory-building, others more comparative and classificatory, and others more diagnostic and relational. As a result, the dissertation is strongest in interpretive depth, conceptual development, and cumulative explanation, but less suited to strong causal claims in a narrow hypothesis-testing sense. The thesis demonstrates patterns, mechanisms, and relationships, but it does not claim statistical generalizability across all cities or universal causal regularities for smart city development.

A third limitation concerns **case selection and external validity**. Two of the most important empirical chapters focus on Budapest and Debrecen, while the comparative portfolio study, although broader, still examines a limited set of nine cities selected through theoretical rather than representative sampling. This means that the dissertation should not be read as providing a statistically representative picture of all smart city developments in Europe, all medium-sized cities, or all Central and Eastern European cases. Budapest and Debrecen are analytically useful and theoretically revealing, but they

remain specific urban cases shaped by Hungarian institutional, political, and development contexts. The medium-sized-city findings are therefore most appropriately interpreted as analytically transferable rather than statistically generalizable.

A fourth limitation relates to **temporal comparability**. The five studies were produced across several years, and the smart city field evolved during that period. Earlier studies captured a phase in which the literature and practice were more strongly shaped by definitional fragmentation and technology-driven narratives, while later studies reflect a more mature stage of discussion around governance, strategic differentiation, and stakeholder inclusion. This temporal spread is valuable because it captures an evolving field, but it also means that the studies are not fully synchronous observations of the same moment. Some differences across findings may thus reflect changes in the field itself as well as differences in case and method. The dissertation addresses this interpretively, but it remains a limitation for direct one-to-one comparability across all articles.

A fifth limitation concerns the **use of secondary and documentary project data** in the later case studies. The Budapest and Debrecen chapters derive much of their evidence from city strategies, municipal project repositories, public documentation, online records, and project descriptions, supplemented in Debrecen by stakeholder-network construction from co-participation data. This makes structured city-level comparison possible, but it also creates limitations. Publicly documented activity portfolios may overrepresent visible, communicable, or formally reported projects while underrepresenting failed, discontinued, informal, or less documented initiatives. Similarly, coding decisions based on documentary materials always involve some interpretive judgement, especially where the boundaries between technology-led and holistic development, or between top-down and bottom-up involvement, are not perfectly clear. The dissertation mitigates this through systematic coding and cross-checking, but the risk of partial visibility remains.

A sixth limitation concerns the **network analysis in the Debrecen study**. The stakeholder network provides a valuable relational perspective, but it is constructed from collaboration recorded through project co-participation and documented initiative data. This means that the network primarily captures formalized or visible collaborative relations. It is less able to capture informal influence, episodic involvement, hidden brokerage, political steering outside project structures, or the qualitative intensity of relationships. In other words, the network reveals important structural features, but not the full political sociology of urban governance. It shows who is connected and how

centrally, but not all aspects of power, trust, conflict, or informal agenda-setting that may shape smart city development.

A seventh limitation concerns the **conceptual frameworks used across the portfolio**. The dissertation uses Porter's Five Forces, the SmartCEPS design logic, value-proposition coding, strategic dichotomies, and stakeholder-network analysis. This plurality is productive, but each framework also simplifies reality in its own way. Porter's model may foreground structural dependencies while giving less attention to political dynamics. Dichotomy-based diagnosis is analytically useful, but cities rarely fit neatly into binary positions. Value-proposition coding clarifies anticipated benefits, but may not fully capture unintended outcomes or contested meanings of projects. Network analysis reveals structure, but not necessarily normative quality. The dissertation's theoretical contribution depends partly on these abstractions, yet they also set limits on what each study can fully explain.

An eighth limitation is that the dissertation focuses primarily on **governance, organization, and strategy**, and less on the direct measurement of policy outcomes or citizen-level effects. The studies examine barriers, organizational arrangements, value propositions, portfolios, and stakeholder structures, but they do not systematically evaluate whether particular smart city initiatives measurably improved service quality, environmental performance, democratic inclusion, or resident well-being over time. This is a conscious boundary of the thesis rather than an oversight, because the dissertation asks how cities become smart in practice rather than how successful each smart city intervention ultimately is. Still, this means that the dissertation speaks more strongly to the conditions and trajectories of smart city development than to the final impact effectiveness of all observed initiatives.

A further limitation, which deserves to be stated explicitly rather than left implicit, concerns the **limited presence of the voice of civil society and citizens** in the dissertation's evidence base. The studies analyse smart city development largely through the perspectives of municipalities, public authorities, technology suppliers, professionals, and documented project portfolios, and through the relational structure of organizational stakeholders. Residents, civic organizations, and citizens as experiencing subjects are not directly represented through, for instance, survey, participatory, or ethnographic methods. This is partly a deliberate scope decision, since the dissertation's research question concerns the strategic, organizational, and governance conditions of becoming smart

rather than citizen experience as such. But it also reflects the empirical reality the dissertation documents: in the predominantly top-down and technology-led governance settings examined here, particularly in Debrecen, genuine quadruple-helix participation by civil society has itself been limited, so that the relative quietness of the civic voice in the data is in part a finding rather than only a methodological gap. This makes the omission doubly significant. It marks a boundary of the present work, and it points directly to one of the most important substantive directions for future research, namely bringing residents' quality of life and civic participation, now central to the field (Chang and Smith, 2023), into the empirical core of CEE smart city governance research (see Section 7.6).

A ninth limitation concerns the **regional concentration** of the deepest empirical insights. Although the portfolio includes a broader comparative article, the most detailed governance and strategic analyses are concentrated in Hungarian cases. This is appropriate given the dissertation's stated interest in Central and Eastern Europe, but it also means that some dissertation-level conclusions about governance bundles, organizational fragility, and technology-led development are most directly grounded in that regional context. Their broader applicability is plausible and analytically suggestive, but would benefit from additional testing in other medium-sized cities across Europe and beyond.

Taken together, these limitations suggest that the dissertation's claims are strongest when interpreted as a **theory-building, analytically grounded, and context-sensitive explanation** of smart city development rather than as a fully general theory applicable in identical form to all cities. The thesis does not claim universal laws of smart urban transformation. Its more precise contribution is to offer a robust framework for understanding how smart city development is conditioned by barriers, organizational design, strategy, portfolios, and stakeholder structures, especially in medium-sized and Central and Eastern European urban contexts.

7.6 Future research directions

The findings of this dissertation open several realistic and important directions for future research. These directions emerge not only from the limitations of the article portfolio, but also from the dissertation's central theoretical proposition that smart city development is a context-sensitive governance process shaped by barriers, organizational design,

strategic orientation, and stakeholder structure. Future research can deepen, test, and broaden this proposition in several ways.

A first priority is the **comparative extension of medium-sized-city research**. One of the main conclusions of the dissertation is that medium-sized cities are analytically central to smart city studies, yet remain underexamined compared to capital cities and flagship cases. Future research should therefore build larger comparative datasets of medium-sized cities across different European regions and, ideally, beyond Europe as well. Such work could test whether the barrier structures and governance bundles identified here are specific to the Hungarian and Central European context or whether they also characterize medium-sized cities in Southern, Western, or Northern Europe. It would be especially valuable to compare cities that are similar in population size but differ in fiscal capacity, institutional structure, regional embeddedness, and innovation ecosystems.

A second direction is the **longitudinal study of smart city trajectories**. The present dissertation reconstructs development patterns from cross-sectional or retrospective materials, but future research could follow cities across longer time periods in a more explicitly longitudinal design. This would make it possible to observe how smart city governance arrangements evolve, whether cities move along the strategic dichotomies over time, and how project portfolios become more or less integrated or inclusive. Longitudinal analysis would be especially useful for testing one of the dissertation's implicit propositions: that smart city development is not a static condition but a trajectory shaped by path dependence, institutional learning, and changing governance coalitions.

A third important direction is the **outcome-oriented evaluation of public value**. The dissertation shows how anticipated benefits and value propositions are embedded in city portfolios, but it does not systematically measure whether those benefits were later realized. Future research could build on the portfolio framework developed here by tracing selected value propositions, such as quality of life, efficiency, stakeholder engagement, or environmental performance, into actual outcomes. This would strengthen the link between smart city strategy and policy effectiveness. Comparative work could examine whether certain governance models are more likely than others to translate intended benefits into realized public value.

A fourth research direction concerns the **micro-politics of smart city governance**. The Debrecen stakeholder network analysis demonstrates the importance of relational structure, but future studies could go further by examining how influence, conflict,

negotiation, and informal power operate within smart city ecosystems. This would require more interview-based, ethnographic, or process-tracing work focused on how projects are prioritized, how partnerships are formed, how disagreements are managed, and how certain actors become central while others remain peripheral. Such research could deepen the dissertation's network perspective by adding a more explicitly political and institutional analysis of governance practice.

A fifth direction is the **further development of organizational design research in urban digitalization**. The SmartCEPS-related chapter suggests that collaborative and platform-based organizational models may better support smart city transition than fragmented conventional arrangements. Future research could test this more directly through comparative organizational case studies, action research, or pilot implementations in cities of different sizes. This would help clarify under what conditions collaborative platform models actually improve coordination, data use, participation, and implementation capacity, and where they may create new barriers such as higher entry thresholds, legitimacy questions, or administrative overload.

A sixth line of future inquiry is the **integration of portfolio analysis with governance analysis** on a larger scale. One of the dissertation's key findings is that integration of activity portfolios and inclusiveness of governance should be treated as distinct dimensions. Future research could formalize this insight by creating comparative typologies of cities based on both portfolio composition and stakeholder-network structure. This might reveal recurring governance configurations, for example cities with broad integrated portfolios but narrow collaboration, or cities with participatory governance but fragmented portfolios. Such a typological approach could strengthen both theory and practice by offering a more precise map of smart city development patterns.

A seventh direction is the **broader regional testing of the Central and Eastern European findings**. The dissertation's Hungarian cases suggest that technology-led modernization may outpace institutional deepening in this region unless organizational support and broader stakeholder infrastructures are deliberately developed. Future research should test whether similar patterns appear in other Central and Eastern European cities, including both capitals and medium-sized cities. Comparative work across countries such as Poland, the Czech Republic, Slovakia, Romania, Croatia, or the Baltic states could help distinguish what is specifically Hungarian, what is regionally

recurrent, and what is more generally characteristic of late-institutionalizing smart city contexts.

An eighth direction concerns the **role of municipal capability-building**. Several studies in the dissertation imply that internal capacity, data literacy, coordination competence, and procurement intelligence are decisive for smart city development, especially in medium-sized cities. Future research could focus more directly on how such capabilities are built, retained, and institutionalized inside municipalities. This could include work on staff competencies, organizational memory, interdepartmental routines, external advisory dependence, and learning from pilot projects. Such research would have strong practical relevance because it would connect smart city theory more directly to administrative development.

A ninth and especially promising avenue is the **study of smart city governance beyond project visibility**. The dissertation relies partly on documented initiatives and formalized project portfolios. Future research could deliberately focus on less visible dimensions: abandoned projects, failed initiatives, dormant strategies, symbolic smart city rhetoric without implementation, or informal experimental activity outside major strategies. This would help balance the bias toward visible and documented interventions and provide a fuller picture of how smart city agendas function in practice, including their discontinuities and failures.

Overall, the most important future agenda emerging from the dissertation is to continue moving smart city research away from narrow techno-centric and flagship-city perspectives and toward a more grounded understanding of **how different cities govern digital urban transition under real constraints**. The present thesis provides one integrated framework for doing so. Future studies can now extend that framework comparatively, longitudinally, and more explicitly toward outcomes, politics, and administrative capability. In that sense, the dissertation does not close the debate on how cities become smart. It clarifies the terms on which that debate should proceed.

References

Adler, P., Florida, R., King, K. and Mellander, C. (2019) 'The city and high-tech startups: The spatial organization of Schumpeterian entrepreneurship', *Cities*, 87, pp. 121–130. https://doi.org/10.1016/j.cities.2018.12.013

Aguilera, U., Peña, O., Belmonte, O. and López-de-Ipiña, D. (2017) 'Citizen-centric data services for smarter cities', *Future Generation Computer Systems*, 76, pp. 234–247. https://doi.org/10.1016/j.future.2016.10.031

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I. and Airaksinen, M. (2017) 'What are the differences between sustainable and smart cities?', *Cities*, 60, pp. 234–245. https://doi.org/10.1016/j.cities.2016.09.009

Albino, V., Berardi, U. and Dangelico, R.M. (2015) 'Smart cities: Definitions, dimensions, performance, and initiatives', *Journal of Urban Technology*, 22(1), pp. 3–21. https://doi.org/10.1080/10630732.2014.942092

Allam, Z. and Dhunny, Z.A. (2019) 'On big data, artificial intelligence and smart cities', *Cities*, 89, pp. 80–91. https://doi.org/10.1016/j.cities.2019.01.032

Allam, Z. and Newman, P. (2018) 'Redefining the smart city: Culture, metabolism and governance', *Smart Cities*, 1, pp. 4–25. https://doi.org/10.3390/smartcities1010002

Almirall, E., Wareham, J., Ratti, C., Conesa, P., Bria, F., Gaviria, A. and Edmondson, A. (2016) 'Smart cities at the crossroads', *California Management Review*, 59(1), pp. 141–152. https://doi.org/10.1177/0008125616683949

Almulhim, A.I. and Yigitcanlar, T. (2025) 'Understanding smart governance of sustainable cities: A review and multidimensional framework', *Smart Cities*, 8, p. 113. https://doi.org/10.3390/smartcities8040113

Angelidou, M. (2014) 'Smart city policies: A spatial approach', *Cities*, 41, pp. S3–S11. https://doi.org/10.1016/j.cities.2014.06.007

Angelidou, M. (2015) 'Smart cities: A conjuncture of four forces', *Cities*, 47, pp. 95–106. https://doi.org/10.1016/j.cities.2015.05.004

Angelidou, M. (2016) 'Four European Smart City Strategies', *International Journal of Social Science Studies*, 4(4), pp. 18–30. https://doi.org/10.11114/ijsss.v4i4.1364

Angelidou, M. (2017) ‘The role of smart city characteristics in the plans of fifteen cities’, *Journal of Urban Technology*, 24(4), pp. 3–28. https://doi.org/10.1080/10630732.2017.1348880

Angelidou, M., Psaltoglou, A., Komninos, N., Kakderi, C., Tsarchopoulos, P. and Panori, A. (2018) ‘Enhancing sustainable urban development through smart city applications’, *Journal of Science and Technology Policy Management*, 9, pp. 146–169.

Anschütz, C., Ebner, K. and Smolnik, S. (2024) ‘Size does matter: A maturity model for the special needs of small and medium-sized smart cities’, *Cities*, 150, p. 104998. https://doi.org/10.1016/j.cities.2024.104998

Anttiroiko, A.-V. (2016) ‘City-as-a-platform: The rise of participatory innovation platforms in Finnish cities’, *Sustainability*, 8(9), p. 922. https://doi.org/10.3390/su8090922

Anttiroiko, A.-V., Valkama, P. and Bailey, S.J. (2014) ‘Smart cities in the new service economy: Building platforms for smart services’, *AI & Society*, 29(3), pp. 323–334. https://doi.org/10.1007/s00146-013-0464-0

Badii, C., Bellini, P., Cenni, D., Difino, A., Paolucci, M. and Nesi, P. (2017) ‘User engagement engine for smart city strategies’, in *2017 IEEE International Conference on Smart Computing (SMARTCOMP 2017)*. https://doi.org/10.1109/SMARTCOMP.2017.7947059

Bakici, T., Almirall, E. and Wareham, J. (2013) ‘A smart city initiative: The case of Barcelona’, *Journal of the Knowledge Economy*, 4(2), pp. 135–148. https://doi.org/10.1007/s13132-012-0084-9

Ballas, D. (2013) ‘What makes a “happy city”?’, *Cities*, 32, pp. S39–S50. https://doi.org/10.1016/j.cities.2013.04.009

Balaton, K. and Hortoványi, L. (eds.) (2018) *Stratégiai és üzleti tervezés [Strategic and Business Planning]*. Budapest: Akadémiai Kiadó.

Balaton, K., Benedek, J., Kocziszky, G. and Somosi, M. (2016) ‘Generating and measuring regional social innovation’, *Theory, Methodology, Practice*, 12(SI), pp. 14–25. https://doi.org/10.18096/tmp.2016.02.02

Barns, S. (2018) ‘Smart cities and urban data platforms: Designing interfaces for smart governance’, *City, Culture and Society*, 12, pp. 5–12. https://doi.org/10.1016/j.ccs.2017.09.006

Barrionuevo, J.M., Berrone, P. and Ricart Costa, J.E. (2012) ‘Smart cities, sustainable progress: Opportunities for urban development’, *IESE Insight*, 14, pp. 50–57. https://doi.org/10.15581/002.ART-2152

Batty, M., Axhausen, K.W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. and Portugali, Y. (2012) ‘Smart cities of the future’, *The European Physical Journal Special Topics*, 214(1), pp. 481–518. https://doi.org/10.1140/epjst/e2012-01703-3

Belanche, D., Casaló, L.V. and Orús, C. (2016) ‘City attachment and use of urban services: Benefits for smart cities’, *Cities*, 50, pp. 75–81. https://doi.org/10.1016/j.cities.2015.08.016

Ben Letaifa, S. (2015) ‘How to strategize smart cities: Revealing the SMART model’, *Journal of Business Research*, 68(7), pp. 1414–1419. https://doi.org/10.1016/j.jbusres.2015.01.024

Beretta, I. (2018) ‘The social effects of eco-innovations in Italian smart cities’, *Cities*, 72, pp. 115–121. https://doi.org/10.1016/j.cities.2017.07.010

Bibri, S.E. (2018) *Smart Sustainable Cities of the Future*. Cham: Springer. https://doi.org/10.1007/978-3-319-73981-6

Bibri, S.E. (2019) ‘The sciences underlying smart sustainable urbanism: Unprecedented paradigmatic and scholarly shifts in light of big data science and analytics’, *Smart Cities*, 2, pp. 179–213. https://doi.org/10.3390/smartcities2020013

Bibri, S.E. and Krogstie, J. (2017) ‘Smart sustainable cities of the future: An extensive interdisciplinary literature review’, *Sustainable Cities and Society*, 31, pp. 183–212. https://doi.org/10.1016/j.scs.2017.02.016

Bibri, S.E. and Krogstie, J. (2020) ‘The emerging data-driven smart city and its innovative applied solutions for sustainability: The cases of London and Barcelona’, *Energy Informatics*, 3, 5. https://doi.org/10.1186/s42162-020-00108-6

Blanck, M. and Ribeiro, J.L.D. (2021) ‘Smart cities financing system: An empirical modelling from the European context’, *Cities*, 116, p. 103268. https://doi.org/10.1016/j.cities.2021.103268

Boda, G. (2017) ‘To what extent is Hungary a knowledge-based economy?’, *Theory, Methodology, Practice*, 13(1), pp. 69–84. https://doi.org/10.18096/tmp.2017.01.06

Bokolo, A.J. (2023) ‘Data driven approaches for smart city planning and design: A case scenario on urban data management’, *Digital Policy, Regulation and Governance*, 25, pp. 351–367.

Bolívar, M.P.R. and Meijer, A.J. (2016) ‘Smart governance: Using a literature review and empirical analysis to build a research model’, *Social Science Computer Review*, 34(6), pp. 673–692. https://doi.org/10.1177/0894439315611088

Borghys, K., van der Graaf, S., Walravens, N. and Van Compernolle, M. (2020) ‘Multi-stakeholder innovation in smart city discourse: Quadruple helix thinking in the age of “platforms”’, *Frontiers in Sustainable Cities*, 2. https://doi.org/10.3389/frsc.2020.00005

Budapest Főváros Önkormányzata (2019) *Smart Budapest: Okos Város Keretstratégia*. Budapest: Budapest Főváros Városépítési Tervező Kft. Available at: https://budapest.hu/Documents/V%C3%A1ros%C3%A9p%C3%ADt%C3%A9si%20F%C5%91oszt%C3%A1ly/Smart%20Budapest%20Keretstrat%C3%A9gia%202019.pdf

Budapest Főváros Önkormányzata (2021) ‘Budapest Portál’. Available at: https://budapest.hu/Lapok/default.aspx (Accessed: 1 February 2021).

Bukovszki, V., Apró, D., Khoja, A., Essig, N. and Reith, A. (2019) ‘From assessment to implementation: Design considerations for scalable decision-support solutions in sustainable urban development’, *IOP Conference Series: Earth and Environmental Science*, 290, p. 012112. https://doi.org/10.1088/1755-1315/290/1/012112

Caragliu, A., Del Bo, C. and Nijkamp, P. (2009) *Smart cities in Europe*. Serie Research Memoranda 0048. Amsterdam: VU University Amsterdam.

Caragliu, A., Del Bo, C. and Nijkamp, P. (2011) ‘Smart cities in Europe’, *Journal of Urban Technology*, 18(2), pp. 65–82. https://doi.org/10.1080/10630732.2011.601117

Carayannis, E.G., Campbell, D.F.J. and Grigoroudis, E. (2022) ‘Helix trilogy: The triple, quadruple, and quintuple innovation helices from a theory, policy, and practice set of perspectives’, *Journal of the Knowledge Economy*, 13, pp. 2272–2301. https://doi.org/10.1007/s13132-021-00813-x

Carver, C.S. and Scheier, M.F. (2012) ‘Cybernetic control processes and the self-regulation of behavior’, in *The Oxford Handbook of Human Motivation*. Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195399820.013.0003

Caselli, B., Pellicelli, G., Rossetti, S. and Zazzi, M. (2022) ‘How are medium-sized cities implementing their smart city governance? Experiences from the Emilia-Romagna Region’, *Sustainability*, 14, p. 15300. https://doi.org/10.3390/su142215300

Castelnovo, W., Misuraca, G. and Savoldelli, A. (2016) ‘Smart cities governance: The need for a holistic approach to assessing urban participatory policy making’, *Social Science Computer Review*, 34, pp. 724–739. https://doi.org/10.1177/0894439315611103

Chang, S. and Smith, M.K. (2023) ‘Residents’ quality of life in smart cities: A systematic literature review’, *Land*, 12(4), 876. https://doi.org/10.3390/land12040876

Chen, T.M. (2010) ‘Smart grids, smart cities need better networks [editor’s note]’, *IEEE Network*, 24(2), pp. 2–3. https://doi.org/10.1109/MNET.2010.5430136

Chesbrough, H. and Brunswicker, S. (2014) ‘A fad or a phenomenon? The adoption of open innovation practices in large firms’, *Research-Technology Management*, March-April, pp. 16–25. https://doi.org/10.5437/08956308X5702196

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J.R., Mellouli, S., Nahon, K., Pardo, T.A. and Scholl, H.J. (2012) ‘Understanding smart cities: An integrative framework’, in *Proceedings of the Annual Hawaii International Conference on System Sciences*, pp. 2289–2297. https://doi.org/10.1109/HICSS.2012.615

Cities-4-People (2021) *Cities-4-People: Sustainable and people-oriented urban mobility solutions*. Horizon 2020 project no. 723194. CORDIS. Available at: https://cordis.europa.eu/project/id/723194 (Accessed: 30 August 2026).

Clement, J., Manjon, M. and Crutzen, N. (2022) ‘Factors for collaboration amongst smart city stakeholders: A local government perspective’, *Government Information Quarterly*, 39, p. 101746. https://doi.org/10.1016/j.giq.2022.101746

Climate-neutral and smart cities - Research and innovation (2026) Available at: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en (Accessed: 25 January 2026).

Colding, J., Barthel, S. and Sörqvist, P. (2019) ‘Wicked problems of smart cities’, *Smart Cities*, 2, pp. 512–521. https://doi.org/10.3390/smartcities2040031

Cook, M. and Karvonen, A. (2024) ‘Urban planning and the knowledge politics of the smart city’, *Urban Studies*, 61, pp. 370–382. https://doi.org/10.1177/00420980231177688

Cretu, G.L. (2012) ‘Smart cities design using event-driven paradigm and semantic web’, *Informatica Economica*, 16(4), pp. 57–67.

Csécsei, N. (2020) ‘Smart City Index 2020: Budapest among the most underdeveloped cities in the region’. Available at: https://dailynewshungary.com/smart-city-index-2020-budapest-among-the-most-underdeveloped-cities-in-the-region/ (Accessed: 5 May 2020).

Csukás, M. (2022) *Database of activities and organisations involved with the Smart City Strategy of Budapest*. Unpublished raw data.

Csukás, M. and Szabó, R.Z. (2022) ‘What are the conditions to become smart? A systematic analysis of the smart city strategy and development activities of Budapest’, *Információs Társadalom*, 22(2), pp. 9–26. https://doi.org/10.22503/inftars.XXII.2022.2.1

Csukás, M.S. and Szabó, R.Z. (2018) ‘Factors hindering smart city developments in medium-sized cities’, *TMP*, 14, pp. 3–14. https://doi.org/10.18096/TMP.2018.01.01

Csukás, M.S. and Szabó, R.Z. (2021) ‘The many faces of the smart city: Differing value propositions in the activity portfolios of nine cities’, *Cities*, 112, p. 103116. https://doi.org/10.1016/j.cities.2021.103116

Cui, S., Li, G. and Liu, J. (2024) ‘Can the construction of smart cities promote the capital allocation efficiency: Evidence from China’, *Technological Forecasting and Social Change*, 208, p. 123677. https://doi.org/10.1016/j.techfore.2024.123677

Dabeedooal, Y.J., Dindoyal, V., Allam, Z. and Jones, D.S. (2019) ‘Smart tourism as a pillar for sustainable urban development: An alternate smart city strategy from Mauritius’, *Smart Cities*, 2, pp. 153–162. https://doi.org/10.3390/smartcities2020011

Dameri, R.P. and Cocchia, A. (2013) ‘Smart city and digital city: Twenty years of terminology evolution’, in *X Conference of the Italian Chapter of AIS (ITAIS 2013)*.

Dameri, R.P. and Rosenthal-Sabroux, C. (2014) ‘Smart city and value creation’, in *Smart City*, pp. 1–12. https://doi.org/10.1007/978-3-319-06160-3_1

Daniell, K.A., White, I., Ferrand, N., Ribarova, I.S., Coad, P., Rougier, J. and Burn, S. (2010) ‘Co-engineering participatory water management processes’, *Ecology and Society*, 15(4), pp. 1–38.

Dashkevych, O. and Portnov, B.A. (2022) ‘Criteria for smart city identification: A systematic literature review’, *Sustainability*, 14, p. 4448. https://doi.org/10.3390/su14084448

Deakin, M. and Reid, A. (2018) ‘Smart cities: Under-gridding the sustainability of city-districts as energy efficient-low carbon zones’, *Journal of Cleaner Production*, 173, pp. 39–48. https://doi.org/10.1016/j.jclepro.2016.12.054

Debnath, A.K., Chin, H.C., Haque, M.M. and Yuen, B. (2014) ‘A methodological framework for benchmarking smart transport cities’, *Cities*, 37, pp. 47–56. https://doi.org/10.1016/j.cities.2013.11.004

Del-Real, C., Ward, C. and Sartipi, M. (2023) ‘What do people want in a smart city? Exploring the stakeholders’ opinions, priorities and perceived barriers in a medium-sized city in the United States’, *International Journal of Urban Sciences*, 27, pp. 50–74. https://doi.org/10.1080/12265934.2021.1968939

Deloitte (2015) *Smart cities… not just the sum of its parts*. Available at: https://www2.deloitte.com/content/dam/Deloitte/xe/Documents/strategy/me_deloitte-monitor_smart-cities.pdf

Desdemoustier, J., Crutzen, N. and Giffinger, R. (2019) ‘Municipalities’ understanding of the smart city concept: An exploratory analysis in Belgium’, *Technological*

Forecasting and Social Change, 142, pp. 129–141. https://doi.org/10.1016/j.techfore.2018.10.029

Dezi, L., Pisano, P., Pironti, M. and Papa, A. (2018) 'Unpacking open innovation neighborhoods: Le milieu of the lean smart city', *Management Decision*, 56(6), pp. 1247–1270. https://doi.org/10.1108/MD-04-2017-0407

Dirks, S. and Keeling, M. (2009) *A vision of smarter cities: How cities can lead the way into a prosperous and sustainable future*. IBM Corporation.

Dirks, S., Gurdgiev, C. and Keeling, M. (2010) *Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy*. IBM Corporation.

Dodgson, M. and Gann, D. (2011) 'Technological innovation and complex systems in cities', *Journal of Urban Technology*, 18(3), pp. 101–113. https://doi.org/10.1080/10630732.2011.615570

Eden Strategy Institute and ONG&ONG Pte Ltd. (2018) *Top 50 smart city governments*. Available at: https://static1.squarespace.com/static/5b3c517fec4eb767a04e73ff/t/5b513c57aa4a99f62d168e60/1532050650562/Eden-OXD_Top+50+Smart+City+Governments.pdf

Eger, J. (2003) *The creative community: Forging the links between art, culture, commerce and community*.

Eger, J.M. (2016) 'This is the decade of cities', *HuffPost*, 2 April. Available at: https://www.huffingtonpost.com/john-m-eger/this-is-the-decade-of-cit_b_9596524.html

Eisenhardt, K.M. (1989) 'Building theories from case study research', *Academy of Management Review*, 14(4), pp. 532–550. https://doi.org/10.5465/amr.1989.4308385

Eisenhardt, K.M. and Graebner, M.E. (2007) 'Theory building from cases: Opportunities and challenges', *Academy of Management Journal*, 50(1), pp. 25–32. https://doi.org/10.5465/amj.2007.24160888

Esteban-Narro, R., Lo-Iacono-Ferreira, V.G. and Torregrosa-López, J.I. (2025) 'Urban stakeholders for sustainable and smart cities: An innovative identification and management methodology', *Smart Cities*, 8, p. 41. https://doi.org/10.3390/smartcities8020041

European Commission (2020) *100 climate-neutral cities by 2030 – by and for the citizens: Interim report of the Mission Board for Climate-Neutral and Smart Cities*. https://doi.org/10.2777/62649

European Commission (2021) 'EU mission: Climate-neutral and smart cities'. Available at: https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/missions-horizon-europe/climate-neutral-and-smart-cities_en (Accessed: 12 December 2021).

Fernandez-Anez, V., Fernández-Güell, J.M. and Giffinger, R. (2018) 'Smart City implementation and discourses: An integrated conceptual model. The case of Vienna', *Cities*, 78, pp. 4–16. https://doi.org/10.1016/j.cities.2017.12.004

Ferrer, J.N., Taranic, I., Veum, K., van den Oosterkamp, P. and Wilson, C. (2017) *The making of a smart city: Replication and scale-up of innovation in Europe*.

Fietkiewicz, K.J. and Stock, W.G. (2015) 'How "smart" are Japanese cities?', in *Proceedings of the Annual Hawaii International Conference on System Sciences*, pp. 2345–2354. https://doi.org/10.1109/HICSS.2015.282

Forum Virium Helsinki (2021) 'Co-creating urban futures'. Available at: https://forumvirium.fi/en (Accessed: 11 February 2021).

Gabrys, J. (2014) 'Programming environments – environmentality and citizen sensing in the smart city', *Environment and Planning D: Society and Space*, 32, pp. 30–48. https://doi.org/10.1068/d16812

García, J. and Sisto, R. (2015) *Smart City: Ranking best masters*. Available at: http://www.smartandcity.com/smart-city-ranking-best-masters/

Gawer, A. and Cusumano, M.A. (2014) 'Industry platforms and ecosystem innovation', *Journal of Product Innovation Management*, 31(3), pp. 417–433. https://doi.org/10.1111/jpim.12105

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N. and Meijers, E. (2007) *Smart cities: Ranking of European medium-sized cities*. Vienna: Vienna University of Technology.

Giffinger, R., Haindlmaier, G. and Kramar, H. (2010) 'The role of rankings in growing city competition', *Urban Research & Practice*, 3(3), pp. 299–312. https://doi.org/10.1080/17535069.2010.524420

Gil-Garcia, J.R., Pardo, T.A. and Nam, T. (2015) 'What makes a city smart? Identifying core components and proposing an integrative framework', *Information Polity*, 20(1), pp. 61–87.

Glaser, B.G. (1978) *Theoretical sensitivity: Advances in the methodology of grounded theory*. Mill Valley, CA: Sociology Press.

Gracias, J.S., Parnell, G.S., Specking, E., Pohl, E.A. and Buchanan, R. (2023) 'Smart cities—A structured literature review', *Smart Cities*, 6, pp. 1719–1743. https://doi.org/10.3390/smartcities6040080

Guan, L. (2012) 'Smart steps to a battery city', *Government News*, 32(2), pp. 24–27.

Hajek, P., Youssef, A. and Hajkova, V. (2022) 'Recent developments in smart city assessment: A bibliometric and content analysis-based literature review', *Cities*, 126, p. 103709. https://doi.org/10.1016/j.cities.2022.103709

Hall, R.E. (2000) 'The vision of a smart city', in *Proceedings of the 2nd International Life Extension Technology Workshop*, Paris, 28 September.

Hall, R.E., Bowerman, B., Braverman, J., Taylor, J., Todosow, H. and von Wimmersperg, U. (2000) 'The vision of a smart city', in *Proceedings of the 2nd International Life Extension Technology Workshop*, pp. 1–6.

Hao, L., Lei, X., Yan, Z. and ChunLi, Y. (2012) 'The application and implementation research of smart city in China', in *2012 International Conference on System Science and Engineering (ICSSE)*, pp. 288–292. https://doi.org/10.1109/ICSSE.2012.6257192

Harrison, C. and Donnelly, I.A. (2010) 'A theory of smart cities', in *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences*.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J. and Williams, P. (2010) 'Foundations for smarter cities', *IBM Journal of Research and Development*, 54(4), pp. 1–16. https://doi.org/10.1147/JRD.2010.2048257

Harvey, D. (2000) *Spaces of Hope*. Edinburgh: Edinburgh University Press.

Hawksworth, J., Hoehn, T. and Tiwari, A. (2009) 'Which are the largest city economies in the world and how might this change by 2025?', *PricewaterhouseCoopers UK Economic Outlook*, November, pp. 20–34.

Heaton, J. and Parlikad, A.K. (2019) ‘A conceptual framework for the alignment of infrastructure assets to citizen requirements within a smart cities framework’, *Cities*, 90, pp. 32–41. https://doi.org/10.1016/j.cities.2019.01.041

Hollands, R.G. (2008) ‘Will the real smart city please stand up?’, *City*, 12(3), pp. 303–320. https://doi.org/10.1080/13604810802479126

Hollands, R.G. (2015) ‘Critical interventions into the corporate smart city’, *Cambridge Journal of Regions, Economy and Society*, 8, pp. 61–77. https://doi.org/10.1093/cjres/rsu011

Hu, W., Wang, S. and Zhai, W. (2023) ‘Human-centric vs. technology-centric approaches in a top-down smart city development regime: Evidence from 341 Chinese cities’, *Cities*, 137, p. 104271. https://doi.org/10.1016/j.cities.2023.104271

Hunter, G., Vettorato, D. and Sagoe, G. (2018) ‘Creating smart energy cities for sustainability through project implementation: A case study of Bolzano, Italy’, *Sustainability*, 10(7), p. 2167. https://doi.org/10.3390/su10072167

José, R. and Rodrigues, H. (2024) ‘A review on key innovation challenges for smart city initiatives’, *Smart Cities*, 7, pp. 141–162. https://doi.org/10.3390/smartcities7010006

Ju, J., Liu, L. and Feng, Y. (2024) ‘Governance mechanism of public-private partnerships for promoting smart city performance: A multi-case study in China’, *Cities*, 153, p. 105295. https://doi.org/10.1016/j.cities.2024.105295

Kaluarachchi, Y. (2022) ‘Implementing data-driven smart city applications for future cities’, *Smart Cities*, 5, pp. 455–474. https://doi.org/10.3390/smartcities5020025

Kim, J. (2022) ‘Smart city trends: A focus on 5 countries and 15 companies’, *Cities*, 123, p. 103551. https://doi.org/10.1016/j.cities.2021.103551

Kitchin, R. (2014) ‘The real-time city? Big data and smart urbanism’, *GeoJournal*, 79(1), pp. 1–14. https://doi.org/10.1007/s10708-013-9516-8

Kitchin, R. (2015) ‘Making sense of smart cities: Addressing present shortcomings’, *Cambridge Journal of Regions, Economy and Society*, 8(1), pp. 131–136. https://doi.org/10.1093/cjres/rsu027

Kitchin, R. (2016) ‘The ethics of smart cities and urban science’, *Philosophical Transactions of the Royal Society A*, 374, p. 20160115. https://doi.org/10.1098/rsta.2016.0115

Klopp, J.M. and Petretta, D. (2016) ‘Can we actually agree on indicators to measure urban development?’.

Komninos, N. (2002) *Intelligent Cities: Innovation, Knowledge Systems and Digital Spaces*. London and New York: Spon Press.

Komninos, N. (2006) ‘The architecture of intelligent cities: Integrating human, collective and artificial intelligence to enhance knowledge and innovation’, in *2nd IET International Conference on Intelligent Environments*. https://doi.org/10.1049/cp:20060620

Komninos, N. (2011) ‘Intelligent cities: Variable geometries of spatial intelligence’, *Intelligent Buildings International*, 3(3), pp. 172–188. https://doi.org/10.1080/17508975.2011.579339

Komninos, N. (2014) *The Age of Intelligent Cities: Smart Environments and Innovation-for-All Strategies*. New York: Routledge.

Komninos, N. and Mora, L. (2018) ‘Exploring the big picture of smart city research’, *Scienze Regionali*, 17(1), pp. 15–38. https://doi.org/10.14650/88815

Kourtit, K. and Nijkamp, P. (2012) ‘Smart cities in the innovation age’, *Innovation: The European Journal of Social Science Research*, 25(2), pp. 93–95. https://doi.org/10.1080/13511610.2012.660331

Kourtit, K., Nijkamp, P. and Arribas, D. (2012) ‘Smart cities in perspective – A comparative European study by means of self-organizing maps’, *Innovation: The European Journal of Social Science Research*, 25(2), pp. 229–246.

Kummitha, R.K.R. (2025) ‘Smart city governance: Assessing modes of active citizen engagement’, *Regional Studies*, 59, p. 2399262. https://doi.org/10.1080/00343404.2024.2399262

Kummitha, R.K.R. and Crutzen, N. (2017) ‘How do we understand smart cities? An evolutionary perspective’, *Cities*, 67, pp. 43–52. https://doi.org/10.1016/j.cities.2017.04.010

Lados, M. (2016) ‘Smart city models in Hungary’, in *New Ideas and New Generations of Regional Policy in Eastern Europe*, pp. 1–46. Pécs.

Lafioune, N., Desmarest, A., Poirier, É.A. and St-Jacques, M. (2023) ‘Digital transformation in municipalities for the planning, delivery, use and management of infrastructure assets: Strategic and organizational framework’, *Sustainable Futures*, 6, p. 100119. https://doi.org/10.1016/j.sftr.2023.100119

Lam, P.T.I. and Ma, R. (2019) ‘Potential pitfalls in the development of smart cities and mitigation measures: An exploratory study’, *Cities*, 91, pp. 146–156. https://doi.org/10.1016/j.cities.2018.11.014

Lazaroiu, G.C. and Roscia, M. (2012) ‘Definition methodology for the smart cities model’, *Energy*, 47(1), pp. 326–332. https://doi.org/10.1016/j.energy.2012.09.028

Lechner Tudásközpont (2021) ‘Smart City Project Database’. Available at: http://okosvaros.lechnerkozpont.hu/en (Accessed: 10 February 2021).

Lee, J., Babcock, J., Pham, T.S., Bui, T.H. and Kang, M. (2023) ‘Smart city as a social transition towards inclusive development through technology: A tale of four smart cities’, *International Journal of Urban Sciences*, 27, pp. 75–100. https://doi.org/10.1080/12265934.2022.2074076

Lee, J.H., Hancock, M.G. and Hu, M.-C. (2014) ‘Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco’, *Technological Forecasting and Social Change*, 89, pp. 80–99. https://doi.org/10.1016/j.techfore.2013.08.033

Lee, J.H., Phaal, R. and Lee, S.-H. (2013) ‘An integrated service-device-technology roadmap for smart city development’, *Technological Forecasting and Social Change*, 80(2), pp. 286–306. https://doi.org/10.1016/j.techfore.2012.09.020

Lentner, C. (2014) ‘A magyar önkormányzatok adósságkonszolidációja [Debt consolidation of Hungarian local governments]’, *Pénzügyi Szemle*, 3, pp. 330–344.

Lim, C., Kim, K.-J. and Maglio, P.P. (2018) ‘Smart cities with big data: Reference models, challenges, and considerations’, *Cities*, 82, pp. 86–99. https://doi.org/10.1016/j.cities.2018.04.011

Lim, M. and Ong, B.Y. (2019) ‘Communities of innovation’, *International Journal of Innovation Science*. https://doi.org/10.1108/IJIS-09-2017-0086

Liu, Z. and Wu, J. (2023) ‘A review of the theory and practice of smart city construction in China’, *Sustainability*, 15, p. 7161. https://doi.org/10.3390/su15097161

Lombardi, P., Giordano, S., Farouh, H. and Yousef, W. (2012) ‘Modelling the smart city performance’, *Innovation: The European Journal of Social Science Research*, 25(2), pp. 137–149. https://doi.org/10.1080/13511610.2012.660325

Lopez-Carreiro, I., Monzon, A. and Lopez, E. (2023) ‘MaaS implications in the smart city: A multi-stakeholder approach’, *Sustainability*, 15, p. 10832. https://doi.org/10.3390/su151410832

Lukács, R. and Csomós, G. (2020) ‘Az okosváros-komponensek megjelenésének vizsgálata a magyar városok 2014–2020-as településfejlesztési stratégiáiban’, *Tér-Gazdaság-Ember*, 8(1), pp. 25–33.

Mahizhnan, A. (1999) ‘Smart cities: The Singapore case’, *Cities*, 16(1), pp. 13–18. https://doi.org/10.1016/S0264-2751(98)00050-X

Malandrino, O., Sica, D. and Supino, S. (2019) ‘The role of public administration in sustainable urban development: Evidence from Italy’, *Smart Cities*, 2, pp. 82–95. https://doi.org/10.3390/smartcities2010006

Manville, C., Cochrane, G., Cave, J., Millard, J., Pederson, J.K., Thaarup, R.K. and Kotterink, B. (2014) *Mapping smart cities in the EU*. Brussels: European Parliament. https://doi.org/10.1017/CBO9781107415324.004

Marsal-Llacuna, M.-L., Colomer-Llinàs, J. and Meléndez-Frigola, J. (2015) ‘Lessons in urban monitoring taken from sustainable and livable cities to better address the smart cities initiative’, *Technological Forecasting and Social Change*, 90, pp. 611–622. https://doi.org/10.1016/j.techfore.2014.01.012

Marvin, S., Luque-Ayala, A. and McFarlane, C. (2015) *Smart Urbanism: Utopian Vision or False Dawn?* London: Routledge.

Maslow, A.H. (1954) *Motivation and Personality*. New York: Harper.

Mayring, P. (2000) ‘Qualitative content analysis’, *Forum: Qualitative Social Research*, 1(2), Art. 20. https://doi.org/10.17169/fqs-1.2.1089

McFarlane, C. and Söderström, O. (2017) ‘On alternative smart cities: From a technology-intensive to a knowledge-intensive smart urbanism’, *City*, 21, pp. 312–328. https://doi.org/10.1080/13604813.2017.1327166

McNeill, D. (2015) ‘Global firms and smart technologies: IBM and the reduction of cities’, *Transactions of the Institute of British Geographers*, 40(4), pp. 562–574. https://doi.org/10.1111/tran.12098

Meijer, A. and Bolívar, M.P.R. (2016) ‘Governing the smart city: A review of the literature on smart urban governance’, *International Review of Administrative Sciences*, 82(2), pp. 392–408. https://doi.org/10.1177/0020852314564308

Mora, L. and Bolici, R. (2016) ‘The development process of smart city strategies: The case of Barcelona’, in Rajaniemi, J. (ed.) *Re-city: Future city—Combining disciplines*, pp. 155–181. Tampere: Tampere University of Technology.

Mora, L. and Bolici, R. (2017) ‘How to become a smart city: Learning from Amsterdam’, in Bisello, A., Vettorato, D., Stephens, R. and Elisei, P. (eds.) *Smart and Sustainable Planning for Cities and Regions: Results of SSPCR 2015*. Cham: Springer, pp. 251–266. https://doi.org/10.1007/978-3-319-44899-2_15

Mora, L., Bolici, R. and Deakin, M. (2017) ‘The first two decades of smart-city research: A bibliometric analysis’, *Journal of Urban Technology*. https://doi.org/10.1080/10630732.2017.1285123

Mora, L., Deakin, M. and Reid, A. (2018) ‘Smart-city development paths: Insights from the first two decades of research’, in *Smart and Sustainable Planning for Cities and Regions*. Cham: Springer, pp. 403–427. https://doi.org/10.1007/978-3-319-75774-2_28

Mora, L., Deakin, M. and Reid, A. (2019) ‘Strategic principles for smart city development: A multiple case study analysis of European best practices’, *Technological Forecasting and Social Change*, 142, pp. 70–97. https://doi.org/10.1016/j.techfore.2018.07.035

Mora, L., Deakin, M., Reid, A. and Angelidou, M. (2019) ‘How to overcome the dichotomous nature of smart city research: Proposed methodology and results of a pilot study’, *Journal of Urban Technology*, 26(2), pp. 89–128. https://doi.org/10.1080/10630732.2018.1525265

Mori, K. and Christodoulou, A. (2012) ‘Review of sustainability indices and indicators: Towards a new city sustainability index (CSI)’, *Environmental Impact Assessment Review*, 32(1), pp. 94–106. https://doi.org/10.1016/j.eiar.2011.06.001

Mu, R., Haershan, M. and Wu, P. (2022) ‘What organizational conditions, in combination, drive technology enactment in government-led smart city projects?’, *Technological Forecasting and Social Change*, 174, p. 121220. https://doi.org/10.1016/j.techfore.2021.121220

Myeong, S., Kim, Y. and Ahn, M.J. (2021) ‘Smart city strategies—Technology push or culture pull? A case study exploration of Gimpo and Namyangju, South Korea’, *Smart Cities*, 4, pp. 41–53. https://doi.org/10.3390/smartcities4010003

Nagy, Z., Tóth, G. and Szendi, D. (2016) ‘Opportunities for adaptation of the smart city concept – A regional approach’, *Theory, Methodology, Practice*, 12, pp. 87–93. https://doi.org/10.18096/tmp.2016.02.08

Nam, T. and Pardo, T.A. (2011a) ‘Conceptualizing smart city with dimensions of technology, people, and institutions’, in *Proceedings of the 12th Annual International Digital Government Research Conference on Digital Government Innovation in Challenging Times*, pp. 282–291. https://doi.org/10.1145/2037556.2037602

Nam, T. and Pardo, T.A. (2011b) ‘Smart city as urban innovation’, in *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance*, p. 185. https://doi.org/10.1145/2072069.2072100

Nam, T. and Pardo, T.A. (2014) ‘The changing face of a city government: A case study of Philly311’, *Government Information Quarterly*, 31(Suppl. 1), pp. S1–S9. https://doi.org/10.1016/j.giq.2014.01.002

Naphade, M., Banavar, G., Harrison, C., Paraszczak, J. and Morris, R. (2011) ‘Smarter cities and their innovation challenges’, *Computer*, 44(6), pp. 32–39. https://doi.org/10.1109/MC.2011.187

Neirotti, P., De Marco, A., Cagliano, A.C., Mangano, G. and Scorrano, F. (2014) ‘Current trends in smart city initiatives: Some stylised facts’, *Cities*, 38, pp. 25–36. https://doi.org/10.1016/j.cities.2013.12.010

Nel, D., du Plessis, C. and Landman, K. (2018) ‘Planning for dynamic cities: Introducing a framework to understand urban change from a complex adaptive systems approach’, *International Planning Studies*, 23(3), pp. 250–263. https://doi.org/10.1080/13563475.2018.1439370

Nguyen, H.T., Marques, P. and Benneworth, P. (2022) 'Living labs: Challenging and changing the smart city power relations?', *Technological Forecasting and Social Change*, 183, p. 121866. https://doi.org/10.1016/j.techfore.2022.121866

Nordregio (2004) *Potentials for polycentric development in Europe*. Stockholm.

Nowaczyk, S., Resmini, A., Long, V., Fors, V., Cooney, M., Duarte, E.K., Pink, S., Aksoy, E.E., Vinel, A. and Dougherty, M. (2022) 'Smaller is smarter: A case for small to medium-sized smart cities', *Smart Cities and Society*, 1, pp. 95–117.

Offenhuber, D. and Schechtner, K. (2018) 'Improstructure – an improvisational perspective on smart infrastructure governance', *Cities*, 72, pp. 329–338. https://doi.org/10.1016/j.cities.2017.09.017

Orbis Research (2018) *Global smart cities market – Analysis of growth, trends and forecasts (2018–2023)*. Mordor Intelligence.

O'Reilly, C.A. and Tushman, M.L. (2008) 'Ambidexterity as a dynamic capability: Resolving the innovator's dilemma', *Research in Organizational Behavior*, 28, pp. 185–206. https://doi.org/10.1016/j.riob.2008.06.002

Pham, C. (2014) *Smart cities in Japan: An assessment on the potential for EU–Japan cooperation and business development*. EU-Japan Centre for Industrial Cooperation.

Porter, D.R. (1997) *Managing Growth in America's Communities*. Washington, DC: Island Press.

Porter, M.E. (1998) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. 1st Free Press edn. New York: Free Press.

Praharaj, S., Han, J.H. and Hawken, S. (2018) 'Towards the right model of smart city governance in India', *International Journal of Sustainable Development and Planning*, 13(2), pp. 171–186. https://doi.org/10.2495/SDP-V13-N2-171-186

Prieto, C. (n.d.) '112 Mission Cities striving for climate neutrality by 2030'. *NetZeroCities*. Available at: https://netzerocities.eu/mission-cities/

Quan, X. and Solheim, M.C.W. (2023) 'Public-private partnerships in smart cities: A critical survey and research agenda', *City, Culture and Society*, 32, p. 100491. https://doi.org/10.1016/j.ccs.2022.100491

Rajakallio, K., Cuthbertson, R., Pulkka, L. and Junnila, S. (2018) 'Creating urban platforms – Opportunities and challenges for innovation in commercial real estate development', *Cities*, 77, pp. 92–103. https://doi.org/10.1016/j.cities.2018.01.016

Ramaprasad, A., Sánchez-Ortiz, A. and Syn, T. (2017) 'A unified definition of a smart city', in Janssen, M. et al. (eds.) *Electronic Government*. Cham: Springer, pp. 13–24. https://doi.org/10.1007/978-3-319-64677-0_2

Reed, M.S. (2008) 'Stakeholder participation for environmental management: A literature review', *Biological Conservation*, 141(10), pp. 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Robinson, R. (2014) 'Six ways to design humanity and localism into smart cities'. Available at: https://theurbantechnologist.com/2014/03/16/six-ways-to-design-humanity-and-localism-into-smart-cities/

Robinson, R. (2015) '6 inconvenient truths about smart cities'. Available at: http://theurbantechnologist.com/2015/02/15/6-inconvenient-truths-about-smart-cities/

Ruhlandt, R.W.S. (2018) 'The governance of smart cities: A systematic literature review', *Cities*, 81, pp. 1–23. https://doi.org/10.1016/j.cities.2018.02.014

Sabatini-Marques, J., da Costa, E.M., Chang, D.L., Yigitcanlar, T. and Selig, P.M. (2018) 'Knowledge-based, smart and sustainable cities: A provocation for a conceptual framework', *Journal of Open Innovation: Technology, Market, and Complexity*, 4(1). https://doi.org/10.1186/s40852-018-0087-2

Salvia, M., Pietrapertosa, F., D'Alonzo, V., Clerici Maestosi, P., Simoes, S.G. and Reckien, D. (2023) 'Key dimensions of cities' engagement in the transition to climate neutrality', *Journal of Environmental Management*, 344, p. 118519. https://doi.org/10.1016/j.jenvman.2023.118519

Schipper, R.P.J.R. and Silvius, A.J.G. (2018) 'Characteristics of smart sustainable city development: Implications for project management', *Smart Cities*, 1, pp. 75–97. https://doi.org/10.3390/smartcities1010005

Schuurman, D., Baccarne, B. and De Marez, L. (2012) 'Smart ideas for smart cities: Investigating crowdsourcing for generating and selecting ideas for ICT innovation in

a city context', *Journal of Theoretical and Applied Electronic Commerce Research*, 7(3), pp. 11–12. https://doi.org/10.4067/S0718-18762012000300006

Sepasgozar, S.M.E., Hawken, S., Sargolzaei, S. and Foroozanfa, M. (2019) 'Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies', *Technological Forecasting and Social Change*, 142, pp. 105–116. https://doi.org/10.1016/j.techfore.2018.09.012

Shabb, K. and McCormick, K. (2023) 'Achieving 100 climate neutral cities in Europe: Investigating climate city contracts in Sweden', *npj Climate Action*, 2, p. 6. https://doi.org/10.1038/s44168-023-00035-8

Shapiro, J.M. (2006) 'Smart cities: Quality of life, productivity, and the growth effects of human capital', *Review of Economics and Statistics*, 88(2), pp. 324–335. https://doi.org/10.1162/rest.88.2.324

Sharifi, A., Khavarian-Garmsir, A.R. and Kummitha, R.K.R. (2021) 'Contributions of smart city solutions and technologies to resilience against the COVID-19 pandemic: A literature review', *Sustainability*, 13(14), 8018. https://doi.org/10.3390/su13148018

Shelton, T., Zook, M. and Wiig, A. (2015) 'The "actually existing smart city"', *Cambridge Journal of Regions, Economy and Society*, 8, pp. 13–25. https://doi.org/10.1093/cjres/rsu026

Shen, L.Y., Jorge Ochoa, J., Shah, M.N. and Zhang, X. (2011) 'The application of urban sustainability indicators – A comparison between various practices', *Habitat International*, 35(1), pp. 17–29. https://doi.org/10.1016/j.habitatint.2010.03.006

Shi, F. and Shi, W. (2023) 'A critical review of smart city frameworks: New criteria to consider when building smart city framework', *ISPRS International Journal of Geo-Information*, 12, p. 364. https://doi.org/10.3390/ijgi12090364

Silva, B.N., Khan, M. and Han, K. (2018) 'Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities', *Sustainable Cities and Society*, 38, pp. 697–713. https://doi.org/10.1016/j.scs.2018.01.053

Söderström, O., Paasche, T. and Klauser, F. (2014) 'Smart cities as corporate storytelling', *City*, 18(3), pp. 307–320. https://doi.org/10.1080/13604813.2014.9067162

Sørensen, E. and Torfing, J. (2018) ‘Co-initiation of collaborative innovation in urban spaces’, *Urban Affairs Review*, 54(2), pp. 388–418. https://doi.org/10.1177/1078087416651936

Szalai, Á. and Fabula, S. (2021) ‘The role of locality and place-specific development paths in creating smart cities: The example of middle-sized Hungarian cities’, *Geographia Polonica*, 94(4), pp. 483–502. https://doi.org/10.7163/GPol.0216

Taylor Buck, N. and While, A. (2017) ‘Competitive urbanism and the limits to smart city innovation: The UK Future Cities Initiative’, *Urban Studies*, 54(2), pp. 501–519. https://doi.org/10.1177/0042098015597162

Tejedo-Romero, F., Araujo, J.F.F.E., Tejada, Á. and Ramírez, Y. (2022) ‘E-government mechanisms to enhance the participation of citizens and society: Exploratory analysis through the dimension of municipalities’, *Technology in Society*, 70, p. 101978. https://doi.org/10.1016/j.techsoc.2022.101978

Thite, M. (2011) ‘Smart cities: Implications of urban planning for human resource development’, *Human Resource Development International*, 14(5), pp. 623–631. https://doi.org/10.1080/13678868.2011.618349

Thomas, V., Wang, D., Mullagh, L. and Dunn, N. (2016) ‘Where’s Wally? In search of citizen perspectives on the smart city’, *Sustainability*, 8(3), p. 207. https://doi.org/10.3390/su8030207

Thuzar, M. (2011) ‘Urbanization in Southeast Asia: Developing smart cities for the future?’, in Montesano, M.J. and Onn, L.P. (eds.) *Regional Outlook: Southeast Asia 2011–2012*, pp. 96–100. Institute of Southeast Asian Studies. https://doi.org/10.1355/9789814311694-022

Tobey, M.B., Binder, R.B., Chang, S., Yoshida, T., Yamagata, Y. and Yang, P.P.J. (2019) ‘Urban systems design: A conceptual framework for planning smart communities’, *Smart Cities*, 2, pp. 522–537. https://doi.org/10.3390/smartcities2040032

Trapp, H. (2018) ‘Lecsengett a smart city hype?’, *GyártásTrend*, 25 January. Available at: http://gyartastrend.hu/varoslako/cikk/lecsengett_a_smart_city_hype

Trencher, G. (2019) ‘Towards the smart city 2.0: Empirical evidence of using smartness as a tool for tackling social challenges’, *Technological Forecasting and Social Change*, 142, pp. 117–128. https://doi.org/10.1016/j.techfore.2018.07.033

Ulpiani, G., Rebolledo, E., Vetters, N., Florio, P. and Bertoldi, P. (2023) 'Funding and financing the zero emissions journey: Urban visions from the 100 Climate-Neutral and Smart Cities Mission', *Humanities and Social Sciences Communications*, 10, p. 647. https://doi.org/10.1057/s41599-023-02055-5

United Nations (2015) *World Urbanization Prospects: The 2014 Revision*. New York: United Nations, Department of Economic and Social Affairs, Population Division. https://doi.org/10.4054/DemRes.2005.12.9

United Nations (2018) *World Urbanization Prospects: The 2018 Revision, Online Edition*. New York: United Nations, Department of Economic and Social Affairs, Population Division.

United Nations Human Settlements Programme (2009) *Planning Sustainable Cities: Global Report on Human Settlements 2009*. London: Earthscan/UN-HABITAT. https://doi.org/10.1002/psp.616

van den Buuse, D. and Kolk, A. (2019) 'An exploration of smart city approaches by international ICT firms', *Technological Forecasting and Social Change*, 142, pp. 220–234. https://doi.org/10.1016/j.techfore.2018.07.029

van der Graaf, S. and Ballon, P. (2019) 'Navigating platform urbanism', *Technological Forecasting and Social Change*, 142, pp. 364–372. https://doi.org/10.1016/j.techfore.2018.07.027

Vanolo, A. (2014) 'Smartmentality: The smart city as disciplinary strategy', *Urban Studies*, 51(5), pp. 883–898. https://doi.org/10.1177/0042098013494427

Varró, K. and Bunders, D.J. (2020) 'Bringing back the national to the study of globally circulating policy ideas: "Actually existing smart urbanism" in Hungary and the Netherlands', *European Urban and Regional Studies*, 27(3), pp. 209–226. https://doi.org/10.1177/0969776419893731

Varró, K. and Szalai, Á. (2022) 'Discourses and practices of the smart city in Central Eastern Europe: Insights from Hungary's "big" cities', *Urban Research & Practice*, 15, pp. 699–723. https://doi.org/10.1080/17535069.2021.1904276

Varró, K. (2025) 'Provincialising smart urbanism further, from the Global East: Articulating the smart city in the context of Hungary's authoritarian state capitalism', *Urban Studies*. https://doi.org/10.1177/00420980251315946

Voorwinden, A. (2021) ‘The privatised city: Technology and public-private partnerships in the smart city’, *Law, Innovation and Technology*, 13, pp. 439–463. https://doi.org/10.1080/17579961.2021.1977213

Washburn, D., Sindhu, U., Balaouras, S., Dines, R.A., Hayes, N.M. and Nelson, L.E. (2010) *Helping CIOs understand “smart city” initiatives*. Cambridge, MA: Forrester Research.

Whyte, J., Hart, T., Yanrong, K., Lei, Z., Cai, C., Yuming, G. and Ying, C. (2014) *EU-China Smart and Green City Cooperation: Comparative Study of Smart Cities in Europe and China*. White paper.

Winden, W. van and van den Buuse, D. (2017) ‘Smart city pilot projects: Exploring the dimensions and conditions of scaling up’, *Journal of Urban Technology*, 24(4), pp. 51–72. https://doi.org/10.1080/10630732.2017.1348884

Winden, W. van, Oskam, I., van den Buuse, D., Schrama, W., van Dijck, E.-J. and Frederiks, M. (2016) *Organising Smart City Projects: Lessons from Amsterdam*. Amsterdam: Hogeschool van Amsterdam.

World Bank (2016) *World Development Report 2016: Digital Dividends*. Washington, DC: World Bank. https://doi.org/10.1596/978-1-4648-0671-1

Yigitcanlar, T. and Velibeyoglu, K. (2008) ‘Knowledge-based urban development: The local economic development path of Brisbane, Australia’, *Local Economy*, 23(3), pp. 195–207. https://doi.org/10.1080/02690940802197358

Yigitcanlar, T., Kamruzzaman, M., Buys, L., Ioppolo, G., Sabatini-Marques, J., da Costa, E.M. and Yun, J.J. (2018) ‘Understanding “smart cities”: Intertwining development drivers with desired outcomes in a multidimensional framework’, *Cities*, 81, pp. 145–160. https://doi.org/10.1016/j.cities.2018.04.003

Yin, C., Xiong, Z., Chen, H., Wang, J., Cooper, D. and David, B. (2015) ‘A literature survey on smart cities’, *Science China Information Sciences*, 58(10), pp. 1–18. https://doi.org/10.1007/s11432-015-5397-4

Yin, R.K. (2009) *Case Study Research: Design and Methods*. 4th edn. Thousand Oaks, CA: SAGE Publications.

Yin, R.K. (2012) *Applications of Case Study Research*. Thousand Oaks, CA: SAGE Publications.

Z. Karvalics, L. (2016) ‘Okos városok: A dekonstrukciótól a hiperkonstrukcióig’, *Információs Társadalom*, 16(3), p. 9. https://doi.org/10.22503/inftars.xvi.2016.3.1

Zhang, K., Ni, J., Yang, K., Liang, X., Ren, J. and Shen, X.S. (2017) ‘Security and privacy in smart city applications: Challenges and solutions’, *IEEE Communications Magazine*, 55(1), pp. 122–129. https://doi.org/10.1109/MCOM.2017.1600267CM

Zhao, F., Fashola, O.I., Olarewaju, T.I. and Onwumere, I. (2021) ‘Smart city research: A holistic and state-of-the-art literature review’, *Cities*, 119, p. 103406. https://doi.org/10.1016/j.cities.2021.103406

Zhen, F., Xi, G., Zhang, S. et al. (2025) ‘Tomorrow’s smart cities: Reflections on the Chinese practices of smart cities and strategy development for the future’, *Chinese Geographical Science*, 35, pp. 929–944. https://doi.org/10.1007/s11769-025-1550-1

Zygiaris, S. (2013) ‘Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems’, *Journal of the Knowledge Economy*, 4(2), pp. 217–231. https://doi.org/10.1007/s13132-012-0089-4

Appendices

Appendix A. List of Abbreviations

Abbreviation	Meaning
ASP	Application Service Provider
BKK	Budapesti Közlekedési Központ (Centre for Budapest Transport)
CEE	Central and Eastern Europe / Central and Eastern European
CoI	Community of Innovation
CRM	Citizen Relationship Management
EU	European Union
GDP	Gross Domestic Product
GIS	Geographic Information System
ICT	Information and Communication Technology
JEL	Journal of Economic Literature
NGO	Non-Governmental Organization
PPP	Public–Private Partnership
QCA	Qualitative Content Analysis / Qualitative Comparative Analysis
SC	Smart City
SCs	Smart Cities
SECAP	Sustainable Energy and Climate Action Plan
SME	Small and Medium-Sized Enterprise
SmartCEPS	Smart City Evaluation Platform and Services
SUMP	Sustainable Urban Mobility Plan
UPM	Urban Planning and Management
VM	Virtual Marketplace

Appendix B. Glossary of Key Terms

Term	Definition
Activity portfolio	The full set of smart city initiatives, projects, and interventions implemented by a city. In this dissertation, activity portfolios are used to interpret a city's strategic orientation and anticipated value propositions.
Bottom-up approach	A mode of smart city development in which citizens, civil society, or non-governmental stakeholders play the principal formative role, rather than the municipality alone.
Community building	A type of smart city activity aimed at strengthening participation, awareness, collaboration, or local social capacity rather than primarily deploying technological solutions.
Data-driven urban development	Urban planning and management supported by urban data, analytics, and evidence-based decision-making rather than intuition or isolated project logic.
Digital infrastructure	The technological backbone of smart city development, including digital platforms, connectivity, sensors, information systems, and other ICT-enabled systems.
Double-helix model of collaboration	A relatively narrow collaboration structure centred mainly on government and industry / private-sector actors.
Holistic strategy	A smart city strategy that treats technology as a means rather than an end and gives weight to wider urban, social, environmental, and institutional conditions.
Integrated intervention logic	A smart city development logic that spans multiple urban domains in a coordinated and cross-cutting way, rather than focusing on one isolated sector only.
Medium-sized city	In this dissertation, a city generally understood in line with the European medium-sized city literature, typically with a population between roughly 100,000 and 500,000, but also characterized by a distinct governance and capacity context.
Mono-dimensional intervention logic	A smart city logic focused on a single domain or on isolated projects rather than on broader integrated urban transformation.
Open innovation	An organizational logic in which knowledge creation and problem-solving take place across organizational boundaries through collaboration, knowledge inflows, and knowledge outflows.
Organizational design	The configuration of roles, responsibilities, coordination mechanisms, and collaborative arrangements through which urban digitalization is planned and implemented.
Platform urbanism / platform-based model	An approach in which urban actors interact through a structured platform that facilitates coordination, data use, knowledge exchange, and service matching across stakeholders.
Public value	The broader urban benefit expected from smart city development, such as improved quality of life, sustainability, inclusion, better services, or more effective governance.

Quadruple-helix model of collaboration	A broader collaboration structure involving government, industry, academia, and civil society in smart city development.
Smart city	A mode of urban development in which digital technologies, governance arrangements, organizational capabilities, and stakeholder collaboration are used to improve sustainability, quality of life, urban services, and decision-making.
Smart city governance	The institutional and relational process through which smart city priorities are set, actors are coordinated, and implementation is organized.
Smart city strategy	The explicit or implicit strategic logic through which a city defines smart city priorities, implementation directions, and desired urban outcomes.
SmartCEPS	A proposed platform-based organizational model for urban planning and management, designed as a data-driven, scalable, evidence-based, participatory decision-support system for small and medium-sized cities.
Stakeholder network	The structured set of relations among organizations participating in smart city initiatives. In the Debrecen study, this is analysed through co-participation in projects.
Strategic framework	Non-project, non-infrastructure activities that create the planning, policy, or institutional basis for smart city development.
Technology-driven strategy	A smart city strategy in which the deployment of ICT solutions, applications, and digital infrastructure is prioritized over broader institutional or social transformation.
Top-down approach	A mode of smart city development in which the municipality and public authorities take the leading role in defining priorities and coordinating implementation.
Urban digitalization	The process through which cities integrate digital technologies, data, and digitally enabled organizational practices into planning, management, and service provision.
Urban Planning and Management (UPM)	The planning, coordination, and governance of urban development and urban services; in the organizational design chapter this is the main field into which SmartCEPS is introduced.
Value proposition	The expected benefit logic embedded in a smart city initiative or portfolio, such as efficiency, inclusion, sustainability, connectivity, or quality of life.

Appendix C. References of publications of the author

Csukás, M. S., and Szabó, R. Z. (2018). *Factors Hindering Smart City Developments in Medium-Sized Cities*. TMP, 14(1), 3-14. https://doi.org/10.18096/TMP.2018.01.01

Csukás, M. S., Bukovszki, V. and Reith, A. (2020) 'Challenges and Solutions for Organizational Design in Urban Digitalization', *European Journal of Sustainable Development*, 9(2), pp. 615-629. https://doi.org/10.14207/ejsd.2020.v9n2p615 .

Csukás, M. S. and Szabó, R. Z. (2021) 'The many faces of the smart city: Differing value propositions in the activity portfolios of nine cities', *Cities*, 112, 103116. https://doi.org/10.1016/j.cities.2021.103116 .

Csukás, Máté and Szabó, Roland Zs. (2022) 'What are the conditions to become smart? A systematic analysis of the smart city strategy and smart city development activities of Budapest', *Információs Társadalom*, 22(2), pp. 9-26. https://dx.doi.org/10.22503/inftars.XXII.2022.2.1 .

Csukás, M. S. and Szabó, R. Zs. (2026) 'Smart city governance in a medium-sized European city: Strategic dichotomies and stakeholder networks in Debrecen (Hungary)', Open Research Europe, 6, 206. https://doi.org/10.12688/openreseurope.23465.1 Based on: Csukás, M.S. (2026) Debrecen (Hungary) city smart city projects and initiatives dataset (2007–2025) [data set]. Zenodo. Available at: https://doi.org/10.5281/zenodo.18436325 .