PLANNING THEORY & PRACTICE
2026, VOL. 27, NO. 1, 52–80
https://doi.org/10.1080/14649357.2026.2622673



# Mapping Urban Innovation Ecosystems: A Tool for Strategic Spatial Planning

Emil Israel[a], Amnon Frenkel[a], Ofer Lerner[a], Aba Attila[b], Domokos Esztergár-Kiss[b], Tomáš Horák[c], Jiri Plihal[d], Alain Thierstein[e] and Fabian Wenner[f]

[a]The Urban and Regional Planning Program, Faculty of Architecture and Town Planning, Technion – Israel Institute of Technology, Haifa, Israel; [b]Department of Transport Technology and Economics, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics, Budapest, Hungary; [c]Department of Smart Cities and Regions, Faculty of Transportation Sciences, Czech Technical University in Prague, Prague, Czech Republic; [d]Department of Signal Processing, the Czech Academy of Sciences, Institute of Information Theory and Automation, Prague, Czech Republic; [e]Department of Architecture, Technical University of Munich, Munich, Germany; [f]Architecture and Civil Engineering, RheinMain University of Applied Sciences, Wiesbaden, Germany

**ABSTRACT**
Planning decisions are frequently impeded by an inadequate understanding of complex urban environments, necessitating data-driven and creative strategies. Based on a developed research question on this need, this study proposes a tool founded in the literature on strategic planning, sustainable development, and planning system innovation. The proposed tool depicts the components and interactions within urban ecosystems. The study employs the public transport sector as a case study to demonstrate the operationalization of the tool in Munich, Budapest, and Prague. The demonstration shows how the tool may better inform and support strategic urban planning decisions.

**ARTICLE HISTORY**
Received 8 August 2023
Accepted 22 January 2026

**KEYWORDS**
Innovation ecosystem; strategic planning; urban transportation; system components

## Introduction

Spatial planning and policy decisions are inextricably linked (Alterman & Duncan, 1983). Thus, the integration of strategic thinking in public policy has also led to its incorporation in spatial and urban planning, resulting in the emergence of the strategic planning approach. Strategic spatial planning has evolved from modernist blueprint approaches to more flexible and relational strategies that address uncertainty and complexity in urban development (Searle, 2020). This approach allows decision-makers to promote plans suited to the circumstances, despite a demanding and constantly changing environment (Albrechts, 2010; Albrechts & Balducci, 2013).

Patsy Healey (2009), for example, emphasized the need for a relational approach to understanding urban complexity and governance in strategic spatial planning. Her research examined the treatment of space and place in European spatial strategies. She highlighted the shift towards dynamic and relative concepts of spatiality, noting that the spatial organization of

**CONTACT** Emil Israel emil.israel@technion.ac.il The Urban and Regional Planning Program, Faculty of Architecture and Town Planning, Technion – Israel Institute of Technology, Haifa, 32000, Israel.

Supplemental data for this article can be accessed online at https://doi.org/10.1080/14649357.2026.2622673.

phenomena is crucial for quality of life, distributive justice, environmental well-being, and economic vitality (Healey, 2004, 2006). In essence, strategic spatial planning aims to coordinate public policy and private strategies to tackle complex urban challenges and promote sustainable development (Bafarasat & Oliveira, 2021; Demazière, 2018).

Its importance notwithstanding, there seems to be a missing link between contemporary strategic planning and the sustainable development strategy (ElMassah & Mohieldin, 2020; Hopwood et al., 2005). One example of strategic spatial planning is the urban transportation system, whose policies have a significant impact on how sustainability develops within and outside of cities. Although it presents challenging circumstances, the urban transportation system also serves as a means of addressing urban issues (e.g., Hamurcu & Eren, 2020). The significance of transportation systems within the broader urban system is the rationale for the focus on it in the current study.

In the realm of spatial and urban planning, numerous decisions remain partial and limited, despite the contribution of strategic planning to decision-making. The primary reasons for this situation include the neglect of the contextual dynamics in which planning decisions are made as well as the disregard of the critical dimensions of time and temporality. Consequently, strategic decisions in spatial and urban planning often result in short-term ad hoc policies (Hutter & Wiechmann, 2022; Moroni & Chif, 2022; Polk, 2011; Raco et al., 2008). Therefore, this study focuses on the following research question: How can strategic planning promote better innovative, data-driven decision-making for complex urban systems (for example, urban transportation ecosystems, as investigated in the current study utilizing three European cities as case studies. See additional explication below), while considering the contextual dynamics and the dimension of time? To answer this question, the study introduces a new mapping tool. Its use can help mitigate some common shortcomings of existing strategic planning such as the emergence of unintended, ad hoc policies.

As a management tool, strategic planning and thinking within urban systems involves two distinct but interconnected thinking processes. First, the governing authority responsible for the urban system must harmonize and coordinate its various components for their effective operation. Doing so involves aligning the city's infrastructure, services, stakeholders, and policies to achieve the governing authority's desired outcome of improving the system. Second, the same governing authority should foster a culture of intuitive, innovative, and creative thinking at all levels of the organization to drive continuous improvement and adaptation (Heracleous, 1998; Mintzberg, 1994, 2007). The study's new mapping tool addresses the problem of integrating these two processes into a comprehensive tool that helps those making decisions about strategic planning. The strategic tool, referred to as "Mapping Urban Innovation Ecosystems," enables the governing authority in charge of the urban system to evaluate the fundamental capabilities (i.e., strengths, key anchors[1]) that are the cornerstones of urban planning and growth, and use these evaluations when making decisions. The tool identifies the elements of the urban ecosystem under examination and the interrelations among them, as well as the degree to which these elements require improvements and additions to achieve optimal functionality.

The expression of urban innovation ecosystem was inspired by literature with analogous meanings to the subject of the current investigation (e.g., Bevilacqua et al., 2023; Spinosa & Costa, 2020). The tool uses quantitative and qualitative methods to track and examine the relationships between capabilities and processes in an urban innovation ecosystem. As such, the tool aims to leverage the principles of ecosystem restoration planning and acknowledges the dynamic nature of urban systems. Understanding the contextual dynamics of an urban ecosystem, its components, and its ability to address the challenges that it faces is essential for informed decision-making. The tool in this study provides policymakers with a comprehensive grasp of the urban ecosystem they are managing. Thus, it should help municipal leaders make more informed decisions by evaluating the wider implications of their actions and recognizing possible unintended repercussions. This enhanced understanding facilitates the formulation of strategic decisions that effectively address challenges to the urban ecosystem.

To examine the "Mapping Urban Innovation Ecosystems" tool and illustrate its application, the study focuses, as mentioned, on urban transportation. The tool is utilized to examine the transportation systems of three European cities. Each city developed differently, with differing prospects for its growth and planning. For many years the transportation systems in two of the cities–Budapest and Prague–were socialist in nature (Fitzová & Matulová, 2020; Kovács et al., 2019). The impact of communism in these cities is still quite evident even decades after this political environment ceased to exist. The transportation system in the third city, Munich, developed under free market conditions. Despite their differences, the cities all face challenges requiring strategic considerations regarding their ongoing urban development. Simultaneously, they have distinctive strengths that they can leverage to facilitate this development, with their transportation systems serving as a critical component of that development. It is reasonable to infer that these systems also play a critical role in the cities' long-term planning.[2]

The study makes a threefold contribution to the literature on strategic planning. First, it provides a method for mapping and identifying the strengths and deficiencies of urban systems, with the goal of improving the planning process. Second, by focusing on the interconnections between the strengths or core competencies of a given urban system and its deficiencies, the study challenges traditional conceptualizations of urban systems research that often lack a strategic view (e.g., Momin, 2023). The study also highlights the underlying contextual dynamics that decision-makers frequently overlook. For example, the analysis of Munich revealed that, despite the presence of collaborative platforms, market-driven entities often influence policy decisions more rapidly than municipal authorities, leading to overlooked contextual dynamics in decision-making. As a result, the needs of people are sometimes disregarded in favor of expedient or sector-specific solutions. Finally, local governments trying to deal with multifaceted issues might benefit by analyzing the interconnections between the components of their urban systems. This approach provides a strategic perspective that can facilitate problem-solving and lead to more efficient allocation of development-oriented resources.[3]

The remainder of the paper is organized as follows. The next section reviews the literature on urban, spatial, and strategic planning approaches, which ultimately led to the development of the tool for mapping an urban innovation ecosystem. The third section describes the methodology behind the model. Section four details the empirical case studies used in the study to test the tool. The study then presents a detailed mapping of each city's transportation sector. The last section discusses the advantages and drawbacks of the study's model.

## Theoretical Background

This literature about strategic spatial planning has shifted from rational planning paradigms toward more adaptive, governance-oriented approaches. This review integrates perspectives from strategic management, sustainable development, and systems thinking to highlight both the potential and limitations of current planning practices. Particular attention is given to the tensions between process and outcome, and between complexity and simplicity. The review ultimately sets the stage for developing tools that enable more effective, integrated urban planning and innovation.

## *Shifting from Rational Urban Planning to Strategic Planning*

Long-term planning has traditionally been guided by the rationality paradigm that prevailed in planning and related disciplines until the mid-1950s. Alexander (1984), who examined the decline of the rational planning paradigm, proposed the development of a new contingent approach or meta-theory of decision-making to replace it. He suggested that combining elements of abstraction and specificity might provide the most promising foundation for a new decision-making paradigm to replace the rational planning model. The acknowledgment of the limitations associated with rational planning outlined in numerous articles since the 1970s (e.g., Bryson & Roering, 1988; Wildavsky, 1973) led to the subsequent acceptance of the strategic planning approach (Albrechts, 2010). The need for planning tools that can help overcome uncertainty in social-spatial systems also prompted this move (Moroni & Chif, 2022). However, despite the great potential inherent in the new planning approaches that try to deal with complexity and uncertainty through strategic planning, especially in urban infrastructures, researchers find that conventional planning approaches are still commonly used (Malekpour et al., 2015).

Planning in the public sector becomes strategic planning if and when: "Participants have a clear recognition of, and desire to stabilize, what should be stabilized, while maintaining appropriate flexibility in terms of goals, policies, strategies, and processes to manage complexity, take advantage of important opportunities, and advance resilience and sustainability in the face of an uncertain future" (Bryson et al., 2018. p. 321). Strategic spatial planning is a process of governance and paradigm shifts, not merely the production of a plan document (Friedmann, 2004). Servillo (2010) argued that it should be seen as an arena for policy creation, recognizing the strategic role of territorial discourse in shaping values, content, and governance. Accordingly, Mäntysalo et al. (2015) emphasized that strategic spatial planning involves a dialectic between strategic and statutory planning, rather than an "either/or" approach. Mäntysalo and colleagues maintained that strategic spatial planning requires balancing seemingly contradictory aspects, such as selectivity and comprehensiveness, action orientation and plan orientation, and dealing with uncertainty while correcting certain certainties. However, Searle (2020) suggested that modernist strategic planning, based on fixed spatial schematics, has become less reliable due to unpredictable factors and the fluid nature of social and economic activities. He advocated for post-modernist strategic planning, which recognizes the need to consider uncertainty when making such plans and adopt more flexible and relational spatial strategies. Recently, Sheffield and Valler (2023) discussed the tension between governance and planning. They coined the concept of "urban intrapreneurialism," meaning deal-based policy in the context of strategic planning policy. This concept provides a framework for assessing deal-based policy responses to local governance challenges, evaluating its potential to address local and sub-regional governance dilemmas.

## *The Tensions Between Strategic Processes, Implementation, and Outcomes*

Strategic thinking was initially viewed as an influential management tool in the business sector (Eadie, 1983). It has been widely utilized in the public sector since the 1970s and led to the development of multiple strategic spatial and urban plans (Kaufman & Jacobs, 1987). As a result, many of the strategic planning processes in the public domain focus on defining opportunities and/or competitive advantages using analytic tools common in business such as SWOT (Gurl, 2017; Krogerus & Tschäppeler, 2017; Momin, 2023). However, these types of analyses pay less attention to the overall promise of strategic planning that Bryson and colleagues (2018) identified: to "advance the resilience and sustainability in the face of uncertain future."

Thus, current strategic planning often seems to focus on immediate results. Such an outcome is not surprising given that the SWOT analysis that dominates strategic planning practices is based on identifying specific elements, such as opportunities and threats. Given that both elements are short-term in nature, a long-term investigation of a location or system is frequently required. Failure to do so could result in the inability to make plans to accomplish long-term strategic goals. Moreover, given that decisions regarding development processes are made in an incremental, fragmented, sectoral, and sometimes even anecdotal way (or even just to satisfy decision-makers), many strategic planning processes that focus on competitive advantages and other similar elements actually impede future development by sacrificing the long term for the short term (Dagnino et al. 2021).

The ability to understand the effectiveness of strategic planning lies in the fact that it is a process-oriented approach consisting of knowledge and action (Ferlie & Ongaro, 2022; Mintzberg, 2007). As such, it provides answers to the questions of what should be done and why. However, it is not certain that these answers actually guide the implementation of plans. There is often a disconnect between the stakeholders' true desires and the stated goals of the plan, particularly when implementation must rely more on consent than authority (Bryson & Edwards, 2017). Therefore, designing a robust stakeholder engagement process is essential for fostering a comprehensive and in-depth consideration of all relevant perspectives, leading to a more legitimate and effective plan. Such engagement encourages participants to broaden their perspectives, think holistically, and consider all aspects of the issue at hand – not just the most obvious or immediate ones. This broader perspective is crucial for identifying new opportunities, avoiding potential pitfalls, building consensus among diverse stakeholders, and developing sustainable solutions. In this regard, strategic planning is approached as a platform for comprehensive communication and discussion among diverse stakeholders, rather than as a technocratic system (Legacy, 2012; Mäntysalo et al., 2019). For instance, Saldert (2021) contended that the municipality's departments might have varying interpretations of the planning processes. Challenges might arise when engaged in strategic urban planning due to the vagueness of the strategies and objectives. Or when many process-oriented approaches lack an inherent statement regarding the nature of the results they seek to promote. In other words, effective and holistic strategic thinking should not only define an effective planning process, but also make a clear statement regarding the nature of the outcomes and outputs of the planning. This clarity in strategic planning should be contextualized by specifying the actions that need to be taken to resolve an issue that requires attention during the planning process.

This tension in planning practices between process-oriented approaches and result-oriented approaches is as old as the discipline itself. On one hand, there are approaches that seek to define the optimal planning process for the purpose of achieving planning goals. Frug's (2001) book, *City Making,* exemplifies an investigation of how legal regulations influence contemporary urban environments and suggests options to dismantle the barriers that segregate city residents. On the other hand, there are approaches that define an "Urban Form" (Kropf, 2009; Lynch & Rodwin, 1958; Rapoport, 2016), meaning understanding the varied effects of different physical forms and of the locations of human activities in relation to these physical forms that we should try to promote. When it comes to strategic planning, the challenge is to formulate a comprehensive approach that bridges the quality of the "City Making" process and the quality of the future "Urban Form" with regard to its spatial, social, and economic aspects (Carmon, 2013). However, many planning practices seem to lack such an approach, as indicated by the link between strategic planning and the sustainable development strategy.

## *Toward Systemic, Ecosystem-Based Approaches to Urban Planning*

Numerous studies have underscored the vital connection between strategic planning and sustainable development. Narang and Reuterswärd (2006) and Dorofeeva and Leont'eva (2021) both highlighted the significance of strategic planning in achieving sustainable urban development. The former emphasized the importance of effective urban governance, and the latter concentrated on the incorporation of sustainable development principles into planning documents. As such, sustainable development has become a cornerstone in planning thinking, departing intentionally or de facto from its environmental origins per se. However, the sustainable development approach not only tries to balance short-term and long-term goals, but is also an umbrella for multiple strategies that seek to balance environmental protection, social equity, and economic development (for example, see in Hopwood et al., 2005).

Despite the ability of these approaches to define planning processes that address pre-defined issues, the attempt to localize environmental challenges that are global in nature and develop local strategies encounters difficulties and often misses its goal (Hopwood et al., 2005). This challenge is quite evident, for example, in the attempt to localize sustainable development goals. In this situation, the so-called strategic process is reduced to a checklist of quantified objectives that lack an overall perspective of the place's sustainability (ElMassah & Mohieldin, 2020). In other cases, especially when addressing non-environmental challenges, sustainability has become a buzzword that lacks a clear pathway for process design or clear criteria for evaluating the results (Apetrei et al. 2021; ElAlfy et al., 2020). As a direct consequence of this gap, and alongside the sustainable development approach, a new environmental strategy evolved – ecosystem or ecological restoration planning (Alexander et al., 2016; Ding et al., 2023; Jax, 2010; Johnson & Hill, 2002).

An ecosystem or ecological system consists of all of the organisms and their physical environment, interconnected through nutrient cycles and energy flows (Chapin et al., 2002). Ecosystem restoration planning aims to maintain the integrity of ecosystems by supporting the stability of their components and interactions. This approach benefits both nature and people (Clewell & Aronson, 2006, 2012). It helps manage growth in urbanized regions through a holistic approach that considers the interrelationships within urban systems. Tomalty et al. (1994), Xu and Madden (1989), and Yigitcanlar and Dizdaroglu (2015) emphasized the importance of multi-disciplinary, ecological perspectives in urban planning. Ahern et al. (2014) proposed an adaptive urban design framework that integrates scientific knowledge, professional practice, and stakeholder participation to enhance innovative urban planning.

In the context of strategic development and planning, the ecosystem restoration planning approach goes beyond its environmental origin and serves as a metaphor for organizations, markets, cities, and regions (for example, Raymond et al., 2013). The tangible notion of an ecosystem, coupled with the renewed powerful concept of innovation, has led to the adoption of a new systematic, strategic approach in the management of technology and innovation and development (for example: Granstrand & Holgersson, 2020; Tsujimoto et al., 2018). These approaches to planning are based on ideas derived from environmental thinking, business thinking, and even from ideas originating from the planning discipline itself. They see cities and regions as systems or integrated subsystems that operate as an organism (for example: Appio et al., 2019; Berkowitz et al., 2003; Filho et al., 2021; Grimm et al., 2003; Johnson, 2012; Yigitcanlar & Teriman, 2015).

Nevertheless, the systems approach, when viewed through the lens of ecosystem restoration planning, has two shortcomings that the tool presented here addresses. First, it can sometimes diverge from the original environmental concept of ecosystems as systems of organisms and their physical environment with diverse interrelationships. However, research suggests that overly complex models can hinder effective planning and decision-making in various fields. Complex models often fail to achieve their intended goals (Lee, 1973) and may overwhelm users, preventing them from acting on useful insights (Zellner et al., 2022). Overly complex models may lead to convergence issues and uninterpretable results (Bates et al., 2015).

While cities are indeed complex due to numerous subsystems and interactions (Berry, 1964; Johnson, 2012), this complexity within planning methodologies undermines the approach's simplicity. Simplicity here refers to identifying and understanding the essential interrelationships and system components, while acknowledging the overall complexity of the urban system. This focus on essential elements allows for more manageable and actionable planning processes. However, it is crucial to recognize the potential risks of oversimplification. To address these challenges, experts suggest adopting a holistic approach using complexity theory, viewing smart cities as complex adaptive systems (Ekman, 2018), and implementing an adaptive, integrative risk governance framework (Renn & Klinke, 2013). As such, a careful balance is needed between simplifying the system for analytical tractability and capturing the essential features that drive urban dynamics.

From the perspective of those who wish to implement the systems approach in strategic planning, it appears that simplicity is necessary to describe and address the system's complexity. By understanding the interconnectedness of different elements within and outside the system, decision-makers can identify new opportunities for innovation and create more effective strategies to improve the system. Moreover, they understand how the systems approach helps organizations adapt to change more effectively. Frenkel and Porat (2017), and Granstrand and Holgersson (2020) provide examples of such endeavors.

Frenkel and Porat (2017) introduced a model based on spatial capital. It sees cities and regions as ecosystems of various interconnected capital assets, including economic, human, social, political, environmental, infrastructural, cultural, and planning capital. Drawing on the works of Krugman (1994), Kitson et al. (2004), and Morgan (2004), Frenkel and Porat proposed the mapping and benchmarking of these assets. They maintained that doing so would enable decision-makers to identify strengths and constraints, and formulate targeted "development engines" that synchronize local capabilities with strategic objectives.

Granstrand and Holgersson (2020) concentrated on what they recognized as innovation ecosystems, defining them as an evolving set of actors, activities, artifacts, institutions, and relationships. These relationships include both complementary and substitute relationships essential for innovative performance. This definition aligns with related concepts in innovation and natural ecosystems. It also emphasizes the interconnectedness of various actors such as firms, universities and research institutions, government agencies, suppliers, customers, investors, NGOs, and the general public within the innovation process. Granstrand and Holgersson argued that understanding the dynamics of these interconnected relationships is crucial for successful innovation. They underscored the importance of collaboration, knowledge sharing, and trust-building within the ecosystem.

In order to streamline the complex nature of systems, and building upon the insights of Frenkel and Porat, and Granstrand and Holgersson, this study presents a tool that categorizes urban system components into two groups: anchors (representing a system's capabilities, such as actors and institutions) and processes (activities and projects that depend on anchors to tackle a system's challenges). Three connected parts are highlighted by placing the suggested tool in current planning theory. Strategic spatial planning is increasingly seen as a relational, co-produced expertise where stakeholders build and negotiate knowledge (Healey, 2009). Second, mapping instruments integrate power relations that determine whose knowledge is visible and legitimate in planning processes (Flyvbjerg, 1998; Legacy, 2012). Third, the tool aligns with the emphasis on reflexive planning, encouraging practitioners to critically examine foundational assumptions, institutional procedures, and decision-making frameworks as integral components of ongoing learning (Hrelja et al., 2015; Vallance & Edwards, 2021). These viewpoints frame our mapping approach as analytical and contemplative, facilitating planning system knowledge.

## *Research Objectives*

The literature review examined a range of planning approaches, including process-oriented, result-oriented, and sustainability-focused methods. This study advocates an approach that combines the strengths of these perspectives. By focusing on both planning processes (stakeholder engagement, communication) and desired urban outcomes (e.g., sustainable development, social equity), the study's approach seeks an integrated perspective. Furthermore, it aims to leverage the principles of ecosystem restoration planning, such as understanding interdependencies, recognizing feedback loops, and acknowledging the dynamic nature of urban systems. Using such an integrated approach can help leaders make more informed choices by considering the broader impact of their actions and identifying potential unintended consequences.

Based on this approach, the study introduces a method for depicting urban innovation ecosystems, specifically identifying the components and interactions within them. Using the resulting tool can help cities anticipate and respond better to change and uncertainty. The study's approach may foster collaboration and knowledge sharing among stakeholders, leading to more creative solutions. It may also ensure that environmental, social, and economic considerations are integrated into varying aspects of urban systems. In general, the ecosystem methodology simplifies the complex challenge of understanding urban systems by providing a framework for identifying and analyzing key interdependencies and facilitating communication and collaboration among stakeholders. By integrating these insights, the study aims to develop a more comprehensive and effective framework for understanding and managing the complexities of urban systems.

The study demonstrates the use of this tool with information about the transportation systems of three major European cities in 2020: Munich, Budapest, and Prague.[4] The focus on these three empirical case studies stemmed from their similarities and differences. Each of them exemplifies a specific European post-World War II urban economy in cities with populations surpassing 1.5 million people. The cities also vary with regard to their planning traditions.

## Methodology

### *Steps for Analyzing a Transportation Innovation Ecosystem*

Drawing inspiration from Granstrand and Holgersson's (2020) framework, which emphasizes the interconnectedness of components within a system, a five-step methodology was developed in order to map the urban transport ecosystem. This methodology recognizes that the urban transport system is a complex system composed of numerous interacting elements. Building upon Granstrand and Holgersson's identification of the components needed for defining innovation ecosystems, the methodology began by identifying the anchors and processes of the ecosystem. Anchors refer to the ecosystem's capabilities, such as its actors and institutions. Processes refer to the activities and projects used to tackle the ecosystem's challenges. The ecosystem relies on the anchors to support its processes. As will be demonstrated later, by analyzing the interactions between the anchors and processes it is possible to determine the strengths and weaknesses of the ecosystem.

Next, these components were categorized into groups to evaluate the strength and direction of the relationships within each group of anchors and processes. Finally, a comparative analysis was conducted based on the mapping ecosystems of the three cities, resulting in insights into the similarities and differences between their ecosystems. Other cities should be able to utilize these insights in their strategies or policies.

### *Step #1: Identification of the Anchors and Processes*

The study begins with the concepts of anchors and processes developed by Granstrand and Holgersson (2020). Anchors are strengths or core competencies of a given city such as its actors, institutions, assets, and capabilities on which innovations in transportation can be built. Examples include the presence of local experts familiar with the urban transportation system, both in terms of its quality and quantity. The experts are capable of aiding decision-makers in the formulation and implementation of the requisite policy. Additional anchors include the ability to monitor and enforce existing measures and regulations; the existence of human capital, academic institutions, and advanced industry; the concentration of professional knowledge in the city, and the ability to obtain a budget from the state for transportation projects.

Processes are activities, programs, plans, and legislation that can enable the city to overcome any constraints that hamper innovative initiatives and prevent the full realization of policies in the urban transportation domain. Examples include a traffic management program based on local needs; the promotion of electric car sharing services; the establishment and promotion of incubators for smart transport start-ups; the expropriation of lanes for private vehicles for public transport, and plans for increasing density in the city.

In collaboration with specialists from the three cities, a list of local experts in the sector of transportation was created.[5] The process of identifying local experts included predefining seven domains relevant to the urban transportation systems in the selected cities.[6] These encompass a range of stakeholders in the related domains. Thus, specialists from multiple domains, including policymakers and business proprietors with expertise in specific or related domains, were consulted. These domains collectively comprise the city's general transportation sector. Consequently, it was assumed that these experts exert influence on the transportation sector and possess comprehensive knowledge of it. Examples of this knowledge include familiarity with key individuals in the transportation sector, prevailing challenges, policies established by other stakeholders, the legal and regulatory framework governing their activities, their colleagues, and their concerns. Their expertise provides them with top-down, bottom-up, or a combination of perspectives on urban transportation systems. Table 1 lists additional details about the domains represented in the pool of experts.

Following the establishment of an initial group of experts – including academic colleagues, social activists, professional managers, and decision-makers who agreed to participate – a snowball sampling technique was employed to expand the network. Experts who consented to participate were contacted and sent a link to the research questionnaire via email.[7]

In the questionnaire, the experts were asked to identify the key anchors and processes that have made it possible to implement transportation and mobility innovations in each city in recent years (see the definitions and explanatory examples at the beginning of the Step #1 section(. The experts were asked to name the anchor/process, provide a short description of it (100-150 words), specify the effects (or possible effects) of this anchor/process, and name the institution/group of people/company/department/that has this strength/competency (for an anchor) or promotes and/or contributes to the process. Additionally, the experts were asked to provide supplementary details about themselves such as their affiliation by sector or discipline and gender.

In total, 223 local experts were recruited, representing various sectors and disciplines relevant to transportation innovation. Table 1 shows the distribution of the recruited experts in the cities according to sector affiliation.

**Table 1.** The number of experts recruited according to sector affiliation.

| Sector affiliation | Munich | Budapest | Prague | Total |
|---|---|---|---|---|
| Policymakers/elected officials | 3 | 7 | 7 | 17 |
| Academic researchers in the field of transportation | 9 | 13 | 13 | 35 |
| Professionals & managers from the municipality, metro/county, and state administration | 11 | 11 | 7 | 29 |
| Experts from the transportation industry | 24 | 13 | 8 | 45 |
| Entrepreneurs active in urban mobility | 12 | 16 | 15 | 43 |
| Relevant NGOs | 8 | 11 | 8 | 27 |
| Citizens involved in the transportation domain | 7 | 12 | 8 | 27 |
| Total | 74 | 83 | 66 | 223 |

After completing the data collection, the information was organized in order to omit or consolidate similar values (i.e., overlaps discovered in the anchors and processes proposed by the various experts). This step resulted in the 100 anchors and 103 processes in the three cities listed in Table 2.[8]

**Table 2.** Data collection - number of anchors and processes.

| City | Anchors | Processes | Total |
|---|---|---|---|
| Munich | 36 | 42 | 78 |
| Budapest | 32 | 31 | 63 |
| Prague | 32 | 30 | 62 |
| Total | 100 | 103 | 203 |

## *Step #2: Cross Impact Analysis*

To understand the interactions within the transportation innovation ecosystem, a cross-impact analysis was conducted. This analysis assessed how each anchor supported or hindered specific processes using a 5-point Likert scale ranging from "strong negative link" to "strong positive link." The scale evaluates the direction and strength of the relationship between the anchors and processes. For example, an anchor related to the City of Munich's Planning Department was evaluated in terms of its impact on a specific process involving a policy proposed by a local NGO. This evaluation examines elements such as the department's encouragement of innovation and its capacity to promote collaboration. During the analysis, the researchers discussed their respective assessments to arrive at an agreement on each anchor-process relationship. Figure 1 provides a hypothetical illustration of these relationships. The actual results for the three cities are in Supplemental Material Appendix 2.

| Anchors/ Processes | Process #1 | Process #2 | Process #3 | Process #4 | Process #5 | Process #6 | Process #7 | Process #8 | Process #9 | Process #10 | Process #11 | Process #12 | Process #13 | Process #14 | Process #15 | Process #16 | .... | .... |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anchor #1 | 1 | 1 | 0 | 0 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | | |
| Anchor #2 | 1 | 1 | 2 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | -1 | 2 | 1 | 0 | | |
| Anchor #3 | 0 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | -1 | 2 | 1 | 1 | | |
| Anchor #4 | 2 | -1 | 1 | 1 | 2 | -1 | 1 | 2 | 1 | 0 | 1 | -1 | 1 | 0 | 1 | 1 | | |
| Anchor #4 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 1 | | |
| Anchor #6 | 0 | -1 | -1 | 1 | -2 | -1 | 1 | 1 | 2 | 1 | 1 | -2 | 1 | -1 | 1 | 2 | | |
| Anchor #7 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 0 | -1 | 1 | 1 | 1 | | |
| Anchor #8 | 2 | 0 | 1 | 2 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | -1 | 1 | -1 | 2 | 1 | | |
| Anchor #9 | 2 | 0 | 0 | 1 | 2 | 0 | 2 | 2 | 0 | 1 | 1 | 1 | 0 | -1 | 1 | 0 | | |
| Anchor #10 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |
| Anchor #11 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | -1 | 0 | 1 | | |
| ..... | | | | | | | | | | | | | | | | | | |
| ..... | | | | | | | | | | | | | | | | | | |

| | |
|---|---|
| Strong positive link | +2 |
| Weak positive link | +1 |
| No linkage | 0 |
| Weak negative link | -1 |
| Strong negative link | -2 |

Figure 1. Hypothetical cross-impact analysis.

## *Step #3: Classification of Processes and Anchors into Groups*

The third step involved classifying the processes and anchors the experts identified into groups to provide a macro perspective on the transportation ecosystem in each city. The list of processes served as variables, while the anchors served as observations. Using the results of an exploratory factor analysis conducted with Statistical Product and Service Solutions software (SPSS), it was possible to group the processes into major factors[9] according to the similarities in their links with the anchor. For instance, among the processes identified were "strategic development planning for settlement and transportation," "mobility concepts as a condition for land purchases and building permits," and "city council resolutions." If they were consistently linked in Step #2 to anchors such as those that were identified as "politics and elected city council representatives" and "city administration and communication of planning competence to political decision makers," the factor analysis grouped these processes into a factor that labeled "strategic and sustainable perceptions in planning transportation." This grouping resulted in higher-level themes composed of different processes.

### Step #4: Ties Between the System's Components

After grouping the anchors and processes into categories, the analysis assessed the overall influence of each anchor group on each process group. Specifically, the analysis measured the extent to which each anchor group supported or hindered the processes within each process group, along with the direction of that influence (positive or negative). To do so, a mathematical procedure was developed to determine the direction and strength of the links between the anchor and process groups. This procedure included two indicators: weighted links and neutral links. The resulting measurements illustrated the aggregate relationships between these higher-level groups and provided a comprehensive overview of the system, its elements, and their interconnections. The weighted links indicated the strength and direction of an anchor group's impact on a process group. They were calculated as the sum of the cross-impact analysis values (see Supplemental Material Appendix 2), for all anchors in the group on all processes in the group, divided by the number of cells in the aggregation, and multiplied by two. The resulting values ranged from −1 (strong negative impact) to 1 (strong positive impact) (See Figure 2). The neutral links indicated the frequency of "no impact" cells (a score of 0 in the cross-impact analysis). They were calculated as the number of "no linkage" cells in each aggregation divided by the total number of cells. The resulting values ranged from 0 to 1.

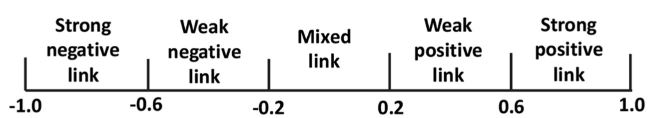


Figure 2. Scales of the linkages.

The aggregate score for each anchor group and process group combination was derived from these two indicators. Specifically, the weighted link score represented the aggregate impact unless the neutral link score exceeded 0.5. In such cases (where "no impact" cells comprised more than 50% of the relationships within the group combination), the aggregate score was classified as "no link," reflecting the dominance of non-relationships. This classification, based on the neutral link index, took precedence over the weighted link index in situations where the majority of individual relationships indicated no connection.

Using the aggregate score of the relationships between the anchors and the processes, it was possible to create schematic diagrams visualizing the transportation ecosystems in the three cities. The diagrams illustrate the strength of the existing ties and the missing links at the group level, revealing the overall structure of the ecosystem's components. This system-level perspective, focusing on the aggregated relationships between the groups of anchors and processes (as opposed to the individual anchor-process links analyzed in the cross-impact analysis), highlights the broader patterns and interconnections between the anchors and the processes. It indicates which group-level relationships can be built upon or require strengthening and reveals the ecosystem's main weaknesses at this higher level of aggregation. Moreover, this macro view enables a comparison of the overall structure and function of the transportation ecosystems across the three cities, revealing their similarities and differences in terms of group-level interactions.

### *Step #5: Comparative Analysis of the Transportation Innovation Ecosystems*

The fifth step compared the three transportation innovation ecosystems with regard to four layers: capital assets; the supply of and demand for innovation; results, processes, and relationships; and the existence and strength of the ties between anchors and processes.

**Layer 1: Capital Assets** – Recognizing that the anchors represent the city's capabilities, a comparative analysis was conducted based on several categories of capital assets (see e.g., Frenkel & Porat, 2017; Friedmann, 2002; Kitson et al., 2004): (1) human capital and know-how; (2) social capital; (3) economic capital; (4) institutional and political capital; (5) infrastructure capital; and (6) environmental structural capital.

**Layer 2: Supply Side and Demand Side Driven Innovation** – The analysis also took into account processes originating from the supply side (top-down), the demand side (bottom-up), or a combination of the two. The supply category (Markman et al., 2009) encompassed top-down programs initiated by various levels of government. The demand category included programs initiated or driven by the market – namely, by consumers or by actors who identified a need for innovative products not provided by the government (Andersen, 2007; Awrey, 2013; Chaston, 2017).

**Layer 3: Results, Processes, Relationships** – Achieving tangible results such as reduced pollution and freeing up urban space, for example, represents important progress towards urban sustainability. However, these outcomes are not the sole measure of success for a transportation innovation ecosystem. True success must also encompass how these results are achieved. Making that determination involves examining the processes used and, critically, the relationships established between people, stakeholders, institutions, and sectors. A successful ecosystem fosters collaboration, knowledge sharing, and trust, creating a foundation for continued progress towards urban sustainability goals. Analyzing these processes and relationships provides a more holistic understanding of an ecosystem's success and its potential for a long-term positive impact on urban sustainability. Accordingly, the third layer evaluated the extent to which the processes identified in Step #3 created a framework for the effective functioning of the system.

The analysis here focused on four categories: strategic results, specific results, processes, and relationships. Regarding strategic results, attention was paid to the extent to which the processes contributed to achieving strategic, comprehensive, and sustainable outcomes. In terms of specific results, the evaluation addressed how the processes supported the attainment of concrete transportation-related outcomes or facilitated the development of tools for addressing transportation challenges. Third, the analysis examined how the processes enhanced decision-making or improved the utilization of data and information, as well as their role in influencing regulatory change. Finally, the contribution of the processes to fostering cooperation and coordination among individuals, stakeholders, institutions, sectors, and initiatives was considered, including their role in building coalitions and institutional capacity.

**Layer 4: The Existence and Strength of the Ties between Anchors and Processes** – The final assessment involved determining the existence and strength of the relationships between groups of anchors and groups of processes. To conduct this assessment, the group of processes that demonstrated strong ties with the anchor groups was identified and associated accordingly.

These associations were based on how the anchor groups aligned with the six dimensions of capital assets–human capital and know-how; social capital; economic capital; institutional and political capital; infrastructure capital; and environmental structural capital – that were identified and defined in the first layer of the 5-step analysis. This analysis indicated which capital assets contribute to innovation-supporting processes and to what extent. It also provided insights into the main differences between the three cities investigated. Note that groups of processes can be supported by more than one dimension of capital assets.

## Results

Based on the data provided by the experts, a comprehensive inventory of the anchors and processes comprising the urban transportation ecosystem was developed (see Table 2 and footnote 4). Subsequently, the anchors and processes in each city were organized into key groupings (Step #3 in the method section). Supplemental Material Appendix 1 shows the results of the factor analysis in the three cities. Supplemental Material Appendix 2 lists the results of the cross-impact analysis (Step #2 in the method section) presented according to the key grouping. Table 3 presents the final division of the identified anchors and processes into their main groups.

Table 3. Final division of the anchors and processes into their main groups.[11]

| City | # Anchors | # Custer of anchors | Processes | # Groups of processes |
|---|---|---|---|---|
| Munich | 36 | 8 | 21 | 6 |
| Budapest | 32 | 7 | 17 | 6 |
| Prague | 32 | 7 | 15 | 5 |
| Total | 100 | 22 | 53 | 17 |

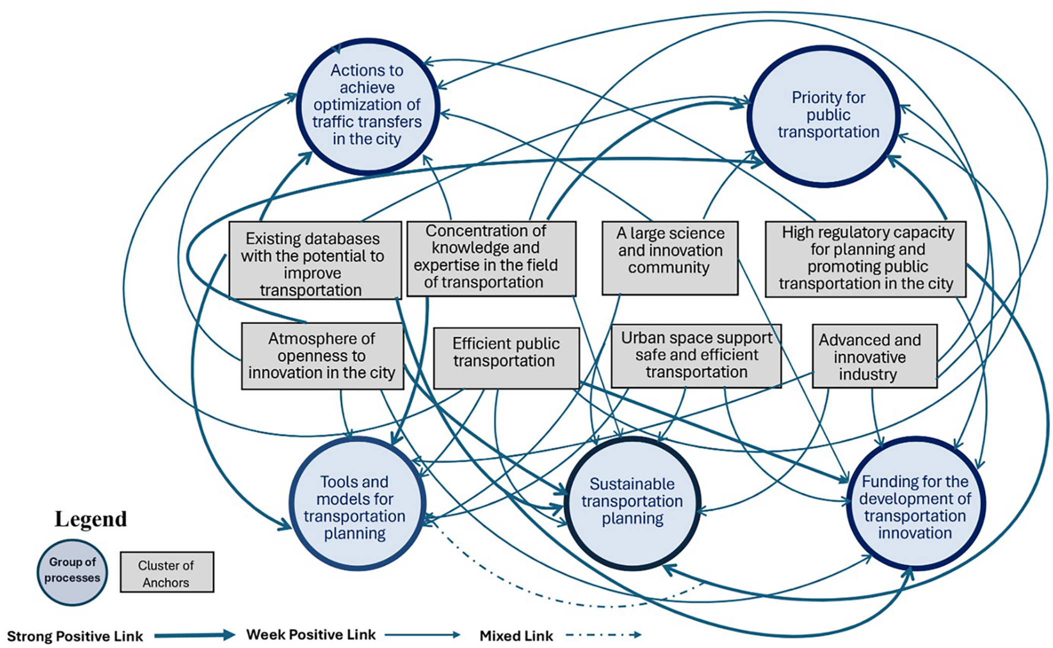


Figure 3. A Visual map of Prague's transportation innovation ecosystem.

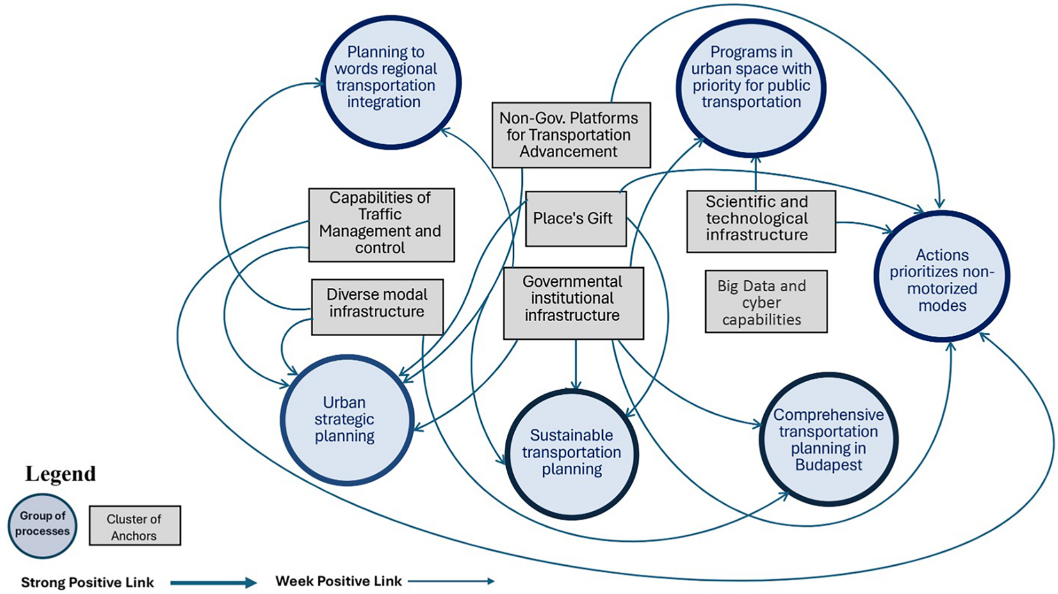


Figure 4. A Visual map of Budapest's transportation innovation ecosystem.

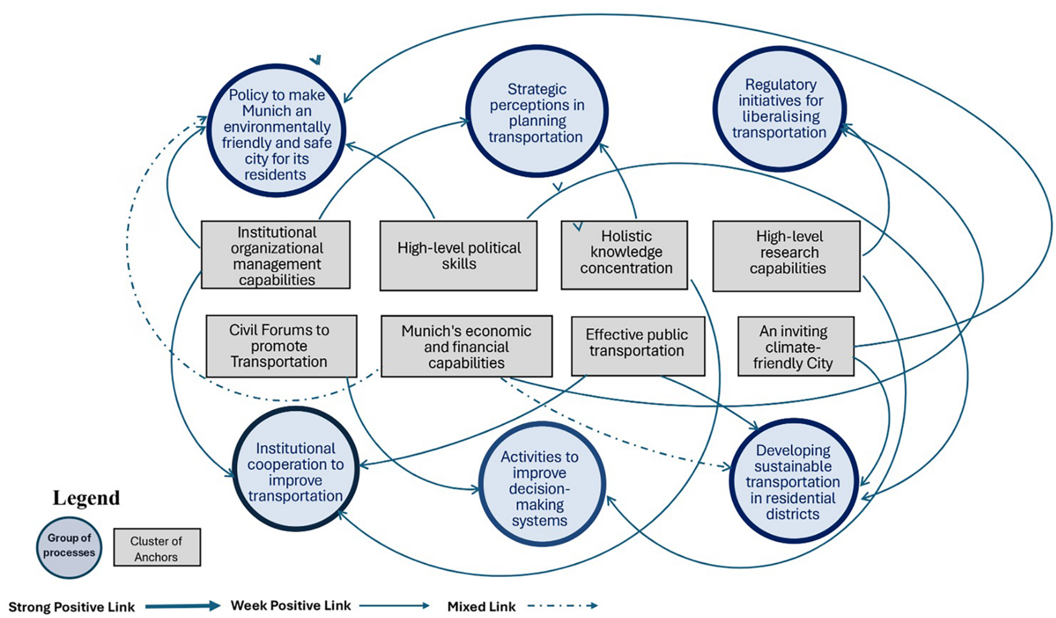


Figure 5. A Visual map of Munich's transportation innovation ecosystem.

Quantifying the connections and their intensity between anchor groups and process groups (Step #4 in the method section) resulted in the creation of visual maps depicting the cities' transportation ecosystems. Figures 3–5 depict the visual macro maps of the cities. Comparing the maps leads to the conclusion that Prague has the most mature system because it has a multiplicity of connections in which groups of anchors support groups of processes.

**Table 4.** Assigning groups of anchors to the six dimensions of capital assets.

| Capital resources - City assets | Munich | Budapest | Prague |
|---|---|---|---|
| institutional & Political capital (regulation, laws) | institutional organizational management capabilities<br>High-level political skills | Governmental institutional infrastructure | High regulatory capacity for planning and promoting public transportation in the city |
| Infrastructure capital | Effective public transportation | Capabilities of Traffic Management and control<br>Diverse modal infrastructure | Efficient public transportation<br>An urban space support safe and efficient transportation |
| Economic capital | Munich's economic and financial capabilities | — | Advanced and innovative industry |
| Human and knowhow capital | Holistic knowledge concentration<br>High-level research capabilities | Scientific and technological infrastructure<br>Big Data and cyber capabilities | A large science and innovation community<br>Concentration of knowledge and expertise in the field of transportation<br>Existing databases with the potential to improve transportation |
| Social capital | Civil Forums to promote Transportation | Non-Governmental Platforms for Transportation Advancement | — |
| Environmental structural capital | An inviting CLIMATE-friendly City | Place's Gift | Atmosphere of openness to innovation in the city |

However, additional investigation of the processes described by the experts revealed that many of these processes still need to mature and await implementation. These processes are essentially suggestions for improving the system, but according to the experts in the study, they are now either in the proposed or declarative stages. Therefore, the significant links that appear in Figure 3 are mainly indicative of the potential of the city's transportation innovation ecosystem.

Budapest benefits from a diverse and unique set of anchors that support or can be utilized to advance the transportation ecosystem. As Figure 4 indicates, examples of these anchors are the government's institutional infrastructure and non-governmental platforms for improving transportation, diverse modes of transportation, and the natural and built environments that produce a unique atmosphere and have a significant impact on the city's livability and health.

According to the data provided by the experts, however, Budapest's transportation innovation ecosystem is in a period of transition as the city undergoes significant development endeavors. Moreover, a significant number of these processes are at the early stages of implementation. This fact may point to the system's immaturity and volatility. For example, there are few interactions between the anchors and the processes. The cross-impact analysis also revealed a widespread lack of connections between various anchors and processes. In addition, the only positive ties that exist between groups of anchors and groups of processes are low-level. Budapest appears to be relying mostly on a small number of key anchors, chiefly those that are related to government institutions and the infrastructure. However, grass-roots institutions are largely absent, supporting the claim that the city's transportation innovation ecosystem lacks maturity.

Munich also benefits from a diverse and unique set of anchors. Unlike Prague and Budapest, Munich's transportation innovation ecosystem (Figure 5) is a more stable system, as it rests on many stable innovation pillars currently operating in the city. The ecosystem relies on a significant number of anchors, as well as numerous processes that work to improve mobility in the

Table 5. Assigning groups of processes to supply or demand driven innovation.

| Supply (top down)/ Demand (bottom up) side of Innovation | Munich | Budapest | Prague |
|---|---|---|---|
| Demand driven innovation | Developing sustainable transportation in residential districts | — | — |
| Supply side of innovation | Policy to make Munich an environmentally friendly city for its residents | Planning towards regional mobility integration planning to increase the connectivity of the city with its suburbs | Funding for the development of transportation innovation |
| | Strategic perceptions in planning transportation | Comprehensive mobility transportation in Budapest | Priority for public transportation |
| | Institutional cooperation to improve transportation | Urban strategic planning | |
| Both supply and demand side of innovation | Regulatory initiatives for improved transportation | Mobility programs in urban space with priority for public transportation | Tools and models for transportation planning |
| | Activities to improve decision-making systems | Actions for prioritizes non-motorized modes | Actions to achieve optimization of traffic transfers in the city |
| | | Sustainable transportation planning | Sustainable transportation planning |

city. Nevertheless, the analysis revealed vulnerabilities in the city's transportation innovation ecosystem related to a misalignment between public and private sector objectives and policies. This misalignment creates challenges for effective and timely collaboration between private organizations and the public administration, which governs both processes and anchors. Private sector actors, often driven by market forces, can introduce innovative mobility solutions, such as those offered by ShareNow, Uber, or Lime, more rapidly than the public administration, which must balance innovation with broader societal considerations. This disparity highlights the need for a comprehensive urban strategy that aligns public and private interests, fosters collaborative processes, and leverages the city's numerous strengths to drive innovation in transportation.

## *Comparisons of the Three Transportation Innovation Ecosystems*

The study also compared the three cities' transportation innovation ecosystems with regard to their capital assets, the nature of the initiatives in the ecosystems as top-down or bottom-up, the results and characteristics of the initiatives, and the strength of the ties between the anchors and processes in each ecosystem.

Table 4 compares the groups of anchors in the three ecosystems with regard to six aspects of the cities' capital assets. Human capital and know-how and infrastructure capital emerged as the most significant capital assets. Nearly half of all groups of anchors in the three cities fell into these two categories. Together with institutional capital they form the common elements of the ecosystems in the three cities. Economic capital and social capital emerged as the weakest dimensions. Budapest's transportation innovation ecosystem showed no evidence of economic capital, and social capital was absent in Prague's transportation innovation ecosystem. The lack of these elements indicates the need for the two cities to establish a strategic policy to create these capabilities.

Table 5 compares the groups of processes with respect to whether they are primarily top-down (supply-driven) or bottom-up (influenced by demand). All three ecosystems have groups of processes representing the supply side of transportation innovation, and groups of processes that reflect a mix of supply- and demand-side influences. While many transportation ecosystems globally are developed almost exclusively through top-down supply-side initiatives, Munich stands out. It features multiple processes generated by the market, research institutions, and the civil society that reflect responses to existing and emerging mobility needs. Munich is also the only city in the study with a group of processes that fall primarily on the demand side, indicating a greater responsiveness to user needs and preferences.

Although Prague and Budapest have some distinctive processes that consider demand-side factors, their ecosystems lack a robust core of activities driven primarily by demand. Budapest's ecosystem is predominantly shaped by top-down, supply-side processes and initiatives, largely designed, adopted, and implemented by governmental institutions. The ecosystem in Prague is quite similar to that of Budapest. Prague also emphasizes top-down, supply-side governmental processes. However, unlike Budapest, Prague's ecosystem shares this top-down characteristic with a strong emphasis on supply-side governmental processes. Furthermore, unlike Budapest, Prague benefits from extensive human capital and know-how, along with strong scientific and infrastructure assets and capabilities.

Thus, most of the processes in the three transportation ecosystems are top-down initiatives. Too little attention is given to the demand side, which is represented by bottom-up processes driven by the market. Strategic thinking emphasizes the need to promote bottom-up processes that are beneficial for more challenging initiatives and do not rely mainly on top-down processes (Hutchison-Krupat & Kavadias, 2015). This finding is of great importance with regard to strategic planning. It highlights the need to involve local markets in the development of transportation ecosystems.

Table 6 compares the groups of processes according to their belonging to the four types of categories discussed in the method section: strategic results, results related to a specific

**Table 6.** Assigning groups of processes to four types of categories.

| Type of processes | Munich | Budapest | Prague |
|---|---|---|---|
| Processes that matter strategic issues | Policy to make Munich an environmentally friendly city for its residents | Urban strategic planning | Sustainable transportation planning |
| | Strategic perceptions in planning transportation | Comprehensive transportation planning in Budapest | Funding for the development of transportation innovation |
| Processes involving tools or focused topics | — | transportation programs in urban space with priority for public transportation | Tools and models for transportation planning<br>Actions to achieve optimization of traffic transfers in the city |
| Processes involving increasing cooperation, building coalitions or coordination. | Institutional cooperation to improve transportation | Planning to words Regional transportation integration<br>Actions prioritizes non-motorized modes | — |
| Processes that involve improving decision-making, regulation or use of information | Regulatory initiatives for improved transportation<br>Activities to improve decision-making systems<br>Developing sustainable transportation in residential districts | Sustainable transportation planning | Priority for public transportation |

issue, improving processes, and increasing cooperation and relationships. As the table indicates, most of the groups of processes involve either strategic processes or processes devoted to improving decision-making, changing regulations, or the use of information. Examples of the former include strategic perceptions in planning transportation in Munich, comprehensive transportation planning in Budapest, and sustainable transportation planning in Prague. Examples of the latter include activities to improve decision-making systems in Munich, sustainable transportation planning in Budapest, and priority for public transportation in Prague.

While Munich's transport system relies heavily on processes focused on a strategic goal, the lack of groups of processes involving concrete results and tools focusing on specific issues may indicate a failure in the city's ecosystem. For example, while the City Council adopted the city's broad, strategic, comprehensive vision that prioritizes mobility, transportation, and sustainability, there are multiple competing perspectives regarding the nature of the development of transportation in the city that reduce its ability to achieve the desired outcomes. The city also initiated and implemented multiple processes that targeted specific issues to promote mobility in the urban space. However, due to the slow progress in realizing some of these processes, they have done little to improve the transportation innovation ecosystem. These issues contrast with the extensive efforts in promoting a broad strategic vision for the city, as well as improving decision-making processes and the regulatory framework.

Prague has made a major effort to promote a broad strategic vision. It has also achieved concrete results by addressing specific issues. However, the city does not have a sufficient number of processes focused on improving decision-making and changing regulations. Moreover, the city appears to be missing processes focusing on increasing cooperation, forming coalitions or coordination between multiple stakeholders. These gaps are especially evident in the lack of collaboration between the municipality and the research community and industry.

In Budapest's transportation innovation ecosystem there is a broad, comprehensive, sustainable strategic vision, manifested in the processes that matter strategically. While the city has multiple arenas for cooperation, coordination, and building coalitions of multiple stakeholders around transportation issues, it lacks a sufficient number of processes that will improve decision-making and change regulations.

Table 7 identifies the most important links within each ecosystem. Grouping the anchors and processes created an aggregation in which some of the ties between the groups did not indicate the existence of very strong ties, especially in Munich and Budapest. Hence, the comparative analysis pertained solely to the ties between the anchor groups and process groups in each transportation innovation ecosystem that scored higher than the average score of the ties between the anchor groups and process groups in a specific city's ecosystem. In this manner, it was possible to determine which capital assets help foster processes supporting innovation and to what extent. This approach also indicated which groups of processes act as innovation accelerators in the transportation innovation ecosystems. Note that groups of processes may be supported by more than one dimension of capital assets. For example, in Munich, regulatory initiatives for improved mobility were linked closely with both economic capital and human capital and know-how. The empty cells in Table 7 indicate that no group of processes was identified as strongly tied with any group of anchors included in this particular dimension.[10]

As Table 7 illustrates, in all of the transportation innovation ecosystems, the leading dimensions are the institutional and political capital and human capital and know-how. Together, they constitute the anchors that form the basis for developing the processes that drive the

**Table 7.** The strength of the ties between anchors and processes.

| Capital resources – City assets | Munich | Budapest | Prague |
|---|---|---|---|
| institutional & Political capital (regulation, laws) | Developing Strategic perceptions in planning transportation | Planning towards regional transportation integration planning to increase the connectivity of the city with its suburbs | Sustainable transportation planning |
| | Developing sustainable transportation in residential districts | Urban strategic planning | Funding for the development of transportation innovation |
| | | Comprehensive transportation planning in Budapest | Giving priority for public transportation |
| Infrastructure capital | — | Planning towards regional transportation integration planning to increase the connectivity of the city with its suburbs<br>Comprehensive transportation planning in Budapest | Funding for the development of transportation innovation |
| Economic capital | Regulatory initiatives for improved transportation | — | Using tools and models for transportation planning<br>Funding for the development of transportation innovation |
| Human and knowhow capital | Regulatory initiatives for improved transportation | Mobility programs in urban space with priority for public transportation | Using tools and models for transportation planning |
| | Support for activities to improve decision-making systems | | Actions to achieve optimization of traffic transfers in the city<br>Sustainable transportation planning<br>Funding for the development of transportation innovation<br>Giving priority for public transportation |
| Social capital | Support for activities to improve decision-making systems | Actions for prioritizes non-motorized modes<br>Sustainable transportation planning | — |
| Environmental structural capital | Developing sustainable transportation in residential districts | Actions for prioritizes non-motorized modes | Sustainable transportation planning<br>Giving priority for public transportation |

ecosystems. However, the differences in the nature of these anchors (i.e., urban capabilities) in the three cities are evident in how institutional and political capital are leveraged to create new government programs that foster unique and innovative policy in the system.

The influence of the other four dimensions of capital – the infrastructure, economic capital, social capital, and environmental structural capital – is relatively modest. The relative weakness of the infrastructure and environmental structural capital is particularly pronounced in Munich's ecosystem. Neither dimension contributes significantly to the creation of pro-innovation processes in the city. The relative weakness of economic capital in Budapest's ecosystem and social capital in that of Prague prevent them from making any significant contribution to the creation of pro-innovative processes in the transportation innovation ecosystems of these cities.

The three ecosystems exhibit path dependencies, governance cultures, and historical institutional frameworks. It seems to influence the maturity of the innovation ecosystem. Munich's coordinated governance differs from Budapest's transitional institutional structure. Prague benefits from a substantial capacity of human capital. It highlights the significance of local expertise in fostering innovation. The disparities across the three cities demonstrate that our method allows planners to monitor the influence of contextual factors on strategic capabilities, rather than only facilitating comparisons between systems.

## Discussion

Strategic thinking has become increasingly integrated into the public policy domain. It has led to the integration of strategic thinking in spatial and urban planning, and to the emergence of the strategic planning approach. However, despite the contribution of strategic planning to decision-making in spatial and urban planning, numerous planning decisions remain partial and limited. A major issue is that these decisions often address specific issues or challenges, without a thorough understanding of the broader context. While strategic thinking encourages intuitive, innovative, and creative thinking, many strategic processes fail to integrate the multiple components of the systems. As a result, they often focus on short-term competitive advantages and opportunities, rather than understanding the complex interrelationships between urban systems' components. This narrow approach leaves planners without an effective tool for comprehensive urban management and development.

To fill this void, this study developed a tool for mapping urban innovation ecosystems and tested it using the transportation systems of Budapest, Prague, and Munich. Doing so helped identify the shortcomings and strengths of the cities' transportation systems. Armed with this information, policymakers and other stakeholders can drive innovative decision-making regarding the urban transportation system, thereby improving their ability to plan and implement policies to address the urban transportation systems' challenges.

The tool expands the existing toolbox for planning by offering a more comprehensive and data-driven approach than traditional methods such as SWOT analysis. SWOT analysis relies on the planning team's internal assessments to identify the system's strengths and weaknesses, opportunities, and threats, and then outlines development strategies. While valuable, this approach can be subjective and limited by the team's expertise and perspectives. The tool complements the SWOT approach by incorporating insights derived from a large number of external experts with in-depth knowledge of the systems under consideration. Furthermore, the cross-impact analysis helps decision-makers determine which processes exist or are desired in the future and are supported by current anchors (capabilities) – information not readily available in a standard SWOT analysis. The tool also identifies the anchors needed to implement a process and the processes that can be implemented immediately based on existing anchors. By exploring both anchors and processes, the tool enables decision-makers to identify the actionable steps they can take to achieve results, bridging the gap between process-oriented and result-oriented approaches in planning. For example, while SWOT identifies "opportunities," the tool presented here concretizes this dimension by pinpointing specific anchors and processes that can effectively address urban system challenges and barriers – a level of detail SWOT typically lacks. The tool's applicability also extends beyond transportation ecosystems to areas such as housing, leisure, urban economy, and amenities, making it a versatile instrument for various spatial scales and geographic, economic, and political contexts.

The method offers a systematic method to finding structural strengths and deficiencies. However, its application by planners is neither impartial nor instinctive. Planners may strategically utilize the tool to promote cross-sector discourse, substantiate investment objectives, or contest established institutional assumptions. Stakeholders may potentially challenge the tool's classifications or the prominence it affords to specific entities. Recognizing this interpretive flexibility enhances the tool's relevance for planning, both conceptually and practically, as tools frequently serve as platforms for negotiation rather than solely analytical instruments.

While the tool offers several advantages, its practical application depends on the subjective assessments of experts with regard to the system's anchors and processes. The subjective nature of these assessments means that different groups of experts might produce slightly different results. Additionally, the cross-impact analysis of the relationships between anchors and processes could yield slightly different outcomes. Furthermore, the mathematical algorithm tailored to the specific context and variables in this study could yield slightly different outcomes and may require adaptation for different contexts or domains. Given the somewhat arbitrary nature of the factors chosen for creating the research tool, exploring alternative approaches to improve, modify, or replace them is a promising avenue for future research.

However, these limitations do not diminish the fundamental value of the tool. It provides a structured framework for identifying capabilities and processes and elucidating the relationships between them. It does so by leveraging the collective knowledge of a broad set of experts in the sector of transportation, representing diverse stakeholders and perspectives. Crucially, this information can significantly enhance strategic planning processes. By explicitly identifying key capabilities, processes, and their interdependencies, the tool provides a robust evidence base for informed decision-making. It allows planners to move beyond intuition and subjective assessments, grounding their strategies in a data-driven analysis of the system's current state and potential future trajectories. Furthermore, the tool can be iteratively applied and refined, allowing for adaptive management and continuous improvement of strategic plans.

Planning has epistemic and political aspects, which are augmented by the mapping methodology. The selected anchors and processes for examination and aggregation embody value-laden subjectivities. Planning literature indicates that mapping strategies define and influence systems by privileging specific information. Understanding these dynamics enhances reflexivity and aligns the instrument with strategic planning dialogues concerning power and knowledge. The tool informs reflexive and adaptive strategy planning, not only validation. By showing system-level interdependencies and where skills are misaligned with intended processes, the approach development helps planners identify governance bottlenecks, devise participatory solutions, and align multi-level actors behind long-term mobility transitions. Instead of technical analysis, the instrument inventories practice and institutional learning to assist strategic spatial planning.

Naturally, the proposed tool is not a finished product. The study's contributions notwithstanding, future studies should make additional refinements and reiterations to the tool. The tool is primarily a methodological addition to knowledge. It potentially enables the representation of urban systems in a manner that is more conducive to policymaking. Consequently, supplementary endeavors are highly desirable, as the tool and analysis provided do not provide decision-makers with a range of potential supplemental utilities. For example, macro analysis, such as the one used here, is merely one step in improving our understanding of such systems. Future studies can also use micro-analyses in which the relevant stakeholders could associate pertinent ecosystem capabilities with urban challenges to determine the correlation between a given challenge and the processes and anchors they have observed. Given that micro-analyses can reveal how well anchors support a city's processes, an analysis that helps policymakers overcome the challenges they face could be an important step in supporting a city's resilience and sustainability.

## Notes

1. For more on urban capabilities, see, for example, Chong et al. (2018) and Sassen (2012).
2. This study is part of a comparative study carried out under the framework of the EIT Urban Mobility (UM) consortium.
   EIT UM is an initiative of the European Institute of Innovation and Technology (EIT), established in 2019 to encourage positive changes in urban mobility. The consortium includes dozens of universities and research institutes, municipalities, and companies in the field of transportation (https://www.eiturbanmobility.eu/about-us/).
   As part of the consortium, a collaboration between four academic and research institutions in Israel, Germany, the Czech Republic, and Hungary emerged to create the planning tool. Another objective was to assess the tool's suitability in different cities within each of the aforementioned nations and to compare the cities in light of the results of the investigation.
3. Acknowledging the tool's limitations and the importance of tailoring solutions to specific urban contexts is imperative. While the study's tool is a supportive instrument that helps address certain challenges such as improving data-driven decision-making and clarifying the interplay of context and temporal dynamics, it does not – and cannot – fully resolve all the complexities and limitations inherent in urban strategic planning.
4. Due to the emphasis on transportation, we used the term "Mapping Transportation Innovation Ecosystems."
5. The co-authors of the paper, each located in their respective countries (one of the four countries), actively supported the research, and subsequently engaged with their municipal specialists and the local experts in the field of the cities' transportation system.
6. The domains were established based on local expertise about the three locations provided by the paper's authors, as well as consultations with experts and stakeholders in the transportation sector within those cities.
7. The online questionnaire was made available in four languages: English, German, Czech, and Hungarian.
8. A complete description of all of the anchors and processes identified by the experts surveyed in each city can be accessed in the online database at this address: https://doi.org/10.5281/zenodo.8220442.
9. For more on the identification technique, see, for example, a similar method used by Israel and Frenkel (2015).
10. However, there might be some weak or bi-directional ties.
11. The large number of processes relative to the number of anchors in the three cities did not make it possible to run a factor analysis that would indicate an adequate grouping that met the threshold conditions for accepting the results. In order to overcome this methodological challenge, we included only those processes of which more than a third had a positive or negative association with any of the anchors on the list. The number of processes that met this threshold was smaller than the total of all of the processes received from the experts listed Table 2.

## Acknowledgments

The authors would like to express their sincere gratitude to EIT Urban Mobility. This work has been established under the FPA Grant agreement No 10020/EIT/Urban mobility supported by the EIT, a body of the European Union. The authors would like to express their great appreciation to the project coordinator of the Technion - Israel Institute of Technology. We would also like to thank the following people, who assisted greatly in the realization of the research: Filip Hauer (Institute of Information Theory and Automation), Diane Arvanitakis (Technical University of Munich), Melanie Groetsch (The City of Munich), Sayalee Pendharkar (The City of Munich), Katharina Candel-Haug, (Munich Transport Company), Marion Eisenschmid-Maier, (Munich Transport Company) and Sophia Bildstein (Munich Transport).

## Disclosure Statement

No potential conflict of interest was reported by the author(s).

## Notes on Contributors

*Emil Israel, Dr*. is an Associate Professor in Urban and Regional Planning at the Faculty of Architecture and Town planning, Technion – Israel Institute of Technology. Currently heads the research lab of Society, Space and Planning which studies issues of social justice and inequality, suburbanization and social distinction, innovation, land-use planning, and building tools for strategic planning of urban and regional ecosystems.

*Amnon Frenkel, Dr*. is Professor Emeritus in Urban and Regional Planning at the Faculty of Architecture and Town planning, Technion – Israel Institute of Technology and the Co-Director of the China-Israel Planning Innovation Centre. Senior research fellow at the Samuel Neaman Institute for National Policy Research, at the Technion. Rrepresentative of the Technion at the Israeli National High Committee for Planning and Building and the former president of the Israeli Section of the European Regional Science Association. He specialized on technology policy, and diffusion of innovation as a catalyst for regional development; The creation of innovative environments, related to technological capabilities as reflected in knowledge and skills of knowledge workers; location considerations of hi-tech firms; identification the choices of co-working spaces as a place for conducting business; building tools for strategic planning of urban and regional ecosystems; measuring regional inequality.

*Ofer Lerner* is an urban planner with diverse experiences as a practitioner, an activist, and a scholar. Ofer has over twenty years of specialization in conducting and facilitating strategic, economic development, urban regeneration, community organizing, and participatory planning processes. Through a vast planning background, and a wide theoretical knowledge, Ofer developed a strong pragmatic theory-based practice. This expertise enables him to build bridges between people and groups in conflict, to overcome cultural and political differences, build trust, and strengthen communities. Ofer is the director of Ofer Lerner – Planning, Development and Strategy consultancy firm and an Associate Teaching Fellow in the Technion Faculty of Architecture and Town Planning.

*Attila Aba* is a Mobility Expert with extensive experience from planning to research and development in both Hungarian and foreign projects. He has been involved in future shaping innovations (e.g., mobility-as-a-service implementation), is also experienced in strategic, conceptual, and network development planning (e.g., sustainable mobility plans, feasibility studies), and is strongly skilled in transport modeling and mobility pilot development. He has contributed to a number of scientific papers in the field of MaaS and sustainable workplace mobility plans.

*Domokos Esztergár-Kiss, Dr*. is a senior lecturer at Budapest University of Technology and Economics (BME). Since 2014 he has been the international project coordinator of the Faculty of Transportation Engineering and Vehicle Engineering. His main research topic is the optimization of multimodal travel chains for passengers in the cities. In addition, he is dealing with the development of mobility as a service solution and establishing workplace mobility plans promoting sustainable commuting. He was the main organizer of several international conferences (e.g., MT-ITS 2015, EWGT 2017, and hEART 2019) and he is involved in several Horizon 2020 projects, Interreg projects. and COST Actions (e.g., MoveCit, LinkingDanube, MaaS4EU, Electric travelling, BE OPEN, RegiaMobil, OJP4Danube). He was a Fulbright scholar at the University of California, Davis in 2021.

***Tomas Horak, Dr***. is an Associate Professor in Transportation Engineering at the Faculty of Transportation Sciences, Czech Technical University in Prague, Czech Republic. His research focus is last mile logistics, smart cities and mobility. He is the head of the Department of Logistics and Transportation Management. His focus as a Vice Dean for International Relations is on international programs, in particular dual degree programs with universities in the United States.

***Jiri Plihal, Dr*. ** is engaged in developing electronics systems at the Czech Academy of Sciences, Institute of Information Theory and Automation as project manager. He completed his doctoral studies at the Technical University of Brno, Faculty of Civil Engineering in 1998. He is active in researching and developing new Human Machine Interface and vehicle control systems. He has participated in and led numerous national/European R&D projects and has long term experience as an expert in developing Technical standards ISO TC204 and CEN TC 278. In the Department of Signal Processing, he is on position Research assistant.

***Alain Thierstein, Dr***. oec. HSG, is a full professor for urban development at the Technical University of Munich (TUM), School of Engineering and Design, Department of Architecture. His focus of research is on urban and metropolitan development; spatial impact of the knowledge economy, in particular the localized networks of firm relationships; the spatial interaction of locational choice of residence, work and mobility; the spatio-functional interaction of rail infrastructure and urban development, as well as the role of star architecture for repositioning small and medium sized cities.

***Ing. Fabian Wenner***, Prof. Dr. Fabian Wenner is Professor in Sustainable Urban Development and Alternative Mobility Concepts at RheinMain University of Applied Sciences, Wiesbaden, Germany. His Research Focus is on land use-transport interaction, land policy, as well as the utilisation of new digital data and methods for spatial research.

## ORCID

Emil Israel http://orcid.org/0000-0002-6313-8248
Domokos Esztergár-Kiss http://orcid.org/0000-0002-7424-4214

## References

Ahern, J., Cilliers, S., & Niemelä, J. (2014). The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation. *Landscape and Urban Planning*, *125*, 254–259. https://doi.org/10.1016/j.landurbplan.2014.01.020

Albrechts, L. (2010). More of the same is not enough! how could strategic spatial planning be instrumental in dealing with the challenges ahead? *Environment and Planning B: Planning and Design*, *37*(6), 1115–1127. https://doi.org/10.1068/b36068

Albrechts, L., & Balducci, A. (2013). Practicing strategic planning: In search of critical features to explain the strategic character of plans. *disP – The Planning Review*, *49*(3), 16–27. https://doi.org/10.1080/02513625.2013.859001

Alexander, E. R. (1984). After rationality, what? A review of responses to paradigm break- down. *Journal of the American Planning Association*, *50*(1), 62–69. https://doi.org/10.1080/01944368408976582

Alexander, S., Aronson, J., Whaley, O., & Lamb, D. (2016). The relationship between ecological restoration and the ecosystem services concept. *Ecology and Society*, *21*(1). https://doi.org/10.5751/ES-08288-210134

Alterman, R., & Duncan, M.Jr (1983). Planning and policy analysis: Converging or diverging trends? *Journal of the American Planning Association*, *49*(2), 200–215. Spring 1983 https://doi.org/10.1080/01944368308977064

Andersen, E. S. (2007). Innovation and demand. In *The Elgar companion to neo-Schumpeterian economics* (pp. 754–765). Elgar.

Apetrei, C. I., Caniglia, G., von Wehrden, H., & Lang, D. J. (2021). Just another buzzword? A systematic literature review of knowledge-related concepts in sustainability science. *Global Environmental Change*, *68*, 102222. https://doi.org/10.1016/j.gloenvcha.2021.102222

Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding smart cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change*, *142*, 1–14. https://doi.org/10.1016/j.techfore.2018.12.018

Awrey, D. (2013). Toward a supply-side theory of financial innovation. *Journal of Comparative Economics*, *41*(2), 401–419. https://doi.org/10.1016/j.jce.2013.03.011

Bafarasat, A., & Oliveira, E. (2021). Disentangling three decades of strategic spatial planning in England through participation, project promotion and policy integration. *European Planning Studies*, *29*(8), 1375–1392.

Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2015). Parsimonious mixed models. arXiv preprint arXiv:1506.04967.

Berkowitz A. R., Nilon, C. H., & Hollweg, K. S. (Eds.). (2003). *Understanding urban ecosystems: A new frontier for science and education*. Springer.

Berry, B. J. (1964). Cities as systems within systems of cities. *Papers in Regional Science*, *13*(1), 147–163. https://doi.org/10.1111/j.1435–5597.1964.tb01283.x

Bevilacqua, C., Pizzimenti, P., & Ou, Y. (2023). Cities in transition and urban innovation ecosystems: Place and innovation dynamics in the case of Boston and Cambridge (USA). *Sustainability*, *15*(18), 13346. https://doi.org/10.3390/su151813346

Bryson, J., & Edwards, L. H. (2017). Strategic planning in the public sector. In R. Aldag (Ed.), *Oxford research encyclopedia of business and management*. Oxford University Press.

Bryson, J. M., Edwards, L. H., & Van Slyke, D. M. (2018). Getting strategic about strategic planning research. *Public Management Review*, *20*(3), 317–339. https://doi.org/10.1080/14719037.2017.1285111

Bryson, J., & Roering, W. (1988). Initiation of strategic planning by governments. *Public Administration Review*, *48*(6), 995–1004. https://doi.org/10.2307/976996

Carmon, N. (2013). The profession of urban planning and its societal mandate *in policy*. In N. Carmon, & S. Fainstein (Eds.), *Planning and people: Promoting justice in urban development*. Penn Press.

Chapin, F. S., Matson, P. A., Mooney, H. A., & Vitousek, P. M. (2002). *Principles of terrestrial ecosystem ecology*. Springer.

Chaston, I. (2017). *Technological entrepreneurship: Technology-driven vs market-driven innovation*. Springer.

Chong, M., Habib, A., Evangelopoulos, N., & Park, H. W. (2018). Dynamic capabilities of a smart city: An innovative approach to discovering urban problems and solutions. *Government Information Quarterly*, *35*(4), 682–692. https://doi.org/10.1016/j.giq.2018.07.005

Clewell, A. F., & Aronson, J. (2006). Motivations for the restoration of ecosystems. *Conservation Biology: The Journal of the Society for Conservation Biology*, *20*(2), 420–428. https://doi.org/10.1111/j.1523–1739.2006.00340.x

Clewell, A. F., & Aronson, J. (2012). *Ecological restoration: Principles, values, and structure of an emerging profession*. Island Press.

Dagnino, G. B., Picone, P., & Ferrigno, G. (2021). Temporary competitive advantage: A state-of-the-art literature review and research directions. *International Journal of Management Review*, *23*(1), 85–115. https://doi.org/10.1111/ijmr.12242

Demazière, C. (2018). Strategic spatial planning in a situation of fragmented local government: The case of France. *disP - The Planning Review*, *54*(2), 58–76. https://doi.org/10.1080/02513625.2018.1487645

Ding, Z., Zheng, H., Wang, J., O'Connor, P., Li, C., Chen, X., Li, R., & Ouyang, Z. (2023). Integrating top-down and bottom-up approaches improves practicality and efficiency of large-scale ecological restoration planning: Insights from a social–ecological system. *Engineering*, *31*, 50–58. https://doi.org/10.1016/j.eng.2022.08.008

Dorofeeva, L. V., & Leont'eva, A. N, Institute for Regional Economic Studies Russian Academy of Sciences. (2021). Implementation of the principles of sustainable development in strategic planning of urban development. *The Economy of the North-West: Problems and Prospects of Development*, *3*(66), 70–75. https://doi.org/10.52897/2411–4588-2021–3-70–75

Eadie, D. C. (1983). Putting a powerful tool to practical use: The application of strategic planning in the public sector. *Public Administration Review*, *43*(5), 447–452. https://doi.org/10.2307/975852

Ekman, U. (2018). Smart city planning: Complexity. *International Journal of E-Planning Research*, *7*(3), 1–21. https://doi.org/10.4018/ijepr.2018070101

ElAlfy, A., Darwish, K. M., & Weber, O. (2020). Corporations and sustainable development goals communication on social media: Corporate social responsibility or just another buzzword? *Sustainable Development*, *28*(5), 1418–1430. https://doi.org/10.1002/sd.2095

ElMassah, S., & Mohieldin, M. (2020). Digital transformation and localizing the sustainable development goals (SDGs). *Ecological Economics*, *169*, 106490. https://doi.org/10.1016/j.ecolecon.2019.106490

Ferlie, E., & Ongaro, E. (2022). *Strategic management in public services organizations: Concepts, schools and contemporary issues*. Routledge.

Filho W. L., Krasnov, E. V., & Gaeva, D. V. (Eds.). (2021). *Innovations and traditions for sustainable development*. Springer Nature.

Fitzová, H., & Matulová, M. (2020). Comparison of urban public transport systems in the Czech Republic and Slovakia: Factors underpinning efficiency. *Research in Transportation Economics*, *81*, 100824. https://doi.org/10.1016/j.retrec.2020.100824

Flyvbjerg, B. (1998). *Rationality and power: Democracy in practice*. University of Chicago press.

Frenkel, A., & Porat, I. (2017). An integrative spatial capital-based model for strategic local planning–an israeli case. *Planning Practice & Research*, *32*(2), 171–196. https://doi.org/10.1080/02697459.2017.1279929

Friedmann, J. (2002). *The prospect of cities*. University of Minnesota Press.

Friedmann, J. (2004). Strategic spatial planning and the longer range. *Planning Theory & Practice*, *5*(1), 49–67. https://doi.org/10.1080/1464935042000185062

Frug, G. E. (2001). City making. In *City making*. Princeton University Press.

Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation*, *90–91*, 102098. https://doi.org/10.1016/j.technovation.2019.102098

Grimm, N. B., Baker, L. J., & Hope, D. (2003). An ecosystem approach to understanding cities: Familiar foundations and uncharted frontiers. In *Understanding urban ecosystems*. Springer.

Gurl, E. (2017). SWOT analysis: A theoretical review. *The Journal of International Social Research*, *10*(51), 994–1006.

Hamurcu, M., & Eren, T. (2020). Strategic planning based on sustainability for urban transportation: An application to decision-making. *Sustainability*, *12*(9), 3589. https://doi.org/10.3390/su12093589

Healey, P. (2004). The treatment of space and place in the new strategic spatial planning in Europe. *International Journal of Urban and Regional Research*, *28*(1), 45–67. https://doi.org/10.1111/j.0309-1317.2004.00502.x

Healey, P. (2006). *Urban complexity and spatial strategies: Towards a relational planning for our times*. Routledge.

Healey, P. (2009). In search of the "strategic" in spatial strategy making. *Planning Theory & Practice*, *10*(4), 439–457. https://doi.org/10.1080/14649350903417191

Heracleous, L. (1998). Strategic thinking or strategic planning? *Long Range Planning*, *31*(3), 481–487. https://doi.org/10.1016/s0024-6301(98)80015–0

Hopwood, B., Mellor, M., & O'Brien, G. (2005). Sustainable development: Mapping different approaches. *Sustainable Development*, *13*(1), 38–52. https://doi.org/10.1002/sd.244

Hrelja, R., Hjerpe, M., & Storbjörk, S. (2015). Creating transformative force? The role of spatial planning in climate change transitions towards sustainable transportation. *Journal of Environmental Policy & Planning*, *17*(5), 617–635. https://doi.org/10.1080/1523908X.2014.1003535

Hutchison-Krupat, J., & Kavadias, S. (2015). Strategic resource allocation: Top-down, bottom-up, and the value of strategic buckets. *Management Science*, *61*(2), 391–412. https://doi.org/10.1287/mnsc.2013.1861

Hutter, G., & Wiechmann, T. (2022). Time, temporality, and planning – Comments on the state of art in strategic spatial planning research. *Planning Theory & Practice*, *23*(1), 157–164. https://doi.org/10.1080/14649357.2021.2008172

Israel, E., & Frenkel, A. (2015). The distribution of capital forms between cities and suburbs and their impact on social justice in space. *Urban Geography*, *36*(4), 578–607. https://doi.org/10.1080/02723638.2014.982484

Jax, K. (2010). *Ecosystem functioning*. Cambridge University Press.

Johnson, B., & Hill, K. (2002). *Ecology and design: Frameworks for learning*. Island Press.

Johnson, J. (2012). Cities: Systems of systems of systems. In *Complexity theories of cities have come of age* (pp. 153–172). Springer.

Kaufman, J. L., & Jacobs, H. M. (1987). A public planning perspective on strategic planning. *Journal of the American planning association*, *53*(1), 23–33. https://doi.org/10.1080/01944368708976632

Kitson, M., Martin, R., & Tyler, P. (2004). Regional competitiveness: An elusive yet key concept? *Regional Studies*, *38*(9), 991–999. https://doi.org/10.1080/0034340042000320816

Kovács, Z., Farkas, Z. J., Egedy, T., Kondor, A. C., Szabó, B., Lennert, J., Baka, D., & Kohán, B. (2019). Urban sprawl and land conversion in post-socialist cities: The case of metropolitan Budapest. *Cities*, *92*, 71–81. https://doi.org/10.1016/j.cities.2019.03.018

Krogerus, M., & Tschäppeler, R. (2017). *The decision book: Fifty models for strategic thinking*. Kein & Aber AG.

Kropf, K. (2009). Aspects of urban form. *Urban Morphology*, *13*(2), 105–120. https://doi.org/10.51347/jum.v13i2.3949

Krugman, P. (1994). Competitiveness: A dangerous obsession. *Foreign Affairs*, *73*(2), 28–44. https://doi.org/10.2307/20045917

Lee, D. B.Jr, (1973). Requiem for large-scale models. *Journal of the American Institute of Planners*, *39*(3), 163–178. https://doi.org/10.1080/01944367308977851

Legacy, C. (2012). Achieving legitimacy through deliberative plan-making processes—Lessons for metropolitan strategic planning. *Planning Theory & Practice*, *13*(1), 71–87. https://doi.org/10.1080/14649357.2012.649947

Lynch, K., & Rodwin, L. (1958). A theory of urban form. *Journal of the American Institute of Planners*, *24*(4), 201–214. https://doi.org/10.1080/01944365808978281

Lyons, G., & Davidson, C. (2016). Guidance for transport planning and policymaking in the face of an uncertain future. *Transportation Research Part A: Policy and Practice*, *88*, 104–116. https://doi.org/10.1016/j.tra.2016.03.012

Malekpour, S., Brown, R. R., & De Haan, F. J. (2015). Strategic planning of urban infrastructure for environmental sustainability: Understanding the past to intervene for the future. *Cities*, *46*, 67–75. https://doi.org/10.1016/j.cities.2015.05.003

Mäntysalo, R., Kangasoja, J. K., & Kanninen, V. (2015). The paradox of strategic spatial planning: A theoretical outline with a view on Finland. *Planning Theory & Practice*, *16*(2), 169–183. https://doi.org/10.1080/14649357.2015.1016548

Mäntysalo, R., Tuomisaari, J., Granqvist, K., & Kanninen, V. (2019). The strategic incrementalism of lahti master planning: Three lessons. *Planning Theory & Practice*, *20*(4), 555–572. https://doi.org/10.1080/14649357.2019.1652336

Markman, G. D., Gianiodis, P. T., & Phan, P. H. (2009). Supply-side innovation and technology commercialization. *Journal of Management Studies*, *46*(4), 625–649. https://doi.org/10.1111/j.1467–6486.2009.00835.x

Mintzberg, H. (1994). Rethinking strategic planning part I: Pitfalls and fallacies. *Long Range Planning*, *27*(3), 12–21. https://doi.org/10.1016/0024–6301(94)90185–6

Mintzberg, H. (2007). *Tracking strategies: Toward a general theory*. OUP Oxford.

Momin, A. (2023, March 4). *5 Alternatives to SWOT analysis tackling its limitations*. https://pestleanalysis.com/alternatives-to-swot-analysis/#:~:text=Alternatives%20to%20SWOT%20Analysis%3A%20Conclusion,-While%20there%20is&text=Some%20of%20those%20tools%20include,options%20than%20a%20SWOT%20analysis

Morgan, K. (2004). The exaggerated death of geography: Learning, proximity and territorial innovation systems. *Journal of Economic Geography*, *4*(1), 3–21. https://doi.org/10.1093/jeg/4.1.3

Moroni, S., & Chif, D. (2022). Uncertainty and planning: Cities, technologies, and public decision-making. *Perspectives on Science*, *30*(2), 237–259. https://doi.org/10.1162/posc_a_00413

Narang, S., & Reuterswärd, L. (2006). Improved governance and sustainable urban development strategic planning holds the key. *European Journal of Spatial Development*, *4*(5), 1–11.

Polk, M. (2011). Institutional capacity-building in urban planning and policy-making for sustainable development: Success or failure? *Planning*. *Planning Practice and Research*, *26*(2), 185–206. https://doi.org/10.1080/02697459.2011.560461

Raco, M., Henderson, S., & Bowlby, S. (2008). Changing times, changing places: Urban development and the politics of space-time. *Environment and Planning A: Economy and Space*, *40*(11), 2652–2673. https://doi.org/10.1068/a4073

Rapoport, A. (2016). *Human aspects of urban form: Towards a man – Environment approach to urban form and design*. Elsevier.

Raymond, C. M., Singh, G. G., Benessaiah, K., Bernhardt, J. R., Levine, J., Nelson, H., Turner, N. J., Norton, B., Tam, J., & Chan, K. M. A. (2013). Ecosystem services and beyond: Using multiple metaphors to understand human–environment relationships. *BioScience*, *63*(7), 536–546. https://doi.org/10.1525/bio.2013.63.7.7

Renn, O., & Klinke, A. (2013). A framework of adaptive risk governance for urban planning. *Sustainability*, *5*(5), 2036–2059. https://doi.org/10.3390/su5052036

Saldert, H. (2021). Spanning boundaries between policy and practice: Strategic urban planning in gothenburg, Sweden. *Planning Theory & Practice*, *22*(3), 397–413. https://doi.org/10.1080/14649357.2021.1930120

Sassen, S. (2012). Urban capabilities: An essay on our challenges and differences. *Journal of International Affairs*, *65*(2), 85–95.

Searle, G. (2020). Metropolitan strategic planning after modernism. *Planning. Planning Theory & Practice*, *21*(2), 325–329. https://doi.org/10.1080/14649357.2020.1723983

Servillo, L. (2010). Territorial cohesion discourses: Hegemonic strategic concepts in European spatial planning. *Planning Theory & Practice*, *11*(3), 397–416. https://doi.org/10.1080/14649357.2010.500135

Sheffield, C., & Valler, D. (2023). 'Dealing' with governance and planning? The limits of urban intrapreneurialism. *Planning Theory & Practice*, *24*(4), 453–472. https://doi.org/10.1080/14649357.2023.2262442

Spinosa, L. M., & Costa, E. M. (2020). Urban innovation ecosystem & humane and sustainable smart city: A balanced approach in curitiba. In J. C. Augusto (Ed.), *Handbook of smart cities* (pp. 1–23). Springer.

Tomalty, R., Gibson, R., Alexander, D., & Fisher, J. (1994). *Ecosystem planning for Canadian urban regions*. Intergovernmental Committee on Urban and Regional Research.

Tsujimoto, M., Kajikawa, Y., Tomita, J., & Matsumoto, Y. (2018). A review of the ecosystem concept – Towards coherent ecosystem design. *Technological Forecasting and Social Change*, *136*, 49–58. https://doi.org/10.1016/j.techfore.2017.06.032

Vallance, S., & Edwards, S. (2021). Charting new ground: Between tactical urbanism and strategic spatial planning. *Planning Theory & Practice*, *22*(5), 707–724. https://doi.org/10.1080/14649357.2021.1966081

Wildavsky, A. (1973). If planning is everything, maybe it's nothing. *Policy Sciences*, *4*(2), 127–153. https://doi.org/10.1007/bf01405729

Xu, S., & Madden, M. (1989). Urban ecosystems: A holistic approach to urban analysis and planning. *Environment and Planning B: Planning and Design*, *16*(2), 187–200. https://doi.org/10.1068/b160187

Yigitcanlar, T., & Dizdaroglu, D. (2015). Ecological approaches in planning for sustainable cities: A review of the literature. *Global Journal of Environmental Science and Management*, *1*(2), 159–188.

Yigitcanlar, T., & Teriman, S. (2015). Rethinking sustainable urban development: Towards an integrated planning and development process. *International Journal of Environmental Science and Technology*, *12*(1), 341–352. https://doi.org/10.1007/s13762-013–0491-x

Zellner, M. L., Milz, D., Lyons, L., Hoch, C. J., & Radinsky, J. (2022). Finding the balance between simplicity and realism in participatory modeling for environmental planning. *Environmental Modelling & Software*, *157*, 105481. https://doi.org/10.1016/j.envsoft.2022.105481