SOCIO-TECHNICAL TRANSITIONS TOWARD SUSTAINABLE CITIES: STAKEHOLDERS' PREFERENCES FOR THE FUTURE OF MOBILITY IN ISTANBUL

by

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ABSTRACT

SOCIO-TECHNICAL TRANSITIONS TOWARD SUSTAINABLE CITIES STAKEHOLDERS' PREFERENCES FOR THE FUTURE OF MOBILITY IN ISTANBUL

One of the most significant decarbonization challenges of the 21st century is transitioning urban mobility systems toward sustainability, particularly in megacities where infrastructure lock-ins and socio-technical complexities hinder decarbonization efforts. While technological advancements are often put forward as principal solutions, this thesis argues that transitions toward sustainability also require simultaneous shifts in mobility cultures, governance structures, and changes in stakeholder priorities in parallel to such technocentric approaches. The research critiques the technocentric narratives of "smart cities" and integrates socio-technical transitions theory to explore how technological innovation, social practices, and institutional dynamics interact. Through a mixed-methods approach, the study develops four future mobility scenarios for Istanbul—Business as Usual, Smart but Not Sustainable, Sustainable but Not Smart, and Smart and Sustainable—based on a STEEP (Social, Technological, Economic, Environmental, Political) analysis. These scenarios are evaluated by semi-structured interviews with 19 stakeholders, including policymakers, industry experts, NGOs, academics, and citizens. Findings reveal that while stakeholders have a strong preference for sustainability-oriented scenarios (C and D), their expectations lean towards a "Smart but Not Sustainable" future (Scenario B), underscoring the prevailing influence of technology over environmental priorities. The study introduces "discourse paths" that categorize stakeholder perspectives based on different views on technological development, environmental concerns, or market alignment. Furthermore, the research highlights significant governance challenges, including power asymmetries and the marginalization of critical voices within mobility decision-making processes.

ÖZET

SÜRDÜRÜLEBİLİR ŞEHİRLERE DOĞRU SOSYO-TEKNİK GEÇİŞLER İSTANBUL'DA MOBİLİTENİN GELECEĞİ İÇİN PAYDAŞLARIN TERCİHLERİ

21. yüzyılın en önemli karbonsuzlaştırma zorluklarından biri, özellikle altyapı kilitlenmelerinin ve sosyo-teknik karmaşıklıkların karbonsuzlaştırma çabalarını engellediği megakentlerde, kentsel mobilite sistemlerini sürdürülebilirliğe doğru dönüştürmektir. Teknolojik gelişmeler sıklıkla temel çözümler olarak öne sürülürken, bu tez sürdürülebilirliğe doğru geçişlerin aynı zamanda mobilite kültürlerinde, yönetim yapılarında ve bu tür teknosentrik yaklaşımlara paralel olarak paydaş önceliklerinde eş zamanlı değişimler gerektirdiğini savunmaktadır. Araştırma, "akıllı şehirler"in teknosentrik anlatılarını eleştiriyor ve teknolojik inovasyonun, sosyal uygulamaların ve kurumsal dinamiklerin nasıl etkileşime girdiğini keşfetmek için sosyo-teknik geçişler teorisini entegre ediyor. Karma yöntemli bir yaklaşımla, çalışma İstanbul için dört gelecekteki mobilite senaryosu geliştiriyor: Bir Değişiklik Olmadan, Akıllı Ama Sürdürülebilir Değil, Sürdürülebilir Ama Akıllı Değil ve Akıllı ve Sürdürülebilir. Bunlar, STEEP (Sosyal, Teknolojik, Ekonomik, Çevresel, Politik) analizine dayanmaktadır. Bu senaryolar, politika yapıcılar, endüstri uzmanları, STK'lar, akademisyenler ve vatandaşlar dahil olmak üzere 19 paydaşla yapılan yarı yapılandırılmış görüşmelerle değerlendirilmiştir. Bulgular, paydaşların sürdürülebilirlik odaklı senaryolara (C ve D) güçlü bir tercihi olmasına rağmen, beklentilerinin "Akıllı ama Sürdürülebilir Olmayan" bir geleceğe (Senaryo B) doğru eğildiğini ve teknolojinin çevresel öncelikler üzerindeki hakim etkisini vurguladığını ortaya koymaktadır. Çalışma, paydaş perspektiflerini teknolojik gelişme, çevresel kaygılar veya pazar uyumuna ilişkin farklı görüşlere göre kategorize eden "söylem yolları" sunmaktadır. Ayrıca araştırma, güç asimetrileri ve mobilite karar alma süreçlerindeki kritik seslerin marjinalleştirilmesi de dahil olmak üzere önemli yönetişim zorluklarını vurgulamaktadır.

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ABBREVIATIONS

AI	Artificial Intelligence
A-S-I	Avoid-Shift-Improve
BELBIM	Electronic Money and Payment Services Inc.
BRT	Bus Rapid Transit
CCTV	Closed Circuit Television
ETS	Electronic Ticketing Systems
ICT	Information and Communication Technologies
IDO	Istanbul Fast Ferries Co. Inc.
ITS	Intelligent Transport Systems
IEA	International Energy Agency
IETT	Istanbul Electric Tram and Tunnel Operations
IL	Intuitive Logics
IMM	Istanbul Metropolitan Municipality
ISBAK	Istanbul IT and Smart City Technologies Inc.
ISPARK	Istanbul Parking Lot Operations Trade
MLP	Multi-Level Perspective
NGO	Non-Governmental Organization
SNM	Strategic Niche Management
SSC	Smart-Sustainable City
STEEP	Social-Technological-Economic-Environmental-Political
SUMP	Sustainable Urban Mobility Plan
TCC	Transport Coordination Centre
TCDD	The State Railways of the Republic of Turkey
TIS	Technological Innovation Systems
TM	Transition Management
TOD	Transit Oriented Development

1. INTRODUCTION

Cities, as the epicenters of human innovation and economic activity, face unprecedented challenges in the 21st century. Rapid urbanization, climate change, resource depletion, and socio-economic inequalities demand transformative approaches to urban development (United Nations, 2018). Among these challenges, transitioning toward sustainable urban mobility systems stands out as a critical imperative. Urban transportation, a cornerstone of city life, contributes to 23% of global energy-related CO_2 emissions (IEA, 2021). Additionally, it exacerbates social inequities through unequal access to services (Lucas, 2012). While technological advancements promise increased efficiency, they often fall short of addressing the systemic and cultural shifts required for sustainability (Hickman & Banister, 2014).

Istanbul, a megacity straddling Europe and Asia, embodies these challenges. With a population of over 15 million and a unique geographical complexity, its mobility system struggles with congestion, fragmented governance, and reliance on private vehicles (Canitez, 2019; IMM, 2022). The city's initial Sustainable Urban Mobility Plan (SUMP)—the first of its kind in Turkey and among global megacities—aims to decarbonize transportation by 2050 (IMM, 2022). However, the plan's success hinges not only on infrastructural investments but also on aligning the diverse preferences of stakeholders with the socio-technical transitions necessary for systemic change (Geels, 2011; Köhler et al., 2019).

This study investigates the interplay between technological innovation and societal transformation in shaping sustainable urban futures. While the "smart city" paradigm has dominated urban discourse, its technocentric focus often overlooks the cultural, institutional, and behavioral dimensions of sustainability (Hollands, 2008; Kitchin, 2014). Drawing on socio-technical transitions theory, this research argues that urban mobility must be reimagined as a co-evolutionary process in which technological advancements are integrated into broader social practices and governance structures (Geels, 2002; Shove & Walker, 2007).

The concept of "smart cities" has gained traction as a panacea for urban challenges, emphasizing data-driven optimization and digital connectivity (Albino et al., 2015; Townsend, 2013). Yet, critiques highlight its neoliberal undertones, overreliance on private-sector solutions, and neglect of equity and participatory governance (Cardullo & Kitchin, 2019b; Shelton et al., 2015). In mobility systems, this manifests in projects prioritizing efficiency over accessibility, often exacerbating

existing inequalities (Büscher et al., 2020). Meanwhile, socio-technical transitions scholarship underscores the need to address "lock-in" effects, entrenched practices, infrastructures, and power dynamics that resist change (Geels, 2011; Seto et al., 2016).

Istanbul's SUMP developed with five scenarios ranging from "Business as Usual" to "Inclusive City," providing a strategic lens to examine these tensions (IMM, 2022). However, the plan's scenarios reveal ambiguities in reconciling smart technologies with social equity, and its implementation faces institutional fragmentation and competing stakeholder interests (Canitez et al., 2020). This study identifies a critical gap: while SUMPs outline technical pathways, they often lack mechanisms to incorporate stakeholders' visions, values, and governance preferences into transition strategies (Börjeson et al., 2006). Therefore, the study is guided by the following research questions:

- How do different stakeholders in Istanbul perceive alternative urban mobility futures, (Business-as-Usual, Smart but Not Sustainable, Sustainable but Not Smart, and Smart and Sustainable) and what types of "discourse paths" emerge form these perceptions?
- Are there any gaps between stakeholders' preferred and expected futures? If yes, what are tension points that contribute to these discrepancies?
- How do existing institutions and power relations between stakeholders promote and/or constrain the transition and transformation dynamics toward a sustainable urban mobility future?
- What governance models do stakeholders envision for a sustainable urban mobility transition, and what are the perceived trade-offs and challenges in balancing top-down with bottom-up methods?

A central finding of this research is the near unanimous stakeholder prioritization of sustainability. Stakeholders overwhelmingly preferred sustainable-oriented scenarios (C and D) but expected more likely outcomes aligned with Scenario B (Smart but Not Sustainable), reflecting the dominant role of technology over environmental priorities. This highlights a tension between ideal futures and realistic expectations, further shaped by "discourse paths" rooted in technological optimism, environmental concern, or market alignment. The study also reveals that sustainability is a deeply contested goal, often divided between technocratic and justice-oriented visions (Agyeman & Evans, 2004; Cardullo & Kitchin, 2019; Hickman & Banister, 2014). For instance, Environmental NGOs framed sustainability through an equity lens, while private sector stakeholders tended to reduce it to techno-managerial metrics, sometimes sidelining social dimensions and reflecting potential "greenwashing" (Agyeman & Evans, 2004; Shelton et al., 2015).

The analysis further indicates that while there is a strong consensus on the need for a sustainable and human-centered approach to urban mobility, significant disagreements persist regarding the optimal role of technology, the balance between public and private sector involvement, and the potential impacts of different mobility scenarios on various social groups. Stakeholder mapping also underscored power asymmetries and the marginalization of critical voices in decision-making processes.

The structure of the thesis is as the following. Chapter 2 provides an in-depth review of the smart city concept, discussing its origins, application domains, and the intersection of smart city initiatives with sustainability. Chapter 3 explores the socio-technical transitions framework, highlighting key theoretical perspectives on technological innovation and systemic change. Chapter 4 outlines the methodological framework, including scenario development and interview design. Chapter 5 presents the case study of Istanbul, analyzing its SUMP and developing new scenarios. Chapter 6 analyzes the stakeholder interviews, mapping preferences, concerns and power relations. Chapter 7 discusses the findings in relation to the main discourses, transition, and governance. Chapter 8 concludes the thesis with a summary of key insights, and suggestions for future research.

2. SMART AND SUSTAINABLE CITIES

Cities are both the centers of innovation and creativity and the destinations that technology has played a key role in urban environments. With the rapid growth of cities coupled with global climate crises and economic instability, a range of challenges have appeared on infrastructures, citizens and the environment. Consequently, new conceptualizations have emerged, and smart projects started being promoted as the solution to different urban challenges. According to Marvin (Hickman & Banister, 2014) they are "being represented as the response to almost every facet of the contemporary urban question", and even considered essential for the survival of our species (Hall, 2000). Therefore, it is important to critically examine "smart city" as an urban development concept. This section will first lay out a review of existing literature about the concept of the smart city. It will then try to elucidate the multifaceted relationship that exists between the smart city and sustainability.

There is a discussion of the complex, divergent, and even contradictory demands propelling innovation in cities, notably concerning transportation. The concept of smart-sustainable city (SSC) has become prominent in academic and political discussions about urban sustainability. In this chapter, smart city concept is examined to see if it can be a potential solution to urban challenges. As indicated by the review of the smart city literature, technological innovation alone is unable to tackle sustainability challenges. The ambiguous smart city literature is connected with socio-technical transitions presenting four primary strands of transition study. The chapter concludes by determining the need for more clearly and systematically critical transition research in light of the facilitation of additional systems of production and consumption, including the transportation industry.

2.1. The Concept of Smart City

2.1.1. Origins

Smart city term was used in 1800s for new West American cities to describe efficiency and self-governance; however, its contemporary origin can be attributed to the "smart growth" movement in 1990s within the framework of New Urbanism, advocating planning strategies in reaction to urban sprawl and other negative externalities (Albino et al., 2015; Bollier, 1998; Downs, 2005; Eger, 2009; Yigitcanlar et al., 2018). The term "smart" was being used referring to the application of information and communication technologies (ICT) in contemporary urban infrastructure (Albino et al., 2015).

Making a city smarter through “rational, rigorous and more ‘scientific’ methods of quantitative and computational data analysis” is not a novel idea (Shelton et al., 2015, p. 2). The use of computational data analysis in urban planning dates back to 1950s. By the late 1960s, the concept of “cybernetics”, which posits that information flows generated by sensing and feedback mechanisms can enhance performance in any system, was conceived (Kitchin et al., 2019). This concept has been used to model transportation, land use and social services in American cities such as Pittsburgh and New York City (Townsend, 2013). However, the attempt to simplify complex urban issues by relying on data and algorithms was unsuccessful in New York City. Fire stations in the poorest neighborhoods were closed to save money but this decision resulted in a number of hard-to-control fires that killed thousands of people and displaced hundreds of thousands more. This exemplifies how technological developments can be sold and commodified within urban settings yet fail to fulfill their promises (Flood, 2010).

In the1980s and 1990s, the use of personal computers for administration and service delivery began to develop in both central and municipal government. Following the acceleration of technological advancement in the 1990s, ICT became more widespread, becoming essential for modern life. The World Wide Web (WWW) and the initial web browsers increased the Internet’s accessibility and usability, enhanced networking, and enabled information exchange (Kitchin et al., 2019). Other than the Internet, the development of smart cities has been facilitated by the technological developments of fiber optics, and cellular phone / network technology. The "infobahn," or information superhighway, was created in the 1990s when copper cables started to be replaced by optical fibers. Also, telephones became mobile with the cable network's demise (Mitchell, 1995). Smart projects emerged as a result of decades of technical advancement in urban settings.

By the late 1990s, a substantial body of literature had been compiled that examined the various ways in which digital was changing politics, the economics, culture, social relationships, and the function of cities (S. Graham & Marvin, 2001). In several studies, ICT was envisioned as the main vehicle for developing democracy and municipal governance in future cities (Aurigi, 2006). Also, large investments started to be made in e-government (the provision of services and public interaction through digital channels) and e-governance (managing citizen activity through the use of digital instruments) (Kitchin et al., 2019). In the 2000s, sensors grew more affordable and widely available, and microcomputers became accessible, low-cost devices accompanying to advances in ICT (Chong et al., 2018). Also, people started to function as sensors by supplying data via mobile phones, digital cameras, and/or the Internet. In addition to having more sensors to generate data, objects started to increasingly interact with each other and share information about the systems which they are attached.

Due to this web of interconnectedness between items and/or people, the interactions within the cities are also changing (Cullen, 2016).

The increased interest on the relation between urban development and networked ICTs has been accompanied by different conceptual frames depending on the "fashion of the moment and the popularity of certain paradigmatic examples" (Ishida et al., 2005, p. 1), including: "wired" (Dutton et al., 1987), the "city as bits" (Mitchell, 1995), "computable city" (Batty, 1997), "cyber cities" (S. Graham & Marvin, 1999), digital cities" (Ishida & Isbister, 2000; Yovanof & Hazapis, 2009), "intelligent cities" (Komninos, 2002), "networked cities" (Hanley, 2004), "sentient cities" (Shepard, 2011), "virtual" (Albino et al., 2015; Nam & Pardo, 2011) , "ubiquitous" (Albino et al., 2015; Townsend, 2013).

Although the concept of a smart city is not novel, its understanding has evolved from digital to intelligent and then to smart (Mora et al., 2019). Digital cities emerged as a response to the cultural and social movements in Amsterdam that demanded more transparent and participatory processes for local development (van den Besselaar & Beckers, 2005). The term refers to "a connected community that combines broadband communications infrastructure; a flexible, service-oriented computing infrastructure based on open industry standards; and, innovative services to meet the needs of governments and their employees, citizens and businesses" (Yovanof & Hazapis, 2009, p. 446), with an emphasis on sharing of networks (Nam & Pardo, 2011). The "intelligent cities" paradigm enhanced the digital city notion by innovation and learning. It brought together the rising knowledge economy, and the ICT development (Albino et al., 2015). However, this conception gave little opportunities for individuals to engage in the decision-making process and was largely expert-focused, (Yigitcanlar et al., 2019).

The smart city concept emerged as a both technocentric and technocratic vision of the urban settings which predicted that ICTs could be used to address all sustainability and management issues (Hall, 2000). Therefore, early talks about the notion of a "smart city" focused on how ICTs will enable improvements in city administration through the supply of real-time information and increased digital connection between services and infrastructure (Batty et al., 2012). One of the first actors exploring the ways that a community can be smart was California Institute for Smart Communities. A few years later, the Center of Governance at the University of Ottawa criticized the term of smart city with a sole emphasis on ICT and expanded the concept with a strong governance-oriented approach (Albino et al., 2015). However, its popularity increased with the speech of Samuel J. Palmisano, then IBM

Chairman, President and CEO, on “A Smarter Planet: The Next Leadership Agenda” in November 2008 (Söderström et al., 2014).

2.1.2. Application Domains

The use of the term “smart city” has grown exponentially with different motivations and application domains (Table 1). According to Forrester research, “rapid urbanization, population-driven resource depletion, and varying demographic needs for services” are the primary motivators (Bélissent, 2010). Therefore, smart cities are seen as a chance to employ technology as an engine for economic growth particularly during periods of economic stagnation (Ben Letaifa, 2015; Hollands, 2008; Townsend, 2013); increasing economic and political efficiency (Hollands, 2008); attracting and maintaining talent, residents, enterprises, investments and tourism (Begg, 2002; Hollands, 2008); and reaching sustainable growth (Hollands, 2008; Monzon, 2015).

Table 2.1. Smart city application domains Source: Adapted from Neirotti et al., 2014, p. 28

Domain		Main Objectives
Natural resources and energy	Smart grids	Electricity networks that efficiently offer sustainable, economical and safe electricity by accounting for all connected customers' activities. Smart grids must be self-healing and fault tolerant.
	Public lighting	Public space illumination with streetlamps that reduce air pollution and provide Wi-Fi. Centralized management systems that directly interact with lampposts can reduce maintenance and operational costs by analyzing real-time weather data and regulating LED light intensity.
	Green/renewable energies	Utilizing renewable energy resources like heat, water, and wind power
	Waste management	Waste management minimizing environmental and human harm
	Water management	Water quantity and quality analysis and management throughout the hydrological cycle and for agricultural, municipal, and industrial applications
	Food and agriculture	Wireless sensors to monitor crop growth and conditions. Combining humidity, temperature, and light sensors reduces frost risk and detects soil humidity-based diseases and watering needs.
Transport and mobility	City logistics	Integrating business requirements with traffic, geography, and the environment to improve city logistics flows
	Info-mobility	Distribution and use of dynamic and multi-modal information pre-trip and on-trip to improve traffic and transport efficiency and ensure a high-quality travel experience.
	People mobility	Innovative and sustainable city transport methods, such as public transport modes and vehicles using environmentally friendly fuels and engines, are supported by new technologies and proactive citizens.
Buildings	Facility management	Cleaning, maintenance, property management, leasing, technology, and operational modalities related to urban facilities
	Building services	Provision of building services to existing structures utilizing computer systems for the management of electrical and mechanical equipment.
	Housing quality	Optimisation of living conditions in a residential buildingsuch as lighting, ventilation, heating and air conditioning
L i	Entertainment	Strategies to promote tourism and provide entertainment and nightlife information

Domain		Main Objectives
	Hospitality	The capacity of a city to provide suitable solutions to the requirements of foreign students, tourists, and other non-residents.
	Pollution control	Using devices to regulate emissions and effluents. Promoting air, water, and environmental improvements.
	Public safety	Protecting citizens and their property through proactive outreach by local public groups, police enforcement, and citizens. Data collection and management for crime
	Healthcare	ICT-assisted disease prevention, diagnosis, and treatment. Ensuring effective healthcare facilities and services
	Welfare and social inclusion	Enhancing quality of life through the promotion of social learning and engagement, particularly for certain demographics such as the elderly and disabled.
	Culture	Promoting the dissemination of information regarding cultural activities and encouraging public participation in them.
	Public spaces management	Public space maintenance, guardianship, and proactive management to improve urban appeal. Strategies to promote a city's main
Government	E-government	Using ICT to manage documents and processes in public administration to improve efficiency and serve residents with fast, innovative services.
	E-democracy	Utilizing advanced ICT systems to facilitate voting processes
	Procurement	Enabling the public sector to improve procurement and contract management for cost-effectiveness and quality.
	Transparency	Allowing citizens to easily access official documents and participate in local decision-making. Reducing officials' ability to abuse the system or hide important data
Economy and people	Innovation and entrepreneurship	Initiatives to enhance innovation systems and entrepreneurship in the urban environment (e.g., availability of local incubators)
	Cultural heritage management	Using ICT solutions like augmented reality to improve customer experiences respecting the city's culture. Maintenance of ancient buildings using asset management information systems.
	Digital Education	Comprehensive utilization of contemporary ICT tools (e.g., interactive whiteboards, e-learning systems) in public educational institutions.
	Human capital management	Strategies to improve human capital investments and recruit and retain talent to prevent brain drain

2.1.3. Different Definitions of Smart Cities

Although the concept of smart city gains a wider currency, there is no single, commonly agreed, precise definition of it, nor a general consensus on its attributes (Albino et al., 2015; Hollands, 2008) (Table 2). According to Yigitcanlar et al. (2018), the reason why there is no singular blueprint for conceptual framing, nor a universal definition applicable to all contexts is because different groups including academic, commercial and international organizations examine and implement smart cities from different perspectives like technology, economy, society, environment, and governance. Cities are branding themselves as smart despite there is no agreed-upon definition of it (Kummitha & Crutzen, 2017). Technology providers have benefitted from the elasticity and variability of the concept by promoting smartness as a panacea to many problems in the urban discourse (Marvin,

2015). The promotion of smart cities is presented as universally agreeable, suggesting an inherent "positive transformation" by default (Söderström et al., 2014, p. 5).

Table 2.2. Overview of Most Popular Smart City Definitions

Authors of Smart City definition	Content of Smart City definition and general interpretation
Hall, R.E. (2000)	A city that monitors and integrates conditions of all its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.
Partridge, H. (2004)	A city where the ICT strengthen the freedom of speech and the accessibility to public information and services.
Giffinger, R. et al. (2007)	A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens.
Rios, P. (2008)	A city that gives inspiration, shares culture, knowledge, and life, a city that motivates its inhabitants to create and flourish in their own lives
Caragliu, A., Bo, C.D., & Nijkamp, P. (2011)	A city to be smart when investments in human and social capital and traditional(transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.
Washburn, D. et al. (2010)	The use of Smart Computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, more interconnected, and efficient
Harrison, C. et al. (2010)	An instrumented, interconnected, and intelligent city. Instrumentation enables the capture and integration of live-world data using various devices and sensors. Interconnected means the integration of those data into an enterprise computing platform and the communication of such information among the various city services. Intelligent refers to the inclusion of complex analytics, modeling, optimization and visualization in the operational business processes to make better operational decisions
González, J.A., & Rossi, A. (2011)	A public administration or authorities that delivers (or aims to) a set of new generation services and infrastructure, based on information and communication technologies
Zhao, J. (Zhao, 2011)	Improving the quality of life in a city, including ecological, cultural, political, institutional, social, and economic components without leaving a burden on future generations.
Lazaroiu, G.C. (2012)	The smart city represents the future challenge, a city model where the technology is in service to the person and to his economic and social life quality improvement.
Schaffers, H., Komninos, N., Tsarchopoulos, P., Pallot, M., Trousse, B., Posio, E., Carter, D. (2012)	Smart city is referred as the safe, secure environmentally green, and efficient urban Centre of the future with advanced infrastructures such as sensors, electronics, and networks to stimulate sustainable economic growth and a high quality of life

Authors of Smart City definition	Content of Smart City definition and general interpretation
Dameri, R.P. (2013)	A smart city is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development.
European Parliament Directorate General for Internal Policies of the Union (2014)	A Smart City is a city seeking to address public issues via ICTbased solutions based on a multi-stakeholder, municipally based partnership.
Piro, G., Cianci, I., Grieco, L.A., Boggia, G., & Camarda, P. (2014)	A smart city is intended as an urban environment which, supported by pervasive ICT systems, can offer advanced and innovative services to citizens in order to improve the overall quality of their life
Lara, A. P., Da Costa, E. M., Furlani, T. Z., & Yigitcanlar, T. (2016)	Smart city is a community that systematically promotes the overall wellbeing for all of its members, and flexible enough to proactively and sustainably become an increasingly better place to live, work and play.
Bibri, J. (2019)	A smart city can […] mean a technologically and data– analytically advanced city that is able to monitor and understand its environment and citizens and explore and analyze various forms of data to generate useful knowledge in the form of applied intelligence that can immediately be used to solve different problems, or to make changes to improve the quality of life and the health of the city
Toli, A.M., Murtagh, N. (2020)	Smart city is a concept of urban transformation that should aim to achieve a more environmentally sustainable city with a higher quality of life, that offers opportunities for economic growth for all its citizens, but with respect to the particularities of each locality and its existing inhabitants. This transformation is currently enabled by various types of technologies that are embedded into the city's infrastructure system.

There are different views on what makes up a smart city including purely ecological, technological (Townsend, 2013,), economic (Kourtit & Nijkamp, 2012), organizational (Hollands, 2008), and societal (Deakin & Reid, 2018). Different classifications are done like top-down vs. bottom-up initiatives (Calzada & Cobo, 2015), supply vs. demand driven approaches (Angelidou, 2015), hard infrastructure vs. soft infrastructure oriented approaches (Angelidou, 2015), ICT vs. knowledge economy focus (Kitchin, 2014). A classification among the working definitions of smart cities can be done according to its focus as pragmatic and adaptable, techno managerial, and certain requirements have to be met.

Table 2.3. Working definitions of smart cities Source: Adapted from Liebert & Wodarski, 2021

Focus	Definition examples
Pragmatic and adaptable	"A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" (Giffinger et al., 2007, p. 11)
Techno managerial	"Smarter Cities are urban areas that exploit operational data, such as that arising from traffic congestion, power consumption statistics, and public safety events, to optimize the operation of city services. The foundational concepts are instrumented, interconnected, and intelligent." (Harrison et al., 2010, p. 1)
Certain requirements have to be met	"We believe a smart city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu et al., 2011, p. 6)

2.1.4. Drivers

A variety of smart city drivers are highlighted in the interdisciplinary literature. According to Nam and Pardo (2011), these drivers are; technology (infrastructures of hardware and software), people (creativity, diversity, and education), and institutions (governance, policy, regulations/directives) (Figure 1). Given the relationship between these drivers, "a city is smart when investments in human/social capital and IT infrastructure fuel sustainable growth and enhance a quality of life, through participatory governance" (Nam & Pardo, 2011, p. 286). Therefore, IT infrastructure systems act as a foundation in the sense that they are used as "means," rather than "ends," for improving a city's potential for innovation. However, technological factors are also dependent on education, participation and social learning.

Likewise, Kunzman (2014) conceptualizes the drivers as; technology, community, and policy. While smart city technology improves the convenience and safety of city living, the community benefits from smart city services and chooses which issues to address. Also, smart city efforts are made possible by policy, which takes precautions to lessen the negative impacts. The comprehension of these different factors emphasizes the significance of a dynamic viewpoint on smart cities. Therefore, smartness of a city should be seen as a dynamic process which takes different dimensions like technological, institutional, and human into account, rather than solely as a state at a specific period.

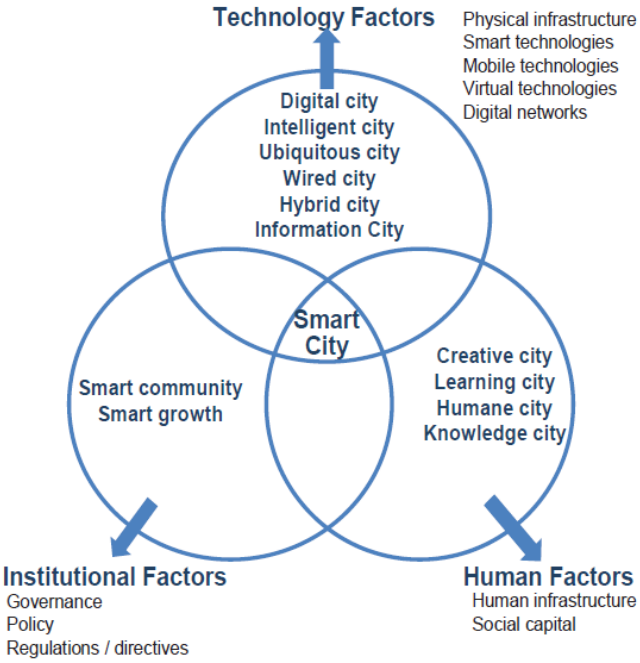


Figure 2.1. Fundamental components of smart city Source: Nam & Pardo, 2011, p. 286

2.1.5. Barriers and Threats

Cities and city systems are already complex, and they become even more complex with the integration of technological systems. Complex social issues cannot be easily quantified, broken down into discrete topics, or addressed by technology based on small datasets. Also, deep rooted structural problems and impacts behind complex cultural, political, social capital aspects on people's lives are not addressed deeply from the root. (Kitchin, 2014). Technological solutions make it possible to handle those issues' symptoms more efficiently rather than solving the root causes (Cardullo & Kitchin, 2019b). Many of these technology solutions follow the same pattern without considering how different cities, regions, and populations are from one another. In the meantime, cities become even more vulnerable to viruses and hacks if they don't have enough knowledge and skills (Townsend, 2013). According to Mora et al. (2017), both the knowledge and the instruments required for building smart cities are still lacking.

As digital technologies advance, the largest software suppliers and corporations in the world have been on the scene working in cooperation or collaboration with the government on various levels. There has been a power shift from government and public community to companies (Hollands, 2008). When a government is dependent on technologies and systems that cannot be reserved or reversed, it is dangerous for these providers to hold monopolistic positions because there may be lock-in consequences (technological, economic, legal, or institutional). Each local government's

decision to pursue smart technologies, as well as the technology solution selected, establishes concrete path dependencies in terms of hardware, middleware, and software. As many technologies have substantial initial investment costs that result in local public debt, lock-in effects become even more severe (Seto et al., 2016). As power shifting from the public sectors to technological private sectors, the outsourcing and privatization of urban management will have unpredictable implications (S. Graham & Marvin, 2001).

There is too much emphasis on efficiency with an overdependence on technocrats and algorithms which poses a risk of rebound effects on the citizens. Cost savings gained from the technical efficiency improvements can lead to more consumption which eventually cancels any benefits from energy-saving technology advancements (Hilty et al., 2006). Therefore, technology does not need to be used just because it is available. Focusing too much on technology can lead to overlooking other cheaper or low-tech solutions that don't rely on a business led approach (Caragliu et al., 2011).

A variety of smart technologies have changed geo-location tracking, undermining the privacy of movement (Kitchin, 2016). Digitally controlled CCTV cameras, capable of monitoring specific pedestrians are widely used in cities. Also, traffic cameras, and automatic number plate recognition systems are employed to oversee substantial segments of the road network. Such data collection has significant effects on privacy, which many people view as a fundamental human right (Kitchin et al., 2019). Also, the dissemination and examination of data trails are another privacy issue (Kitchin, 2016). "Predictive privacy harms" can be produced based on the individual profiles like credit risk, likely tastes, etc. and this can be utilized to socially categorize and delineate populations (Graham, 2005). Also, location tracking, co-proximity, and co-movement with others can be employed to imply social, political, or religious connection, potentially indicating membership in specific organizations (Leszczynski, 2017). These kinds of conclusions might result in incorrect portrayals of individuals and concerns about "data determinism" (Kitchin et al., 2019) and social exclusion.

According to the critical urban theory, cities are significant for the production, distribution, and consumption of goods; therefore, they are "sculpted and continually reorganized in order to enhance the profit-making capacities of capital" (Brenner et al., 2012; Kitchin et al., 2019). Exchange value, focused on profit, is being prioritized over use value, which addresses basic requirements (Brenner et al., 2012; Kitchin et al., 2019) allowing a limited group of actors who possess and manage the means of production and perpetuate inequality and social and geographic disparities through the functioning of capitalism in urban environments (Harvey, 2009). From this perspective, the smart city represents the latest endeavor to utilize and restructure urban environments as a strategy for accumulation,

fostering a technology-oriented form of urban entrepreneurship wherein private interests seek to intensify the neoliberal political economy by seizing public assets and services through the provision of technological solutions to urban challenges (Hollands, 2008).

Neoliberal smart cities are clearly commercial endeavors that seek to draw foreign direct investment, support local start-up sectors or digital hubs, and draw elite creatives (Evans et al., 2018). City administrations face pressure to use industry expertise to develop "smart" urban policies and to deliver technology-driven city services via public-private partnerships, leasing, deregulation and market competition, and privatization in order to acquire public assets (Shelton et al., 2015).

Despite appearing to be a popular solution to urban challenges with the aim of balancing efficiency and sustainability concerns from energy, water, and waste management to education, housing, and transportation to promote economic prosperity and improve the quality of life for city residents, the value of smart cities is still questioned. There is ambiguity, overreliance on technological innovation, and absence of specific strategic frameworks or roadmaps to support the notion. For the transportation sector, narratives of technology-based smart urbanism need to be critically analyzed because they seem to only offer technologically optimized projections from the status quo with a short-term perspective. Therefore, the next section provides an overview of urban transportation.

2.2. Smart Mobility

The widespread advocacy of technical solutions to the issue of transportation emissions supports the prevailing view that society continues to prioritize mobility as it is, yet technology must evolve to be more environmentally sustainable (Hickman & Banister, 2014). Fuel-optimized engines and a diverse array ranof low carbon fuels can be given as a few examples of such greener technology. The advancement of novel materials, enhanced vehicle designs, energy recovery technologies, and idle-reduction technologies are expected to yield incremental improvements. (Mokhtarian, 2009).

It is debatable, nevertheless, to place so much emphasis on technical advancement as the primary factor in cutting carbon emissions. Without corresponding long-term changes in mobility patterns and individual travel behavior, decoupling techniques by themselves are insufficient to accomplish sustainable development. Technology advancements run the danger of causing rebound effects like the increased transportation demand brought on by the growth of road space in earlier decades (Herring & Roy, 2007). Therefore, it is plausible to assume that short-term improvements in

efficiency resulting from technological advancements in urban transportation will result in longer-term increases in demand for transportation. While efficiency gains in a consumption sector could promote growth in others, the overall environmental externalities could also increase (Anable & Shaw, 2007).

Urban transportation sector interventions in smart cities place a strong emphasis on "hard" material changes to the current transportation infrastructure (Neirotti et al., 2014). The utalization of extensive ICT solutions to improve the effectiveness of urban transportation networks regarding travel duration and cost is promoted in commercial smart city transportation projects. Nevertheless, accelerating the pace of travel does not lessen trips or ease congestion (Mokhtarian, 2009).

Transport systems that are technologically advanced and environmentally friendly are beholden to the paradigm that sees demand for transportation as derived and they promote high mobility and transport effectiveness through travel flow (Banister, 2011). Transportation in the technologically smart cities place a heavy emphasis on preserving present levels of mobility and transportation behaviors while looking to technological and ICT applications to lessen the negative social and environmental effects. However, unpredictable rebound effects pose a serious threat (Berkhout et al., 2000).

One of the concrete paradigms that is strongly supported by the International Energy Agency (IEA), Gesellschaft für Internationale Zusammenarbeit (GIZ), and Sustainable Urban Mobility by WRI (EMBARQ) is A-S-I (Avoid-Shift-Improve). It stresses strategies for managing travel demand and spatial planning to restrict the rise of urban mobility and prevent unnecessary transportation activities. The paradigm argues for improving motorized mode-dependent travels that cannot be switched to or avoided by other technical advancements. This approach questions the notion of high mobility, emphasizes a combination of active and public transportation that is socially fair, and gives technology a less significant role in the design of urban transportation systems (Jaeger et al., 2015).

2.2.1. Sustainable Urban Mobility Plan (SUMP)

Origin and background

The Sustainable Urban Mobility Plan (SUMP) concept originated from a European Commission initiative to enhance urban transport planning practices. This initiative, driven by the need to address pressing sustainability challenges within urban areas, sought to integrate best practices from local planning experiences, existing national guidelines, and relevant research. A comprehensive dialogue

involving diverse stakeholders and planning experts across the European Union played a crucial role in refining the SUMP concept (May, 2015). The initial SUMP guidelines were published in 2014, followed by an updated version in 2019. Continuous research efforts, such as those undertaken by the CIVITAS projects (SUMPs-UP, SUMP-PLUS, and SUITS), contribute to the ongoing evolution of the SUMP framework. While rooted in established transport planning methodologies, SUMP explicitly aims to depart from traditional, car-centric approaches and paradigms (Hartl et al., 2024).

Governance structures

SUMP is designed to be integrated into the existing operational frameworks of city transport departments, positioning these departments as key actors in initiating and guiding the planning process. However, the implementation of SUMP within these established governance structures faces significant challenges. Firstly, deeply entrenched planning traditions and entrenched sectoral responsibilities within these departments can create institutional inertia. Past experiences, even if outdated or unsuitable for current challenges, can heavily influence current planning practices and hinder the necessary paradigm shifts (Wolfram, 2018). Secondly, a preference for standardized procedures, measurable outputs, and predictable outcomes within administrative contexts can impede the implementation of SUMP. This is because socio-technical transitions are inherently uncertain and context-dependent, requiring flexibility and adaptability rather than rigid adherence to pre-defined plans (Peris & Bosch, 2020).

Legitimation

SUMP emphasizes the importance of broad stakeholder engagement and democratic legitimacy. By actively involving a diverse range of societal actors and seeking approval from democratic institutions such as city councils, SUMP seeks to foster societal and political consensus. This approach aligns with the principles of liberal democracy by ensuring that city administrations and elected officials are responsible for the results of SUMP processes (Hartl et al., 2024).

Normative of sustainability

SUMP provides a more concrete operational "sustainable transport system" definition by outlining key criteria including accessibility, a balanced consideration of economic feasibility, social equity, health, and environmental quality, alongside the efficient utilization of urban space and existing transportation infrastructure. The prioritization of these criteria is determined through local-level negotiations and deliberations (Bührmann et al., 2011).

To sum up, this chapter has discussed the multifaceted concept of the "smart city," examining its origins, evolution, and diverse interpretations. While the promise of smart city technologies to address urban challenges like congestion, pollution, and inequality is undeniable, a critical analysis reveals significant limitations. These include concerns regarding data privacy, the potential for exacerbating existing inequalities, the dominance of neoliberal agendas, and the overemphasis on technological solutions at the expense of addressing deeper social and political issues. Furthermore, the absence of a unified definition and the ambiguity surrounding the concept of "smartness" hinder effective implementation and evaluation. Recognizing the complex interaction of technological, social, economic, and political factors, it becomes evident that a more nuanced comprehension of urban change is required. This understanding is essential for effective frameworks development for urban mobility transitions, such as the Sustainable Urban Mobility Plan (SUMP), which emphasizes the importance of integrating diverse stakeholder perspectives, addressing institutional inertia, and fostering democratic governance to ensure that urban mobility transitions are equitable, sustainable, and responsive to the needs of all citizens. The subsequent chapter delves into the socio-technical transitions literature, providing a theoretical framework for comprehending the intricate interplay of technological, social, and institutional factors that drive transformative change within urban transportation systems.

3. SOCIO-TECHNICAL TRANSITIONS

The preceding chapter explored the multifaceted concept of "smart cities," examining its origins, evolution, and diverse interpretations. While the promise of smart city technologies to address urban challenges like congestion, pollution, and inequality is undeniable, a critical analysis revealed significant limitations, including concerns regarding data privacy, the dominance of neoliberal agendas, and the potential for exacerbating existing inequalities. These limitations underscore the need for a more nuanced understanding of the complex interplay of technological, social, and institutional factors that drive urban transformation. This chapter delves into the theoretical framework of socio-technical transitions, providing a lens through which to analyze the dynamics of urban mobility transitions. By examining how technological, social, and institutional factors interact and co-evolve, this chapter aims to provide a deeper understanding of the challenges and opportunities associated with achieving sustainable and equitable urban mobility in the 21st century.

In socio-technical systems literature, transition refers to non-linear, drastic changes that have a substantial impact on social practices compared to prior state, a process that takes decades. According Geels and Schot (2010) transitions have the following features: (1) co-evolution and numerous changes in socio-technical systems or configurations, (2) multi-actor interactions involving companies, user groups, scientific communities, policy makers, social movements, and special interest groups (3) radical change in terms of scope of change (not speed of change) (4) long-term processes over 40–50 years periods. Thus, transitions are complex processes that are both multi-scalar and multi-actor, taking place over a long period of time (Schot et al., 2016).

Technological change, in particular the emergence and spread of innovative technologies, is at the center of the examination from a socio-technical viewpoint. This perspective is based on evolutionary economics, innovation studies, history of technology, sociology, and society, which collectively suggest a view of technological change as a social phenomenon (Geels, 2004a). However, it differs from the alternative perspectives on environmental issues that emphasize markets, technology or behavioral change (Geels et al., 2008). In the case of neo-liberal policies, the goal is to "get the prices right." Under specific conditions like perfect markets and rational agents, this approach can be effective; however, it presents difficulties for radical innovations and transitions (Geels et al., 2008).

Another approach, ecological modernization, focuses on clean technologies assisting economic growth and sustainable development, introducing a supply-side perspective. However, this perspective is also criticized for its sufficiency for more radical changes (Langhelle, 2000). Eco-centric approaches like deep ecology propose that environmental issues are closely intertwined to the values of modernity; however, their radical undertones may limit it to a niche activity (Geels et al., 2008). Large technical systems, technological systems, and sectoral innovation systems view the creation of innovations primarily from the supply side, concentrating on the organized production of new technologies by enterprises or whole industrial sectors.

The socio-technical systems approach is distinct from other systems theories, based on the idea that technologies both influence and are influenced by the larger social and economic systems in which they are integrated and strive to serve. It seeks to overcome the preceding approaches' restricted focus on either markets, technology, or behavioral change by examining the dynamic interrelatedness and co-evolution between them. The rising importance of sustainability issues has prompted socio-technical change and transition academics to concentrate more specifically on so-called sustainability transitions (Geels, 2004a).

Over time, a variety of theoretical frameworks for analyzing socio-technical transitions have arisen; however, “Dutch approach” is the most significant body of innovation-focused transition research which originates in the Netherlands (Chappin & Ligtvoet, 2014). The mostly used four approaches are: technological innovation systems (TIS) (Carlsson & Stankiewicz, 1991; Markard & Truffer, 2008), transition management (TM) (Rotmans et al., 2001), strategic niche management (SNM) (Kemp et al., 1998), and the multi-level perspective (MLP) (Geels, 2002, 2011; Geels & Schot, 2007).

3.1. Technological Innovation Systems (TIS)

The technological innovation system (TIS) is a framework that focuses on the creation, diffusion, and usage of a certain technology to investigate a specific system based on technologies or innovations more deeply (Bergek et al., 2008). It arose from a synthesis of literature on innovation systems (Freeman et al., 1987; Malerba, 2002) and technological systems (Carlsson & Stankiewicz, 1991). Innovation systems can be defined as a collection of organizations and institutions, as well as the links that exist between them (Edquist, 2005) and when they are assigned to a certain technology or product, they are referred as technological systems (TS) in the literature (Markard & Truffer, 2008). TIS argues that the number of individuals, institutions, and network relationships that comprise

sectoral and national innovation systems limit dynamic assessments of systemic innovation (Hekkert et al., 2007). Therefore, it seeks to reduce this complexity by focusing on the actions and interactions of actors, networks and institutions (Bergek et al., 2008).

Firms, government agencies, research institutes, and other organizations such as interest groups can all be actors. Networks are especially important for the transfer of implicit and explicit knowledge. When an actor joins a network, it significantly expands the knowledge base. While such networks may guide views about future desired or viable courses of action, they might also limit technology options. Institutions encompass the norms, rules, laws, regulation, routines and culture that direct an actor's actions during interactions and significantly influence the trajectory of technological development (Bergek et al., 2008). However, the three elements of its system structure (actors, institutions, and networks) are insufficient to explain the system's performance.

A closer look to the functions is needed because the positive fulfillment of these seven functions is thought to result in the emergence of a new technology: 1) knowledge development and diffusion, 2) entrepreneurial experimentation, 3) influence on the direction of search, 4) market formation, 5) legitimation, 6) resource mobilization and 7) development of positive externalities. Although these system functions are inducing, if one of them is lacking or feedback mechanisms between functions are overlooked in national policy, technology progress might result in unforeseen consequences or fail to operate. (Bergek et al., 2008).

TIS is useful in uncovering "blocking factors" and "system flaws", prompting policy intervention to promote certain technologies (Hojckova et al., 2020). It is a preferred framework in the context of urban transportation innovation because transportation policy and practice include a wide range of actors which operate and interact at various geographical and functional scales. While its' technology centrism is beneficial in understanding the dynamic and multifaceted characteristics of systemic innovation processes, this unintentionally causes a significant inward bias because of its static understanding of a particular technology. TIS has a significant problem in reconciling its static technological conceptualization with the dynamic processes of sociotechnical innovation (Markard & Truffer, 2008).

3.2. Transition Management (TM)

Transition Management is a policy-focused framework which takes a reflexive governance approach incorporating principles from governance theory (Rotmans et al., 2001) and complex systems theory (Rotmans & Loorbach, 2009). Its core premise is that there are a variety of chronic problems that are both complicated and unpredictable. TM transposes these chronic issues into governance challenges that emphasize the identification, development, and experimentation of diverse solutions and methodologies. It suggests that policymakers can shape transitions in four stages: 1) Strategic initiatives within a "transition arena" aim to formulate visions and determine feasible transition pathways 2) Tactical efforts involve formulating detailed plans for designated routes and establishing agendas and supportive coalitions for these routes, ideally accompanied by investment commitments. 3)Operational activities include on-the-ground initiatives such as innovation experiments, demonstration projects, and implementation activities aimed at facilitating learning through practical experience. 4) Reflective actions must lead to revisions in vision and the articulation of best practices (Loorbach, 2010).

The primary concept of Transition Management's transition arenas is to modify governance to support transitions by bringing different actors together and developing cooperation between them. However, not only different interests of regime actors and resistance to change but also societal structural problems like inequality appear to be as the barriers (Köhler et al., 2019). According to Kenis et al. (2016), TM views change as a quasi-market process in which creative niches compete with and exceed the present regime. However, the importance of power and politics should not be disregarded and need to be incorporated into the framework (Shove & Walker, 2008).

3.3. Strategic Niche Management (SNM)

Strategic Niche Management (SNM) is an analytical approach used for studying the emergence of radically new inventions. According to SNM scholars, radical innovations develop from experimentation with novel technologies in "protected spaces" where they are sheltered from general market selection. The experimental approaches comprise incorporating the actors' knowledge and experience into the technology development process, as well as establishing interactive learning processes and institutional adaptation (Kemp et al., 1998).

3.4. Multi-level Perspective (MLP)

The Multi-level perspective was developed to understand better how technical innovation leads to complicated, large-scale structural change (Geels, 2002, 2004a). It studies the dynamic interactions between a) socio-technical systems, b) actors, and c) institutions in fundamental socio-technical change processes (Figure 2). Geels (2004a) defines socio-technical systems as a group of components encompassing both material and immaterial aspects such as technology, regulation, user practices, markets, cultural meaning, infrastructure, maintenance networks, supply networks. Technology producers, users, and other stakeholders can be given as an example of the actors. Institutions can act both as enabler or disabler in the technology production, diffusion, and use processes (Geels, 2004a).

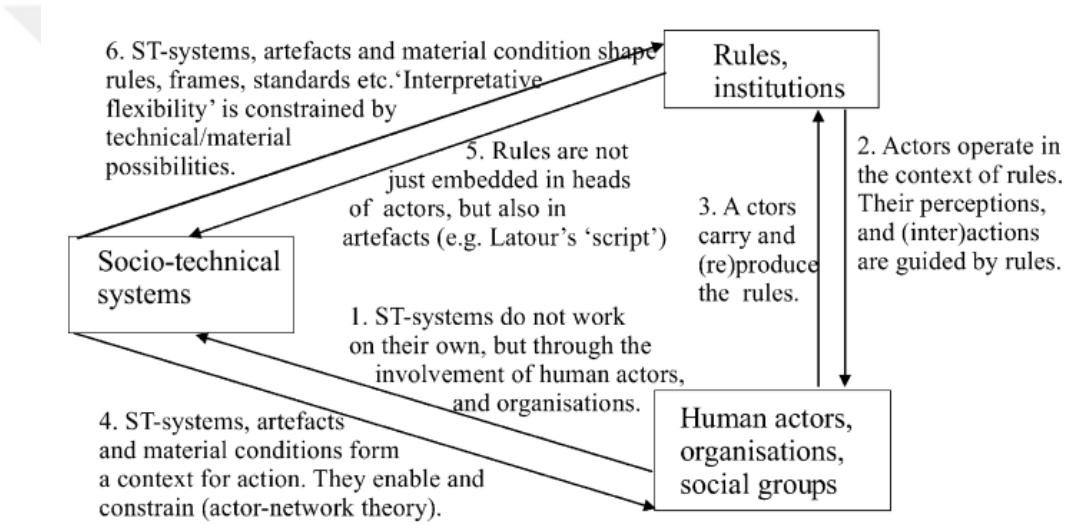


Figure 3.1. Interactions between socio-technical systems, actors, and institutions (Geels, 2004a)

The interactions between these dynamically co-evolving elements are central to non-linear socio-technical change processes that underpin large-scale, long-term transitions. They occur within and between three analytical levels: niche innovations (micro-level), socio-technical regimes (meso-level), the broader socio-technical landscape (macro-level) (Geels, 2002).

Socio-technological innovation processes are assumed to emerge with the advancement of a new technologies in niches, which serve as an "incubation room" that new configurations can emerge, and grow, and gain momentum (Kemp et al., 1998). Niches are significant as they facilitate learning processes, including technical specifications, user preferences, governmental policies, and symbolic meanings, as well as experimentation and the development of social networks, such as supply chains and user–producer relationships (Geels, 2004a).

"Socio-technical regime" on the meso-level of the MLP framework is where mature socio-technical systems exist with a cohesive set of institutions that are widely recognized and employed by numerous actors using advanced technologies. (Geels, 2011). Although the regime term resembles that of the socio-technical system, it emphasizes coordination, alignment, and orientation rather than just noting interactions (Geels, 2004b). The mutual reinforcement between its elements propels self-reproductive and path dependent dynamics which enhances the regime's internal coherence. Its internal coherence makes the regime more resistant to being displaced by new, inferior socio-technical configurations (Geels, 2004b).

At the landscape level, extensive processes and changes in and environmental, socio-economic, demographic and cultural factors occur beyond the influence actors operating at the regime and niche levels (Geels & Schot, 2007). In general, a regime would have emerged—and would persist—in alignment with the landscape level. It is difficult for novel niche technologies to arise particularly when they fail to resonate sufficiently with changes affecting the landscape level. On the other hand, the long-term macro level trends and contextual drivers can also exert pressure on the current system, creating opportunities for emerging technologies to break through and trigger a shift.

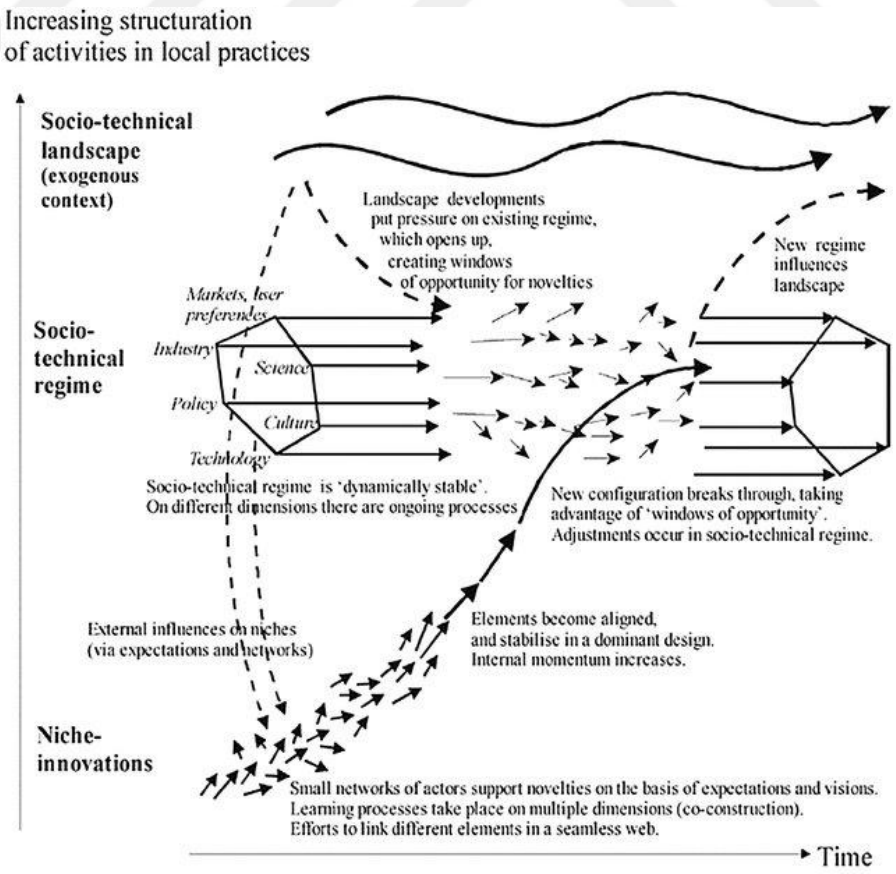


Figure 3.2. Multi-level perspective on transitions (Geels, 2011)

MLP scholars have recognized two different patterns in an attempt to comprehend more about how to affect transition processes and provide room for alternative systems: niche accumulation and hybridization (Raven, 2007). To prevent early rejection, niche accumulation keeps experimentation at the niche level until the system is robust enough to challenge the current regime. The other approach, hybridization, occurs close to the prevailing regime with the ultimate goal of radical transformation by deviating from current trajectories in favor of more desirable ones. However, these two approaches should be viewed as extremes, as Raven (2007) noted, and transitions frequently combine the two.

MLP is a popular analytical framework for examining transitions in many different fields, including transportation (Geels, 2002, 2005b), water supply and waste management (Geels, 2005a; Nastar, 2014; van der Brugge et al., 2005), aviation (Nakamura et al., 2013), food production (Belz, 2004), urban development (Næss & Vogel, 2012), innovation policy (Kern, 2012). In the energy field, it has been applied to transitions in energy supply (Rosenbloom & Meadowcroft, 2014; G. Verbong & Geels, 2007; G. P. J. Verbong & Geels, 2010), transport (Marletto, 2014; McDowall, 2014), and the residential buildings sector (Horne et al., 2014; Yücel, 2013).

While the MLP is a useful approach for studying socio-technical change in general, it is less effective in acquiring a better knowledge of internal niche dynamics. Several studies from different disciplinary traditions have criticized the MLP for overemphasizing technology artifacts (Genus & Coles, 2008; Shove & Walker, 2007) and producing unduly homogenous conceptualizations of regimes, implying a degree of internal coherence which rarely corresponds to reality (Fuenfschilling & Truffer, 2014). This deficiency is directly related to MLP's disregard for geographical grounding and socio-spatially varied transition processes (Bulkeley & Betsill, 2005). MLP is criticized for depending on overly simplified conceptualizations of the social and cultural contexts in which socio-technical changes occur. Accounts of agency and locally specific power relations in transitions to sustainability remain largely overlooked due to the absence of a suitable geographical grounding of transition case studies (Raven et al., 2012; Shove & Walker, 2007).

In conclusion, this chapter has explored key theoretical frameworks for understanding socio-technical transitions. Drawing on the Multi-Level Perspective (MLP), Technological Innovation Systems (TIS), Transition Management (TM), and Strategic Niche Management (SNM), the chapter highlights the complexity and contested nature of sustainability transitions in urban mobility systems. These frameworks collectively emphasize that transitions are not merely about deploying new technologies, but factors such as the creation of coalitions, the development of political consensus,

and the establishment of legitimacy within the socio-technical regime are crucial for successful transitions. Building upon this theoretical foundation, the following chapter will outline the research methodology employed in this study. This includes a detailed description of the research approach, and scenario building.

4. METHODOLOGY

This chapter will delve into the methodologies employed in this research. Recognizing the multifaceted and interdisciplinary nature of this research, an exploratory approach is adopted, emphasizing a bottom-up understanding of the research phenomenon through qualitative data collection and analysis. A case study approach centered on Istanbul is utilized to capture the unique complexities of this specific urban context. Furthermore, given the inherent uncertainty surrounding the future of urban mobility, scenario building methodologies are employed to explore potential future pathways.

4.1. Research Approach

The smart city concept presents a multifaceted and intricate challenge, as discussed in chapter 2. A consensus on the precise definition and operationalization of a smart city remains unclear, with diverse perspectives emerging from various stakeholders (Kitchin, 2014; Marvin et al., 2015; Yigitcanlar et al., 2018). These divergent viewpoints stem from differing worldviews and priorities held by citizens, policymakers, businesses, and other actors involved. The integration of sustainability considerations into the smart city concept (i.e. smart and sustainable) further complicates the matter (since sustainability itself is a rather complex and multidimensional issue), necessitating an interdisciplinary approach that transcends traditional disciplinary boundaries (Funtowicz & Ravetz, 1993). To effectively address this complexity, a participatory approach is essential. A comprehensive understanding of this research problem can only be obtained by actively engaging a wide range of stakeholders and incorporating their diverse forms of knowledge. This inclusive approach ensures that the voices and perspectives of all stakeholders are considered, fostering a more nuanced and informed understanding of the challenges and opportunities presented by the smart city paradigm.

Recognizing the multifaceted nature of this research, which investigates an area with limited existing knowledge, an exploratory research methodology is adopted. This approach emphasizes a bottom-up understanding of the research phenomenon in an inductive manner, without having pre-defined hypotheses. By systematically collecting and analyzing qualitative data, the aim is to generate new insights and develop a grounded theory that emerges from the empirical evidence. A comprehensive review of existing literature is conducted to situate the research within the broader academic discourse. This review served to identify gaps in the current body of knowledge and pinpoint areas where this dissertation can contribute new insights and understandings. Building upon

this foundation, a case study strategy is employed to investigate the specific context of Istanbul. Case studies, with their capacity for in-depth exploration, are particularly well-suited to capture the intricate nuances and complexities and this methodological approach allows for a rich and nuanced understanding of the research setting, providing a robust foundation for subsequent theoretical development.

To gather comprehensive and diverse perspectives, semi-structured interviews are conducted with key stakeholders, selected through a mix of purposive and snowball sampling. These interviews provide valuable qualitative data, allowing for an in-depth understanding of stakeholders' experiences, opinions, and insights. The data collected through interviews, alongside the insights gleaned from the literature review, are then subjected to qualitative data analysis. This process involved coding and thematic analysis to identify recurring patterns, themes, and key insights that emerge from the data.

This multifaceted approach ensures that the research is firmly grounded in empirical evidence, providing a robust foundation for the development of meaningful and insightful conclusions. By combining data collection and analysis with a thorough review of existing literature, this research aims to generate valuable new knowledge and contribute significantly to the existing body of scholarship in this field.

This research investigates the transformative trajectory towards smart and sustainable cities, a problem inherently concerned with future possibilities. To explore these potential futures, scenario analysis is deemed an appropriate methodological approach, as shown in figure 4.1. As a first step, the scope of the analysis is defined as “smart mobility in the city”, with Istanbul serving as the focal city for this investigation. Following this, a comprehensive desktop research is undertaken to identify the key challenges and opportunities facing Istanbul. Then an institutional analysis is conducted to map the key stakeholders and actors involved in urban mobility challenges (e.g. manufacturers, users, policy makers, operators, NGOs, academics and experts, and so on). Drawing upon insights from the institutional analysis and the literature reviews, key issues of concern are identified, which subsequently informed the development of plausible future scenarios for Istanbul. These envisioned scenarios are then evaluated through semi-structured in-depth interviews with selected stakeholders, providing valuable insights into their perceptions, concerns, and potential responses to the unfolding urban future.

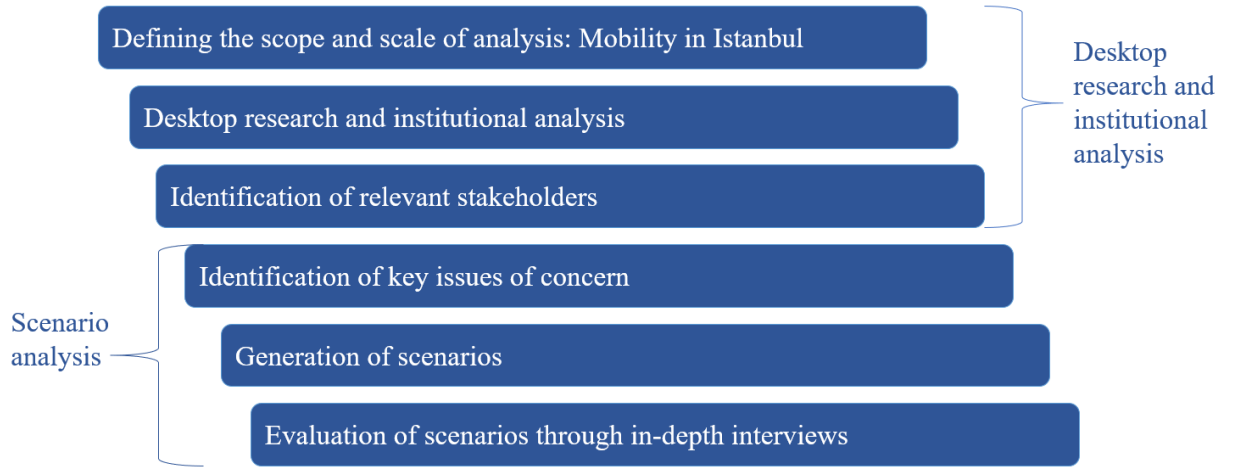


Figure 4.1. Research approach

The next section will provide a comprehensive overview of scenario building methodologies. This will include an exploration of different types of scenarios, such as exploratory and normative scenarios, and a review of key methods for scenario development, including trend-based approaches, systematic-formalized methods, and creative-narrative approaches. Furthermore, the section will examine the specific applications of scenario building within the field of urban mobility, discussing its potential to address the challenges and uncertainties associated with urban transportation planning.

4.2. Scenario Building

Historically, transport planning has predominantly depended on projections to anticipate future conditions (Anderson et al., 2017). Long-term transportation policy decisions based on the "predict and provide" approach presuppose that:

i) the future of mobility is sufficiently understood to forecast changes,

ii) the selected transportation system model is precise enough to evaluate policy impacts, and

iii) there is adequate comprehension of the importance that stakeholders currently attribute, or will attribute in the future, to various policy outcomes.

Nonetheless, these assumptions frequently prove inaccurate for long-term transportation policy decisions (Marchau et al., 2010). Forecasting models frequently underperform with profound long-term uncertainty (Cruz & Sarmento, 2020; Lyons & Davidson, 2016), as they rely on trend extrapolation, hence perpetuating existing path dependency (Sustar et al., 2020). Forecasts are typically created by specialists who are skilled in linear future projections (Soria-Lara & Banister, 2018), neglecting unexpected events (Voulgaris, 2019).

Conventional transport planning methods fall short in meeting sustainability objectives and enhancing the resilience of mobility systems to unexpected disruptions. To address this, it is significant to complement traditional, forecast-driven strategies with alternative approaches that can better manage uncertainty. Scenario building is one such approach; it allows for the exploration of multiple plausible futures and offers a systematic way of understanding future possibilities (Hickman & Banister, 2014). By enabling flexibility, scenarios help stakeholders prepare for a range of outcomes rather than focusing solely on the most likely one (Bishop et al., 2007). Evidence suggests that scenario planning can enhance organizational performance (Phelps et al., 2001) However, their application in policy making remains limited and underexplored. Nonetheless, scenario development presents a promising avenue for tackling mobility issues and promoting sustainability by outlining adaptive strategies and identifying critical steps toward sustainable development (Butler et al., 2016). While the transportation sector has begun to adopt scenario-based methods (Anderson et al., 2017), their full potential in equipping policy processes for uncertain futures has yet to be fully harnessed (Volkery & Ribeiro, 2009).

4.2.1. Scenario Types

Exploratory and normative scenarios are the two primary categories of scenarios that need to be differentiated. Exploratory scenarios begin with the present and construct hypothetical futures by analyzing events, driving forces, and potential outcomes. They address the subject of "what-if" by examining potential alternative developments from a range of viewpoints (Börjeson et al., 2006). However, normative scenarios pose inquiries regarding the ideal future, defining the future as the starting point rather than the present (Avin & Goodspeed, 2020). They are frequently the outcome of exploratory scenario construction initially, to avoid unrealistic future ambitions, and they aid in the analysis of how to achieve certain goals (Börjeson et al., 2006). As exploratory scenarios are designed to be plausible rather than probable, they can serve as a foundation for constructing normative scenarios. While urban planning has traditionally focused on normative scenarios, there has been a growing trend toward examining a broader spectrum of potential futures. Despite this shift, the integration of exploratory scenarios into actual policymaking remains limited (Avin & Goodspeed, 2020). Moving away from fixed visions toward the consideration of diverse future possibilities can be instrumental in enabling planners to better navigate uncertainty.

Scenario development can follow either a forecasting or a backcasting approach, though forecasting scenarios should not be mistaken for precise predictions. In the forecasting method, the

present serves as the starting point, and various potential future trajectories are examined from that baseline (Greeuw et al., 2000). Conversely, backcasting begins with a defined, often desirable future outcome and works backward to determine the necessary steps to reach that future (Robinson, 1982). This approach places greater emphasis on envisioning long-term goals and desirable futures (Banister & Hickman, 2013).

To summarize, scenarios depict either plausible alternatives (exploratory) or preferred outcomes (normative), whereas forecasts aim to represent the most likely future developments. As illustrated in Figure 4.2 (adapted from Voros 2003), these concepts are interconnected.

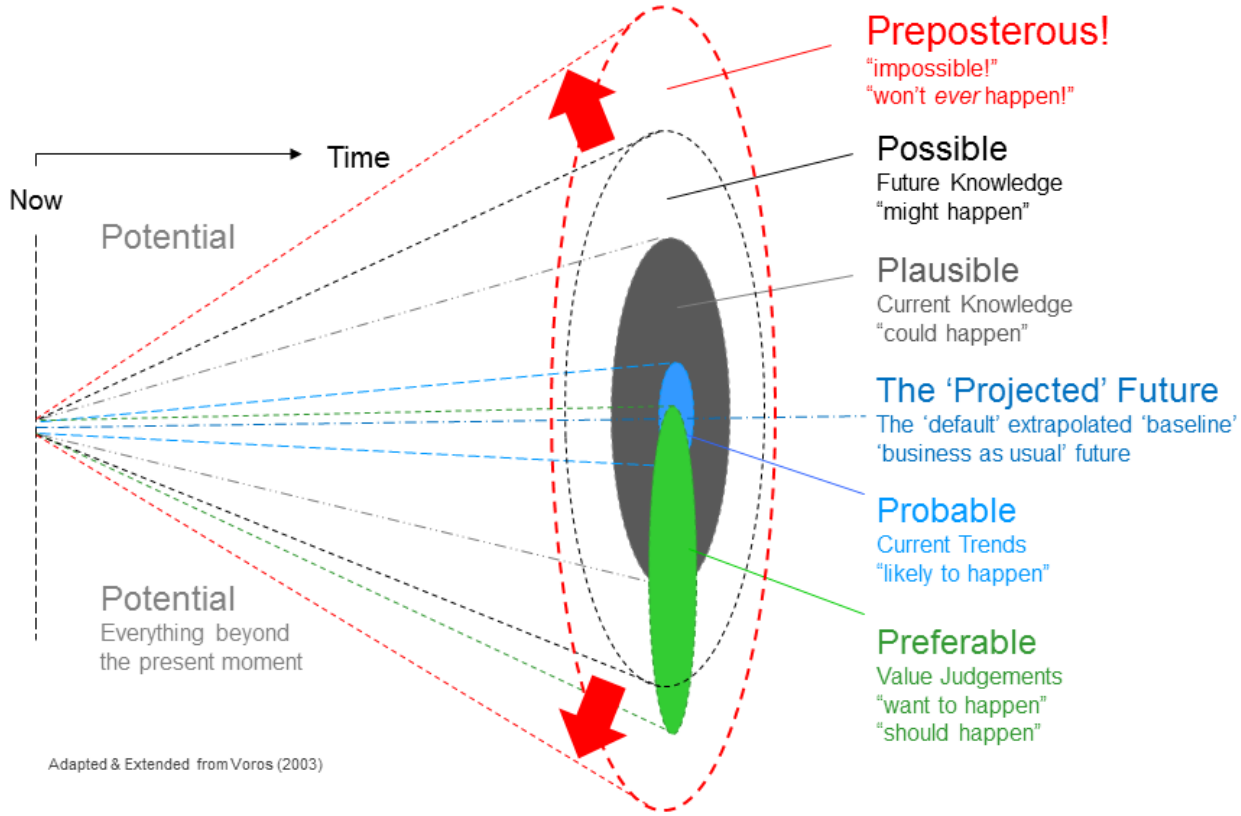


Figure 4.2. Futures Cone

4.2.2. Methods for Scenario Development

Durance and Godet (2010) emphasize that there is no single standardized method for scenario development. As the popularity of scenario planning continues to grow, the diversity of approaches has expanded, resulting in what Bishop et. Al. (2007) describe as a "methodological chaos." To bring clarity to this variety, Kosow and Gaßner (2007) categorize scenario development methods into three broad types::

- Trend-based approaches rely on existing or historical trends, projecting them into the future. These techniques are grounded in trend analysis and extrapolation, which can be either qualitative or quantitative. However, when used in isolation, such projections often produce a 'trend scenario' that resembles a forecast more than a true scenario. As a result, while these methods offer a useful foundation, they may be too narrow when only one dominant trend is considered (T. Gordon et al., 1974).
- Systematic-formalized approaches begin with the identification of key variables, which are then varied and combined to construct different scenario outcomes. These methods emphasize analyzing the interdependencies among factors and are commonly employed for creating exploratory scenarios. Notable examples include Impact Analysis (Godet, 1987) and Cross-Impact Analysis (T. J. Gordon & Hayward, 1968).
- Creative-narrative approaches draw on intuitive reasoning, creative processes, and tacit knowledge to construct scenarios. Methods in this category include Morphological Analysis (Zwicky, 1969) and Intuitive Logics (IL) (Wack, 1985).

In addition to methodological differences, scenario approaches also vary by the type of data used—quantitative, qualitative, or mixed. Quantitative approaches typically aim to capture system behavior using mathematical models and are rooted in system dynamics, which "uses a perspective based on information feedback and circular causality to understand the dynamics of complex social systems" (Richardson, 1991, p. 144). Despite offering a greater perception of accuracy, their technical complexity can hinder stakeholder engagement, often turning the process into a "black box" (Weimer-Jehle, 2006). In contrast, qualitative methods help to challenge assumptions and broaden perspectives about future possibilities (Symstad et al., 2017), although they are sometimes criticized for inadequately handling complex systems and potentially omitting critical elements in the analysis (Weimer-Jehle et al., 2020).

4.2.3. Scenario Building in Urban Mobility

As mentioned earlier, historically, transport planning has predominantly depended on projections, specifically attempting to predict future conditions (Anderson et al., 2017). The "predict and provide" model typically relies on quantitative, business-as-usual forecasting—projecting how current and historical trends are expected to continue into the future (Varho & Tapio, 2013). However, applying such forecasts in large-scale infrastructure projects often neglects unexpected developments, which can result in cost overruns, project delays, and benefits falling short of expectations, ultimately jeopardizing the project's success(Flyvbjerg, 2017).

Today's mobility landscape is shaped by an unprecedented level of uncertainty. Shifts in travel behavior—such as reduced commuting and evolving shopping patterns (Marsden et al., 2018) are accompanied by significant technological advancements (Lyons et al., 2018), and growing uncertainity linked to climate change (Lyons et al., 2021). Furthermore, the dominant automobility regime appears to be giving way to a yet-undefined new mobility system (Geels et al., 2012). Therefore, scenarios offer a valuable tool for transport planning by enabling a structured and comprehensive way to explore long-term impacts of shifts in key variables (Zegras et al., 2004).

5. URBAN MOBILITY IN ISTANBUL AS A CASE STUDY

Istanbul, a megacity straddling Europe and Asia with a population exceeding 16 million (Istanbul Metropolitan Municipality, 2023), faces significant urban mobility challenges. The city's complex geography, divided by the Bosphorus, presents unique obstacles for developing a robust and integrated transport system. Rapid urbanization, coupled with a growing tourism sector attracting approximately 16 million visitors annually (Istanbul Tourism Association, 2023), has intensified travel demand. Despite ongoing investments in public transport, the motorization rate continues to climb, with an estimated 4.8% annual increase (Istanbul Metropolitan Municipality, 2023). This surge in car ownership, evident in the consistent monthly addition of approximately 16,000 vehicles to the road network, necessitates comprehensive and sustainable urban planning solutions.

Public transportation plays a crucial role in addressing the city's mobility needs. Istanbul's public bus fleet, operated by IETT (Istanbul Electric Tram and Tunnel Operations), comprises around 2,800 vehicles serving over 800 routes across the city (IETT, 2024). The 52-kilometer Metrobus BRT system, launched in 2007, remains a vital component of the public transport network, accommodating approximately 1 million passengers daily (Istanbul Metropolitan Municipality, 2023). While BRT has achieved operational efficiency and high ridership, challenges such as overcrowding and limited integration with other modes persist, hindering a significant modal shift from private vehicles (Babalik-Sutcliffe & Cengiz, 2015).

Istanbul's urban rail network has undergone significant expansion, growing from 45.1 km in 2004 to approximately 315 km in 2023 (Metro Istanbul, 2023), including the Marmaray, a 13.5-kilometer rail tunnel connecting the European and Asian sides of the city. Despite these infrastructural investments, challenges such as high construction costs, operational inefficiencies, and limited integration with land-use planning persist, hindering the full realization of the intended benefits of these projects (Ozgur, 2011; Beyazit, 2015).

5.1. Mapping Actors and Stakeholders

The Istanbul Metropolitan Municipality (IMM) is the primary authority responsible for urban mobility planning and implementation. The Istanbul Sustainable Urban Mobility Plan (SUMP) serves as the guiding framework for developing and implementing sustainable transportation strategies. The plan aims to reduce car dependency by investing in and improving public transport services, enhancing urban accessibility, and fostering a more livable environment (Istanbul Metropolitan Municipality, 2022). The Transport Coordination Centre (TCC)[1] is the top decision-making body for urban transportation through which IMM executes its functions. The board of TCC comprises various government entities, including the Governorship of Istanbul, the Police Directorate, Istanbul's Provincial Special Administration, and representatives from operators. However, the dual accountability of the TCC to both the IMM and the Ministry of Interior can create ambiguity in decision-making and hinder effective coordination.

Urban mobility policy planning in Istanbul is fragmented among multiple bodies, including the Ministry of Transportation, the Ministry of Environment and Urbanism, the Istanbul Metropolitan Municipality (IMM), the Istanbul Electric Tram and Tunnel Operations (IETT), and the Transportation Coordination Center (TCC). As shown in Figure 5.1., there are various urban transport actors. While IMM formulates transport policy through the Master Plan, IETT is tasked with transport planning in Istanbul under statutory legislation (Legislation No. 3645) and is responsible for managing, coordinating, and monitoring all urban bus services in Istanbul. In addition to IETT, the transport departments of IMM, including the Department of Public Transport Services, Department of Transport Planning, and Department of Transport Coordination, possess decision-making authority in the administration of all public transport modalities (IMM, 2017b).

[1] UKOME, Ulaşım Koordinasyon Merkezi in Turkish.

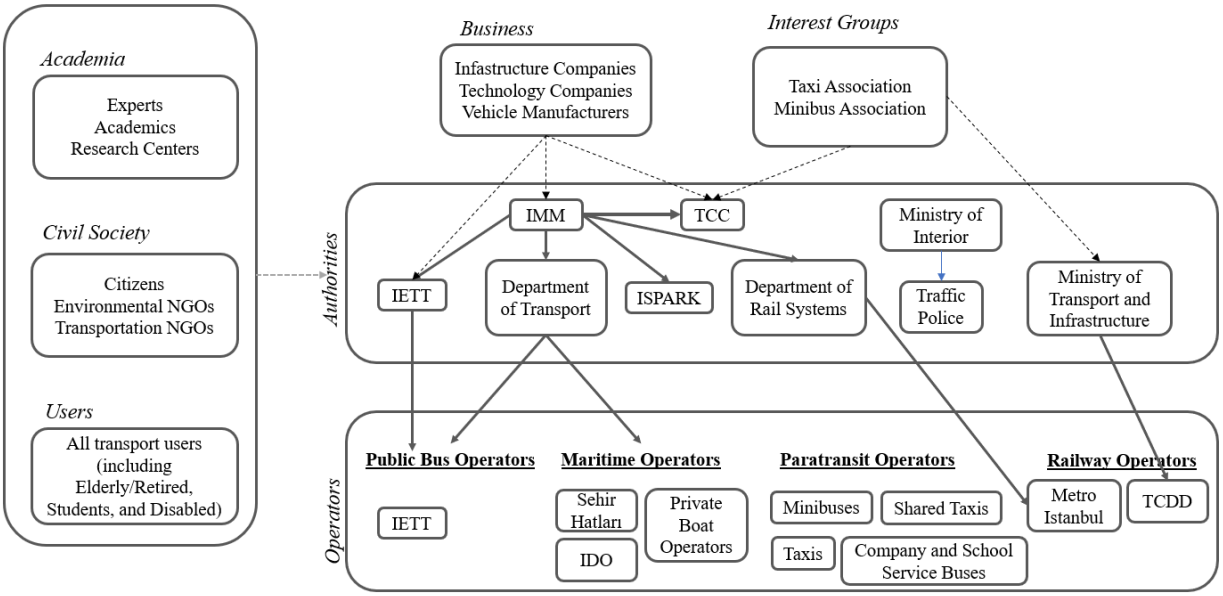


Figure 5.1 Urban Transport Actors in Istanbul and strong and weak relations between them Source: Created by the author using Canitez, 2019

The Business sector, including Infrastructure Companies, Technology Companies, and Vehicle Manufacturers, plays a vital role in providing the foundational elements of the transport system. IMM possesses numerous subsidiary firms to facilitate urban transport service provision. Although they lack decision-making authority over service provision, they frequently complicate and fragment the implementation of urban transport infrastructure. ISBAK, a subsidiary of IMM, provides intelligent transport systems (ITS) and information and communication technologies (ICT) related to urban transport. At the same time, BELBIM, a subsidiary of IMM, offers electronic ticketing systems (ETS). IETT, similarly, allocates a specific budget for the provision of ITS, ICT, and ETS for bus services. This fragmented depiction of technological infrastructure providing exemplifies the ambiguity around duties in urban transport infrastructure delivery (Canitez, 2019). The absence of an institutional framework defining the specialized tasks in urban transport policy formulation is a significant issue that further fragments and obscures the governance structure (Canitez, 2020).

In Istanbul, the policymaking landscape is shaped not only by official transport authorities tasked with managing and operating the urban mobility system but also by a range of powerful interest groups.. These include minibus unions, taxi associations, private bus operator groups, and service vehicle organizations, all of which actively promote policy options aligned with their commercial interests. Compared to these well-organized stakeholders, ordinary passengers—who lack formal organization—have significantly less influence in shaping transport policies. Disorganized interests may be inadequately represented in policy processes (Olson, 2009), which is a significant issue

considering the absence of influential passenger groups or associations championing passenger rights in Istanbul.

Figure 5.1 further delineates other crucial groups of actors. Academia, comprising Experts, Academics, and Research Centers, provides essential intellectual and analytical contributions to transport planning and policy. Civil Society, encompassing Citizens, Environmental NGOs, and Transportation NGOs, represents public interests and advocacy efforts, maintaining an indirect, often consultative, relationship with the IMM. Users, segmented into Elderly/Retired, Students, and Disabled individuals, highlight the diverse needs of the population utilizing transport services

The table 5.1 below presents a power-interest matrix, a widely used tool in stakeholder analysis to categorize actors based on their capacity to influence decisions (power) and their level of concern or involvement in the outcomes (interest). Originating from strategic management and policy planning literature (Bryson, 2004; Eden & Ackermann, 2001), the power-interest matrix has become a key method for stakeholder mapping in urban governance and sustainability transitions (Avelino & Wittmayer, 2016). By categorizing actors into four quadrants—high power/high interest, high power/low interest, low power/high interest, and low power/low interest—it enables a strategic assessment of which actors should be empowered, monitored, or engaged further (Bryson, 2004).

In this study, the classification of stakeholders within the matrix was carried out through a combination of field observation, and stakeholder input, consistent with common practices in stakeholder mapping (Reed et al., 2009). Power was assessed based on regulatory authority, and influence on policy agendas. Interest was measured by how much actors are affected by or involved in urban mobility planning, such as by taking part in planning procedures or operational activities.

Actors with decision-making power, budgetary authority, or regulatory control (e.g., IMM, IETT, TCC, Ministry of Transport and Infrastructure) were identified as high-power stakeholders. Conversely, interest levels were assessed by examining the extent to which actors are directly affected by mobility outcomes or demonstrate proactive involvement—such as through advocacy, planning input, or service provision. This evaluative framework guided the classification of stakeholders within the matrix.

In the high power-high interest quadrant are key public authorities such as the Istanbul Metropolitan Municipality (IMM), IETT (Istanbul Electric Tram and Tunnel Company), Transport Coordination Center (TCC), Metro Istanbul A.Ş., the Ministry of Transport and Infrastructure, and

influential associations like those representing taxis and minibuses. These entities have significant power and interest over urban mobility planning, infrastructure investments, and operational decisions.

Table 5.1. Power – Interest analysis of the stakeholders and actors

Power \ Interest	Low	High
High	• Infrastructure (Construction) Companies • Ministry of Transportation and Infrastructure • Ministry of Interior • Vehicle Manufacturers	• IMM • IETT • TCC • Metro Istanbul • Taxi Associations • Minibus Associations
Low	• Private boat operators • Small maritime operators • School/Company Service Buses	• Citizens • Environmental NGOs • Academia • Research Centers • Experts • Technology (Micromobility) Companies

The infrastructure companies, vehicle manufacturers, technology firms, and certain units within the Ministry of Interior and Ministry of Transport and Infrastructure that focus on national-level priorities are positioned in high power-low interest quadrant. These stakeholders hold substantial power through regulatory authority, capital, or technical expertise, yet their direct engagement with urban mobility challenges is often limited to contractual or regulatory compliance. Strategic engagement with these actors requires mechanisms to align their activities with Istanbul's long-term mobility goals, particularly through incentive structures and regulatory frameworks.

Civil society organizations, comprising individuals, environmental NGOs, universities, and experts, technology companies have significant interest in mobility issues. Nevertheless, their ability to directly affect policy decisions is limited. Empowering stakeholders via participatory planning, consultations, and advocacy platforms is crucial for enhancing policy legitimacy and ensuring responsiveness to community needs.

Stakeholders such as private boat operators, school and company bus providers, and other small-scale transport service providers are located in the low power and low interest quadrant. Their role in shaping urban mobility policy is limited, and their primary interest lies in their immediate operational concerns rather than broader strategic objectives. These actors require monitoring to ensure compliance with citywide standards, but generally do not necessitate intensive engagement.

In conclusion, Istanbul as a metropolitan that is expanding at a rapid pace is confronted with substantial urban mobility challenges. Despite expenditures in public transport infrastructure, such as the metro network expansion and the implementation of the BRT system, these initiatives are inadequate to satisfy the needs of a growing population and a car-reliant society. The existing transportation system suffers from congestion, fragmentation, and insufficient integration across modes and land use planning. The Sustainable Urban Mobility Plan (SUMP) for Istanbul seeks to tackle these difficulties by emphasizing sustainable transportation alternatives, promoting a transition from private vehicles, and enhancing urban accessibility.

5.2. SUMP Istanbul

This section empirically examines Istanbul's Sustainable Urban Mobility Plan (SUMP), the first SUMP in Turkey and the first global SUMP for a megacity, aimed primarily at prioritizing citizens in planning processes and promoting sustainable transportation methods, including public transit, walking, and cycling. The Istanbul Sustainable Urban Mobility Plan (SUMP) was developed by the Istanbul Metropolitan Municipality (IMM) with technical support from international organizations, including the European Union (EU) SUMP Guidelines, the German International Cooperation Agency (GIZ), and various academic and private sector experts. The project was initiated in 2018 as part of Istanbul’s efforts to adopt a more sustainable, people-oriented approach to urban mobility and was officially completed in 2022. It focuses on the reduction of automobile reliance and the detrimental impacts of carbon emissions, air and noise pollution, and accidents with the below-stated vision (Reed et al., 2009):

> *“An inclusive and innovative transport system, focusing on people and the environment, providing the right mix of safe, integrated, accessible, and affordable mobility alternatives, compatible with the unique geography and historical values of Istanbul for a sustainable and resilient future.”*

The development of the Istanbul SUMP strategy is predicated on an examination of the existing transportation infrastructure in Istanbul and its associated challenges. Scenarios, a vision, objectives, and targets were formulated, followed by the delineation of projects to accomplish them.

In scenario development, external factors that influence mobility in Istanbul are taken as economy, governance, climate change, pandemic, earthquake, technology, and population-demography. Certain external factors are seen as less unpredictable than others. For instance, the prevailing tendency in population dynamics suggests that population expansion is quite probable in the foreseeable future. Furthermore, climate change is assessed as “currently occurring” in the report, and earthquakes are deemed as “not rare occurrences”. Technology is advancing rapidly, and this trend is expected to persist. On the other hand, economic prosperity and governance systems are taken as the two critical factors that are the least certain and most difficult ones to predict.

The economic situation of Turkey in the future is a complex and challenging prediction, encompassing a wide range of factors. Low economic prosperity suggests that regional economic imbalances and the wealth gap between rich and poor will persist, leading to an increased proportion of households facing reduced incomes. On the other hand, increased economic prosperity is associated with a more equitable allocation of regional resources, a reduction in income gaps among the population, and higher household incomes.

The future of Turkey's governance structure, efficiency, and quality are also very uncertain. Various strategies will have a significant impact on Istanbul's mobility patterns. There are several ways to alter the decision-making structure, from top-down to bottom-up. The central government is crucial to a top-down strategy and has significant authority and influence over local governments. A more decentralized governance structure is provided by bottom-up decision-making, where citizens and stakeholders are more involved in the city's decision-making processes and local authorities have more authority.

The Istanbul SUMP addresses uncertainties by using a 'What if?' approach, considering policies and projects needed in limited economic growth or bottom-up decision-making. Five scenarios were developed, focusing on the city's current business-as-usual scenario. Future changes in the economy and governance could shift the city to another quadrant, with four potential futures developed (Figure 5.2.).

The Sprawl City Scenario suggests an improved economy, but unplanned growth and sprawl may increase dependency on the city center. The Efficient City, Resilient/Green City, and Inclusive City scenarios aim for improvements in efficiency, resilience, and inclusiveness. These scenarios change urban life through better accessibility, increased social awareness, balanced growth, and equal distribution of resources. The Inclusive City Scenario is desired, but other futures may occur depending on governance structure and economic development (IMM, 2022). Scenario details can be found in the Appendix A.

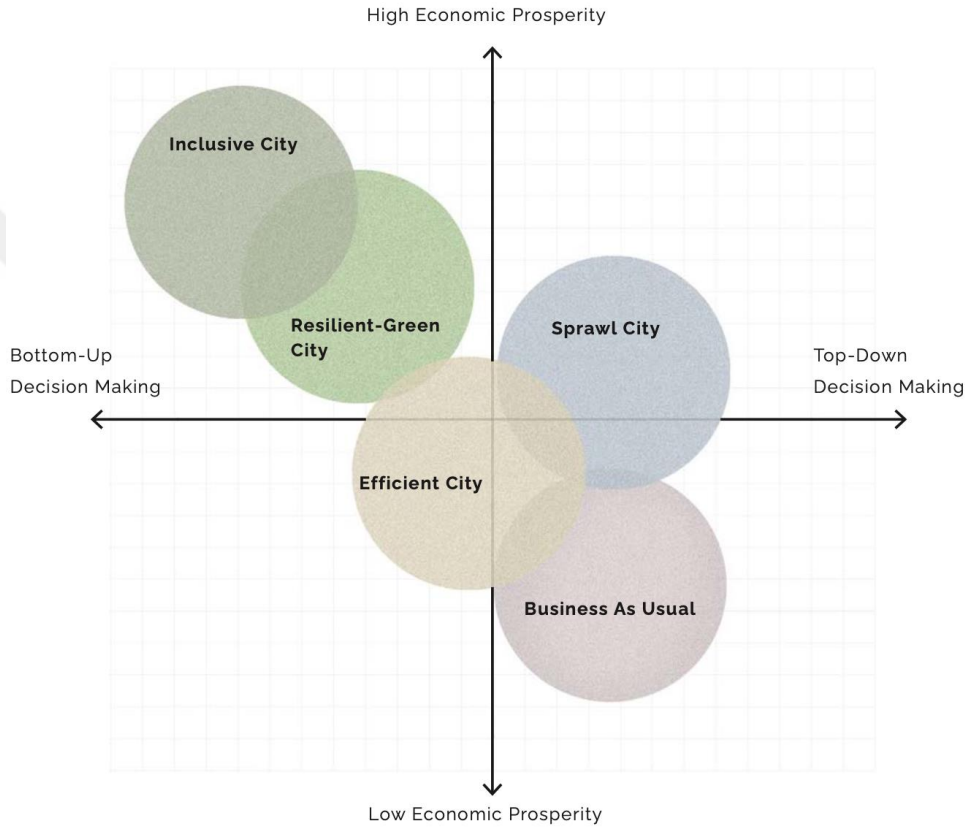


Figure 5.2. Istanbul SUMP Scenarios

5.3. Scenario Development

This research employs the STEEP framework, an established analytical tool that categorizes influential factors into five dimensions: Social, Technological, Economic, Environmental, and Political (Figure 5.3). STEEP analysis has its origins in strategic business planning, where it has traditionally been used to examine macro-environmental factors beyond the direct control of individual actors (Fleisher & Bensoussan, 2015). STEEP analysis is widely used in futures studies and scenario planning to ensure a comprehensive, multidimensional understanding of the key drivers shaping complex systems (Börjeson et al., 2006). By applying this framework, this thesis classifies 25 principal drivers identified through an extensive assessment of academic and gray literature on transportation scenario building (Table 5.2). This methodical approach enhances analytical clarity

and enables a more holistic examination of the complex, interrelated dynamics influencing the future of urban transportation in Istanbul.



Figure 5.3. STEEP Analysis

Social drivers encompass accessibility, mobility demand, mobility choice, awareness, socio-political acceptance, inequalities, digital divide, population, and social inclusion. Technological drivers include the rate of technology uptake and data management capabilities, and development and deployment of innovative technologies such as autonomous vehicles and smart mobility solutions. Economic drivers encompass the level of economic development, production and consumption patterns, funding requirements for infrastructure and services, job creation and employment opportunities, the uptake of shared mobility business models, and market orientation.

Environmental drivers include land use patterns, local environmental quality, resilience to climate change impacts, and greenhouse gas emissions. Finally, political drivers encompass factors such as effective governance, the level of political commitment to sustainable mobility, transparency in decision-making processes, and the mitigation of corruption. Detailed descriptions of the drivers can be found in Table 5.3.

Table 5.2. Inventory of Drivers

Social	Technological	Economic	Environmental	Political
Accessibility	Technology uptake	Economic Development Level	Land Use Pattern	Governance (Decision Making)
Mobility demand	Data management	Production and Consumption Patterns	Local Environmental Quality	Political implementation effort
Mobility choice		Funding requirement	Resilience	Transparency and corruption
Awareness		Job creation and employment opportunities	GHG Emission	
Socio-political acceptance		Uptake of Shared Mobility Business Models		
Inequalities		Market Orientation		
Digital divide				
Population				
Social inclusion				

Table 5.3. Description of Drivers

Dim.	Trends	Description
SOCIAL	Accessibility	Capacity to access spatially distributed opportunities (desired goods, services, activities, and destinations) regardless of age, gender, disability, economic or social status.
	Mobility Demand	The amount (e.g. how often to travel - number of trips, what route to take - travelled distance) of travel that people would undertake in specific conditions which can be affected by a variety of factors, such as availability, quality, and cost of alternatives (Victoria Transport Policy,2015)
	Mobility Choice	Mobility choices done between different transport modes (ex. active mobility vs. motorized transport, private vehicle vs. public transportation, innovative mobility alternatives like (Mobility as a Service [MaaS], shared mobility, e-mobility) vs. existing modes of transport)
	Awareness	Level of stakeholders' awareness of sustainability
	Socio-political acceptance	The acceptance of a technology or innovative mobility alternative (e.g. e-mobility) by key stakeholders, the public and policy makers (Wolsink, 2010)
	Inequalities	Unequal distribution of travel between social groups in all forms of transport including distribution of transport related resources like car ownership, access to public transport. (https://inequalityintransport.org.uk)
	Digital divide	The gap between demographics and regions that have access to modern information and communications technology (ICT), and those that don't or have restricted access - demographic, economic, and social inequalities regarding access to and use of ICTs (Lythreatis et al., 2022)
	Population	The change in the number (i.e. distribution and balance of population growth) due to different factors (e.g. migration) and in the attributes of people (i.e. demographic composition) of living in the city
	Social inclusion	The process of improving the terms on which individuals and groups take part in society—improving the ability, opportunity, and dignity of those disadvantaged based on their identity (Worldbank).
TECHNOLOGICAL	Technology Uptake	The level of technology uptake in mobility (e.g. electrification of mobility, autonomous driving, smart-city technology adoption, seamless and connected/integrated multi-modal mobility)
	Data Management	Data from different partners and formats leading to disruption of collaboration and data sharing problems
ECONOMIC	Economic Development Level	Prosperity level, household income level and economic development balance between different regions in the country
	Production and Consumption Patterns	The nature of production and consumption patterns (e.g. community organized small-scale production and distribution vs. globalized economy, operating global brands with localised distribution and supply chains)
	Funding requirement	Funding requirement level and key financing (private investment, public investment, public-private-partnerships, etc.)
	Job creation and employment opportunities	Employment opportunities created by the sharing economy with changing work arrangements (ex. part-time employment, flexible work arrangements, work-on-demand)
	Uptake of Shared Mobility Business Models	Proportion of travel using modes offered through new business models (e.g. Collaborative consumption, sharing economy) (sharing economy vs. possession economy)

Dim.	Trends	Description
	Market Orientation	Key economic relations and actors (e.g. state, metropolitan government corporations, citizens, co-operatives)
ENVIRONMENTAL	Land Use Pattern	The location and level of spatial accumulation of activities such as retailing, management, manufacturing, or residence generating flows supported by transport systems (Rodrigue, 2020).
	Local Environmental Quality	The level of local air pollution (PM, NOx, etc.) and noise
	Resilience	The level of resilience to external factors (e.g. pandemics, climate change and earthquake)
	GHG Emission	Greenhouse gas emissions depending on the travel mode (i.e. low emission modes such active travel, EVs with a high share of renewable energy vs high emission modes such diesel engines in personal cars) and the amount of travel
POLITICAL	Governance (Decision Making)	The nature of governance (e.g. participatory vs closed decision making, bottom up vs. top-down mechanisms, level of stakeholder participation in decision making)
	Political implementation effort	Time and resources needed for the effective implementation of the governance mechanisms (e.g. higher time and effort in participatory mechanisms)
	Transparency and corruption	Public abuse for private gains effecting the functioning of public services (e.g. misuse of funds) and legislative transparency

An examination of the Istanbul Sustainable Urban Mobility Plan (SUMP) indicated a significant convergence between the "Resilient-Green City" and "Inclusive City" scenarios, the last two of the five proposed scenarios. To address this redundancy, these two scenarios were combined into a single, comprehensive scenario. This consolidation led to the creation of four unique scenarios. The four scenarios were distinguished according to two key dimensions: sustainability and smartness (Figure 5.4).

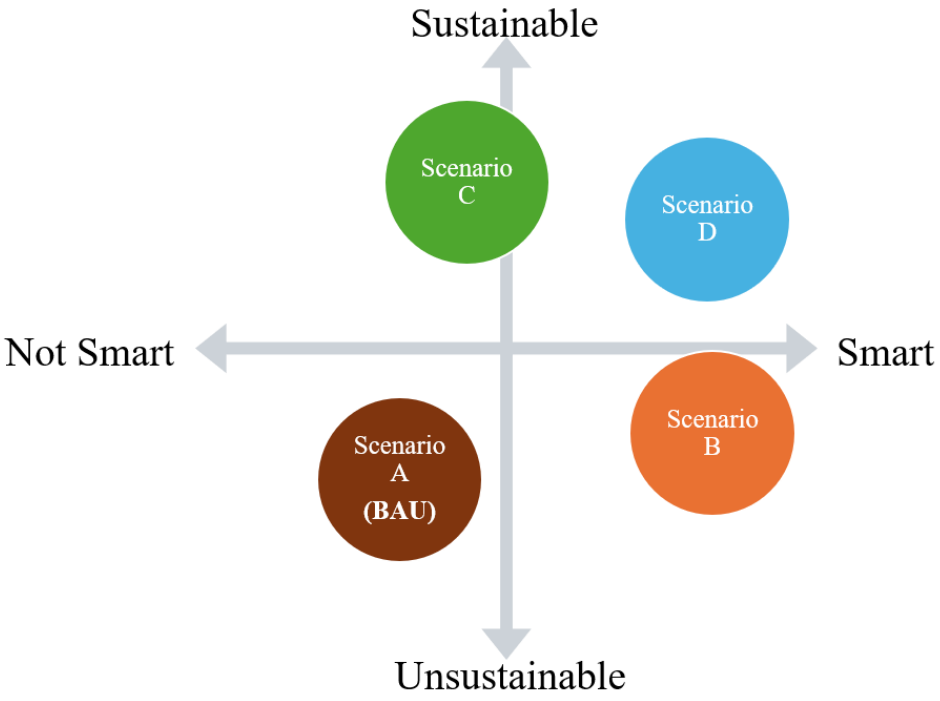


Figure 5.4. Scenarios in smartness-sustainability matrix

To further elaborate on these scenarios, a comprehensive table was constructed (Appendix B). This table outlines each scenario within the STEEP framework (Social, Technological, Economic, Environmental, and Political) and offers comprehensive descriptions for each driver. This structured approach facilitated a deeper understanding of the implications of each scenario. To ensure the validity and robustness of these scenarios, the comprehensive table was presented to and discussed with three transportation and mobility experts through a series of interviews.

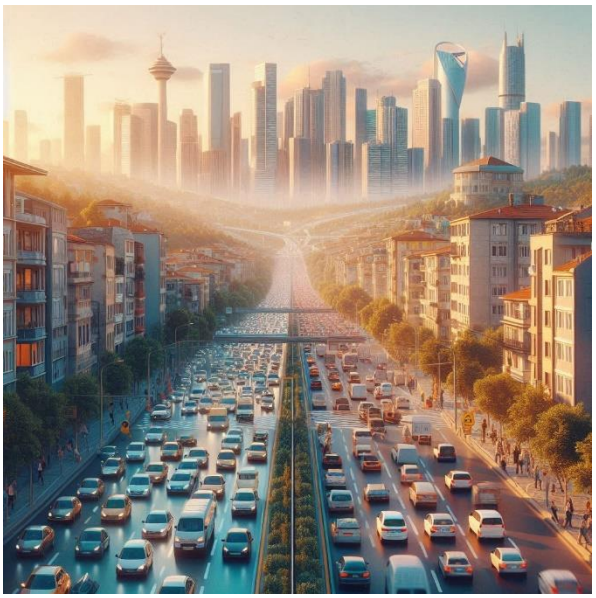
5.4. Scenarios

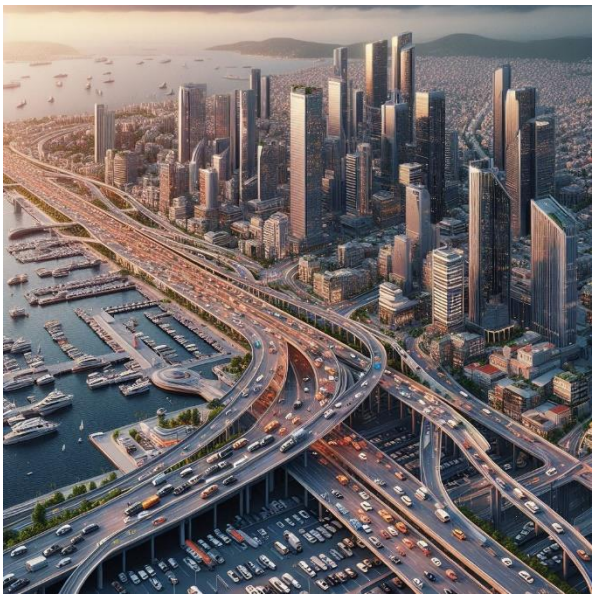
Scenario cards have been developed to enhance the clarity and presentation of the scenarios detailed in Appendix B. These cards offer a brief and visually appealing overview of each scenario. The English versions of these cards are displayed here, while the Turkish versions, including the visual elements used during the interviews, can be found in Appendix C. This method sought to guarantee effective communication and understanding of the scenarios among participants.

Scenario A

- There is a car-first city model.
- The city is spread around the periphery of the city, and job and education opportunities are concentrated in the city center.
- People go to work and school with their private cars from the periphery of the city.
- Public transport is not enough; there is no incentive pricing system.
- Individual car usage is high.
- There are no bicycle paths; sidewalks are inadequate.
- Owning a car is considered a matter of prestige in society.
- Urban transportation infrastructure is not suitable for autonomous vehicles.
- The traffic problem has been relieved to some extent with newly built highways, tunnels, and bridges, but a lot of time is still spent in traffic.
- Many new underground and aboveground parking areas have been built.

Accessibility	*Low*
Population structure	*Young population*
Financing requirement/cost	*Lowest*
Job and employment opportunities	*Poor*
Market structure	*Public and private sector are balanced*
GHG emissions	*Highest*

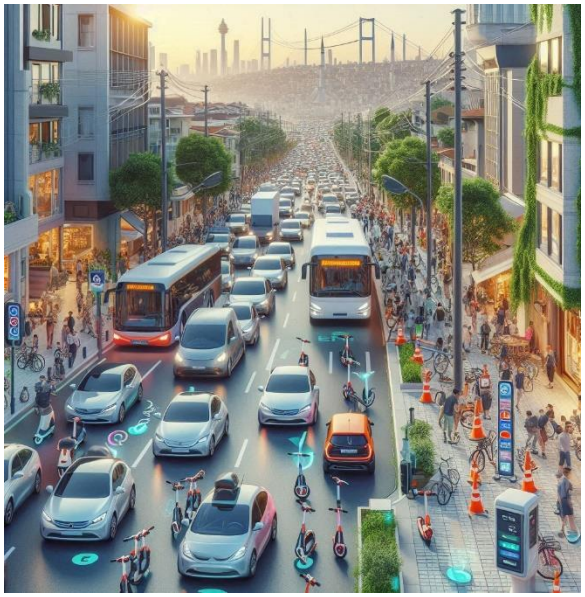




Scenario B

- There is a car-first city model.
- As the city grows and spreads to the periphery of the city, the demand for travel increases.
- Individual electric car usage is high.
- Although there are improvements using smart mobility solutions such as optimization in public transportation, it is still insufficient.
- Shared mobility, e-mobility, micro mobility etc. movement alternatives are made using digital infrastructure.
- The use of electric bicycles and scooters is common.
- There are inequalities in access and use of technology.
- There are high levels of data sharing, privacy and standardization issues.
- Many new underground and above ground parking areas have been built

Accessibility	*Low*
Population structure	*Young population*
Financing requirement/cost	*High*
Job and employment opportunities	*Strong*
Market structure	*Strong private sector, weak public sector*
GHG emissions	*High*





Scenario C

- There is a polycentric urban form consisting of neighborhoods connected by short distances.
- Active transportation types such as walking and cycling are mainly used.
- Due to carbon taxation, modes of transportation using fossil fuels are expensive.
- Car use is limited in central areas / neighborhood centers.
- Public transport usage is at a high level.
- A limited amount of car sharing platforms developed by local companies are used.
- Awareness of environmental sustainability is at a high level.
- High-level technology use such as the use of autonomous vehicles, real-time traffic management systems and mobility platforms as a service is not supported.
- Parking spaces are limited, and fees are high.

Accessibility	*High*
Population structure	*Aging population*
Financing requirement/cost	*Low*
Job and employment opportunities	*Poor*
Market structure	*Strong public sector, weak private sector*
GHG emissions	*Low*





Scenario D

- There is a polycentric urban form consisting of neighborhoods connected by short distances.
- Active transportation types such as walking and cycling are mainly used.
- Due to carbon taxation, modes of transportation using fossil fuels are expensive.
- Although there is a high-capacity increase in public transportation, it still cannot keep up with the increasing demand.
- It is mandatory to comply with the personal carbon budget allocated to everyone by the state with smartphones and various applications.
- Shared mobility, e-mobility, micro mobility etc. Movement alternatives are made using digital infrastructure.
- Awareness of environmental sustainability is at a high level.
- Inequalities in access and use of technology partially continue.
- Data sharing, privacy and standardization problems partially continue.
- Parking spaces are limited, and fees are high.

Accessibility	*High*
Population structure	*Aging population*
Financing requirement/cost	*Highest*
Job and employment opportunities	*Strong*
Market structure	*Strong public sector, weak private sector*
GHG emissions	*Low*





5.5. Interviewed Stakeholders

Following the development of the four distinct scenarios, a crucial step involved identifying relevant stakeholder groups to participate in their evaluation. Stakeholder mapping is a widely recognized methodology for this purpose. While existing literature, such as Mladenovic et al. (2013), broadly categorizes stakeholders into the public and private sectors, Keseru et al. (2016) provide a more nuanced perspective, identifying the government, the public (citizens), transport operators, businesses, and transport users as key stakeholder groups within the urban mobility domain. Drawing upon these insights, the following stakeholder groups were identified for the present research (Table 5.4).

Table 5.4. Stakeholder groups selected for interviews

Stakeholder Group	Explanation
Manufacturers	
IT Solution Developers	Developers of smart mobility system solutions
Vehicle Manufacturers	Manufacturers of private and commercial vehicles and public transport vehicles
Users	
Elderly/or disabled transport users	Elderley and/or disabled transport users
Generation Z transport users	Born after 2000 transport users
Policy makers	
National or regional authorities	Policy makers, transport authorities at the national or regional level
Local authorities	Policy makers, transport authorities at the local level
NGOs	
Transportation NGO	NGOs that work to provide design and implement high quality transport systems
Environmental NGO	NGOs that work in the field of environmentalism
Academia	
Academics	Academics and researchers
Experts	Experts in think tanks, NGOs and other relevant authorities

This research employed a qualitative research approach, specifically in-depth semi-structured interviews, to investigate stakeholder perceptions and preferences regarding four future mobility scenarios for Istanbul. Prior to the main data collection phase, a series of pilot interviews were conducted to assess the clarity and comprehensibility of the scenarios and interview questions. These pilot interviews provided valuable feedback for refining the interview guide and ensuring a smooth and effective data collection process. A total of 19 in-depth interviews were conducted between July and December 2024 (Table 5.5). Participants were selected through a combination of purposive sampling, to ensure the inclusion of key stakeholder categories (e.g., policymakers, private sector actors, NGOs, academics, and citizen organizations), and snowball sampling, where initial interviewees recommended further participants within their professional networks who held relevant

expertise or influence in urban mobility discussions. This dual sampling strategy was used to capture a wide range of perspectives and ensure diversity in the stakeholder pool.

Each interview lasted approximately one hour and thirty minutes. During the interviews, participants were presented with scenario cards in Turkish (Appendix C). These cards visually depicted and explained each of the four mobility scenarios. Each scenario is further presented orally in detail, using the information presented in Appendix B, and questions from the interviewees are answered and necessary clarifications are made before moving into the evaluation stage.

Table 5.5. Interviewee list and Interview dates

ID	Description	Interview Date
1	Expert, Consulting Company Representative	24/07/2024
2	Expert, Smart City Consultant	26/07/2024 & 05/09/2024
3	Expert, Transportation Consultant	01/08/2024
4	Local Government, Marmara Municipalities Union Repr.	07/08/2024
5	Expert, Consulting Company Representative	26/08/2024
6	Government, Ministry of Transportation and Infrastructure	28/06/2024
7	Expert, Transportation	29/08/2024
8	Local Government, Istanbul Metropolitan Municipality Repr.	04/09/2024
9	Expert, Cycling Transportation Consultant	06/09/2024
10	Sector Repr., İstanbul Taxi Professionals Chamber	23/09/2024
11	Elderly User, Retired	27/09/2024
12	Gen Z User, University Student	02/10/2024
13	Business, Car Company Representative	18/10/2024
14	Minibus Driver	06/11/2024
15	User with disability, Accessibility Activist	13/11/2024
16	User with disability, Accessibility Activist	21/11/2024
17	Expert, Sector NGO Representative	21/11/2024
18	Civil Society Repr. – Urban Planning NGO	27/11/2024
19	Civil Society Repr. – Environmental NGO	06/12/2024

5.5. Interview process

The interview guide (see Appendix D for the questions) encompassed three main areas of inquiry: scenario preference, scenario expectation, and governance preferences. To mitigate the potential for benchmarking or interviewer bias, participants in the interviews were only given alias names (A, B, C, D) for the scenarios. The specific scenario names and their corresponding properties, as depicted in the sustainability-smartness matrix (Figure 5.4), were intentionally withheld.

For scenario preference, participants were first asked to identify their most preferred scenario and justify their choice based on specific criteria, assess the potential impacts of the preferred scenario on various stakeholder groups, rank the other scenarios according to their preference, and suggest modifications to their preferred scenario to enhance its desirability. For scenario expectation, participants were asked to identify the scenario they believed was most likely to occur, explain the reasons behind the discrepancy between their preferred and most likely scenarios, and explain why other scenarios were deemed less likely to occur. For governance preferences, participants were asked to identify the most appropriate governance actors for their preferred scenario, describe their preferred governance model (e.g., top-down vs. bottom-up), and assess the level and type of government intervention deemed necessary to achieve the preferred scenario.

This structure reflects the conceptual framework of the futures cone (Figure 4.2.), where scenario preference corresponds to participants' visions of preferable futures—what they desire to happen—while scenario expectation relates to their perception of probable futures—what they realistically expect to happen given current trends and systemic constraints. By distinguishing between these two dimensions, the research was able to capture both the normative aspirations and the perceived path dependencies shaping urban mobility transitions.

In addition, the interview process included a series of optional questions designed to delve deeper into stakeholder perspectives on collaborative governance and preferred regulatory approaches. By exploring these optional questions, the research aimed to gain a more nuanced understanding of stakeholder perspectives on collaborative governance and the role of regulation in shaping the future of urban mobility. A detailed depiction of the interview process is provided in Table 5.6.

Table 5.6. Interview Process

1. Introduction and Presentions of Scenarios
2. Scenario Preferences • What is the most preferred scenario? • Which stakeholders will be most affected by this scenario? How? • Please rank other scenarios according to your preferences? • What would you change in your most preferred scenario?
3. Expected Scenario • Which of these scenarios do you think will happen in the future? Why?   ○ (If preferred expected scenarios are different) why do you think that your preferred scenario will not happen? What is the most important obstacle preventing your preferred scenario from happening? • Why the other scenarios are less likely to occur?
4. Governance Preferences • Who should have the governance authority (power?) in your preferred scenario? • What kind of management model can be used to reach your preferred scenario? *Do you prefer top-down (central government has strong decision-making authority over local governments) or bottom-up (decentralized/distributed management solutions where local governments have high authority) decision-making processes?* • Do you think state intervention is necessary? Why?   ○ If yes, how necessary? (Minimum, moderate, significant or comprehensive) What kind of intervention do you think would be more effective? (Example intervention styles: regulatory, incentive-based, collaborative, planning, command and control) • (If bottom up processes are preferred) The fact that bottom-up processes require more time and have higher costs affect your preference? • What role do you think different stakeholders (e.g. government, private sector, civil society, academia) should play?
5. Optional Questions • Cooperation and communication methods between different stakeholders • Public-private partnerships • Regulatory mechanisms, incentive schemes, subsidies, and other policy tools.
6. Closing remarks (if any)

6. RESULTS

This section lays out in detail the findings of the interview data, presenting the interviewees' responses to questions regarding scenario preferences, expected future scenarios, and preferred governance models. Table 6.1 provides a concise overview of these responses, encompassing preference rankings, expected scenarios, and governance preferences. Subsequent sections provide a comprehensive analysis of these findings. Section 6.1 examines the most favored scenario among interviewees, exploring the reasons behind their choices and identifying any desired modifications to these scenarios. Section 6.2 investigates potential discrepancies between preferred scenarios and those with high expectations, analyzing the underlying factors contributing to these differences. Finally, section 6.3 analyzes the interviewees' responses concerning their preferred governance models, providing insights into their perceptions of effective and desirable governance structures.

Table 6.1. Main summary

Interviewee ID	Preference Ranking	Expected Scenario	Governance Preference
1	D>C>B>A	A	Balanced
2	D>C>B>A	B	Balanced
3	D>C>B>A	A	Bottom-up
4	D>C>B>A	B	Balanced
5	C>D>B>A	B	Bottom-up
6	D>C>A=B	C	Balanced
7	C>D>B>A	B	Bottom-up
8	D>C>A=B	C	Bottom-up
9	D>C>B>A	C	Bottom-up
10	B>A>D>C	B	Bottom-up
11	D>C>B>A	B	Bottom-up
12	D>C>B>A	B	Bottom-up
13	D>C>B>A	A	Bottom-up
14	D>C>B>A	D	Bottom-up
15	C>D>B>A	B	Bottom-up
16	C>D>B>A	B	Bottom-up
17	D>C>B>A	B	Bottom-up
18	D>C>B>A	A	Bottom-up
19	D>C>B>A	B	Bottom-up

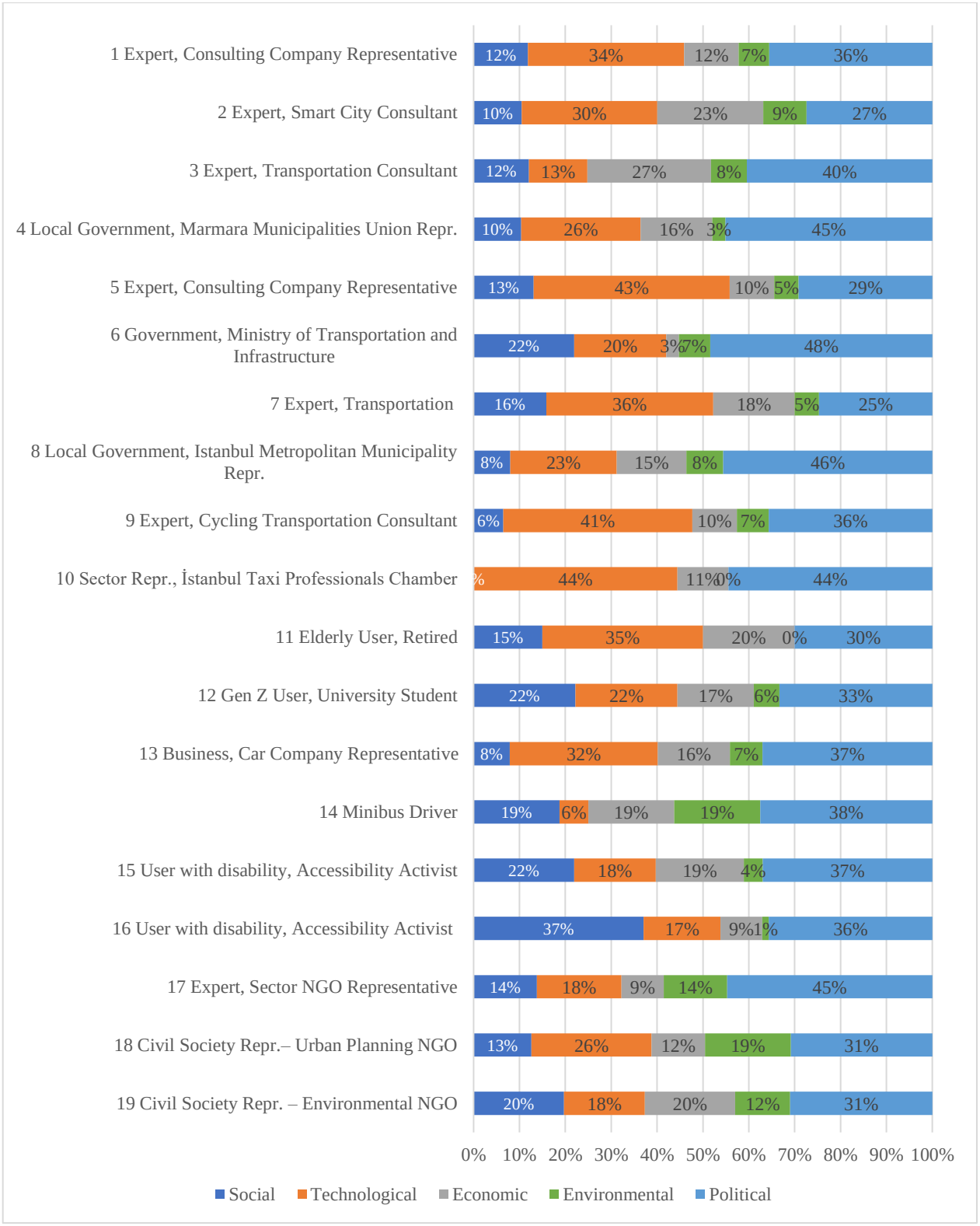


Figure 6.1. Relative Prominence of Keywords as Mentioned by Interviewees Across STEEP Categories

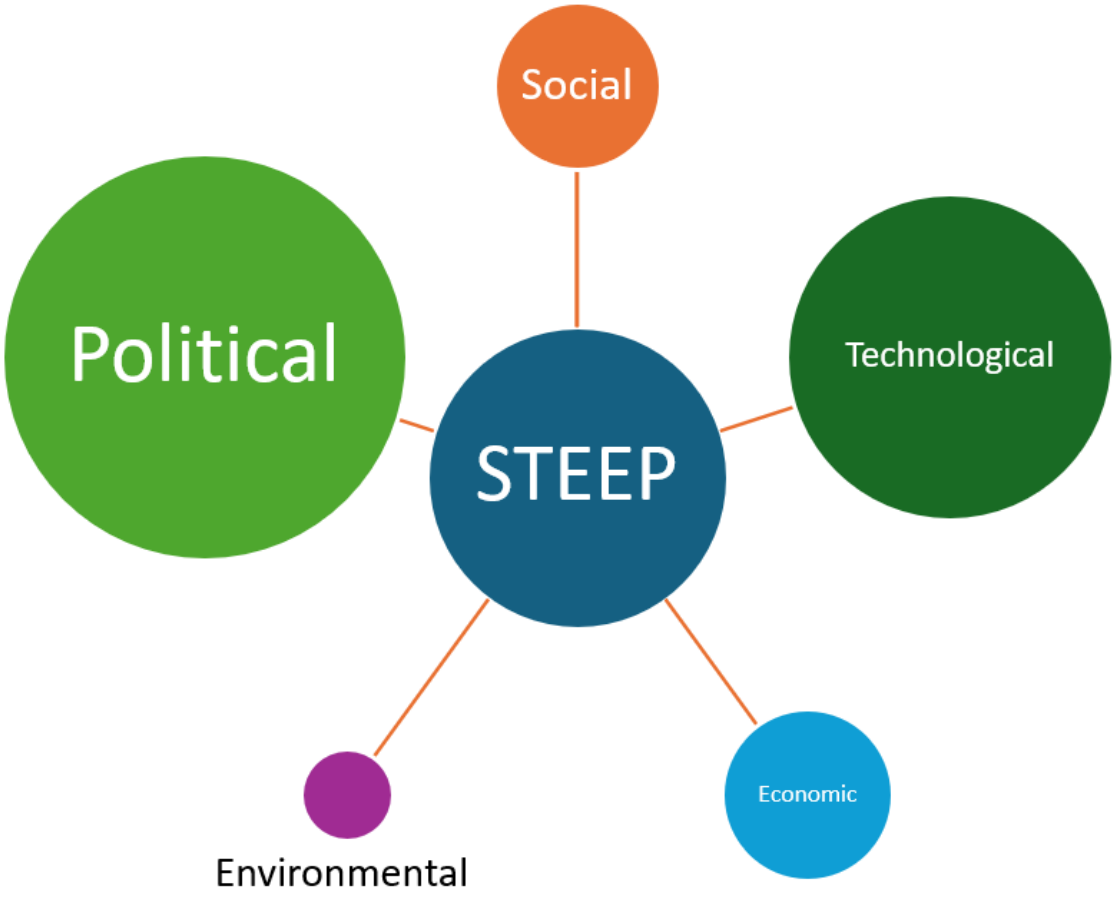


Figure 6.2. Relative Prominence of Keywords as Mentioned by Interviewees Across STEEP Categories (All interviews)

Figure 6.1 was generated by systematically coding the interview transcripts using MAXQDA software. Keywords were identified under each STEEP category (Social, Technological, Economic, Environmental, Political) based on inductive coding, and their relative frequencies were calculated per interview. The most commonly cited keywords include “accessibility” and “equity” under Social, “digitalization” under Technological, “funding” under Economic, “climate change” and “GHG emissions” under Environmental, and “governance” and “coordination” under Political. This visual representation helps indicate which themes were emphasized most by stakeholders in qualitative interviews.

These statistics indicate that discussions among government officials, NGOs, and civil society members predominantly focused on political themes. This suggests a widespread concern regarding the distribution of power, the functionality of institutions, and their capacity to manage affairs effectively. Environmental NGOs and urban planning professionals were particularly recognized for

their frequent discussions on environmental issues, underscoring the significance of these matters within respective domains.

Figure 6.2 consolidates data from all interviews, corroborating these conclusions on a broader scale. The political dimension emerged as the predominant theme for the interviewed individuals. The frequent mention of governance procedures, power relations, and lobbying capabilities indicates that stakeholders regard political considerations as crucial in influencing future mobility scenarios. Despite a broad preference for environmentally favorable scenarios, as seen by the rankings, the environmental issue received minimal attention in the debates. This suggests a potential inconsistency between expressed scenario preferences and the actual subject of discussion. Simultaneously, technological themes constituted the second most prevalent category of mention. This is a broad consensus that technology can either facilitate or hinder future mobility shifts. The social and economic dimensions were discussed with roughly similar frequency, indicating a balanced, though secondary, emphasis on these factors relative to political and technological matters.

Figures 6.1 and 6.2 collectively illustrate the significance of governance and political processes in shaping stakeholders' perspectives on the future of mobility in Istanbul. They also demonstrate that environmental discourse is inadequately represented in stakeholder narratives, despite its significance in favored scenarios. This study underscores the need for integrative frameworks that can more efficiently align environmental concerns with governance and technical elements in urban mobility planning.

6.1. Scenario Preferences

The analysis of interview data revealed a notable preference among participants for scenarios that prioritized either sustainability or a combination of sustainability and smart technologies. A majority of interviewees expressed a preference for Scenario D (Smart and Sustainable) or Scenario C (Sustainable but not smart). Notably, Scenario B (Smart but not sustainable) garnered support from only one participant: the representative from the İstanbul Taxi Professionals Chamber. This finding suggests a nuanced perspective among stakeholders, with a strong emphasis placed on environmental considerations and a varying degree of acceptance for technological advancements.

The findings suggest that while "smartness" is a valued characteristic in future imaginaries, it is not a sufficient condition for widespread preference. Individuals who prioritized a sustainable future, as evidenced by their selection of scenario C (sustainable but not smart), demonstrated a stronger emphasis on environmental sustainability. The justifications for this preference frequently centered on keywords such as “environmental awareness" "low GHG emissions" and "carbon tax" highlighting a primary concern for a future where sustainability takes precedence. Conversely, those who favored scenario D (smart and sustainable), while acknowledging the importance of smart technologies and systems (mentioning the keyword “digitalisation”), consistently prioritized their integration within a sustainable framework, indicating a preference for a future where "smartness" enhances, rather than undermines, environmental sustainability. This suggests that a future envisioned as both "smart" and "sustainable" is contingent upon the latter; "smartness" alone is insufficient.

Apart from the above, participants' preferences were influenced by other socio-political and economic considerations. For instance, many participants placed a significant emphasis on fostering a human-centered urban environment. This manifested in a preference for polycentric urban forms, non-car mobility options (such as robust public transportation systems and and active mobility options like cycling and walking), alongside the imperative of creating accessible cities for individuals with disabilities. Economic considerations also played a significant role, with participants prioritizing employment opportunities and lower financial requirements for reaching and maintaining the preferred scenario. Another notable factor emerged regarding the role of the public sector versus market forces in urban development. Some participants advocated for a more prominent role for the public sector.

Table 6.2. Reasons for scenario selection put forward by the interviewees

ID	Preferred scenario	Why do you prefer this scenario? *	
		Keywords	Comments
1	D	• Digitalization • Carbon tax • Polycentric urban form • Shared mobility	D is optimistic and dreamy, focusing on smart tools, taxation sanctions, multi-centered neighborhoods, shared mobility, and sustainable urbanism principles.
2	D	• Low GHG emissions • Polycentric urban form • Carbon tax • Public transportation • Digitalization • Strong public sector	Low greenhouse gas emissions, multi-centered urban forms, and carbon taxation are crucial for low-carbon transportation. The fact that public transportation cannot keep up with the increasing demand shows that there is demand for public transportation. Shared mobility, micro mobility already have to use digital infrastructure. Maybe more than hardware, they have to invest in digital infrastructure on the business side because it is important for user satisfaction there. There will always be inequalities on the technology side. Data sharing, privacy, standardization problems are already foreseen. High-cost investments will be required for transformation. The public sector needs to be strong in terms of mobility market structure.
3	D	• Environmental awareness • Polycentric urban form	The most important thing is environmental sustainability. For sustainable transportation that is in line with environmentally sustainable city approaches, taking people further away faster is not the solution. Instead, if they develop sub-centers, this would be a more accurate approach. In the next 10 years, this sub-centered structure like a tree branch should be supported by transportation with bicycle paths that determine the sub-centers and reach the sub-centers.
4	D	• Not car-focused • Polycentric urban form • Strong public sector • Carbon tax • Digitalization	There is no car-focused approach, we are talking about a close neighborhood structure. We should consider innovation based on transportation and shift to scenario D. A little more public power is also an advantage. Thus, it can be a more socially focused structure shaped according to the public's demands, rather than a situation in the hands of the private sector. At the same time, it makes more sense when we look at it in terms of vision, both in terms of its contribution to employment. Especially this carbon tax and the fact that these are tracked with smart devices can also be an advantageous situation in terms of limiting our digital carbon footprint.
5	C	• Polycentric urban form • Carbon tax • Not car-focused • Public transportation • Shared mobility • Environmental awareness	Cycling and walking will increase because there will be short-distance neighborhood settlements. There is carbon taxation. Therefore, we are talking about the decrease in car use. In central areas, car use has been terminated in the neighborhood. Public transportation use is high. Car sharing platforms are high. Therefore, environmental awareness is high. It does not matter that the use of autonomous vehicles is not supported because if it is not supported by the MaaS platform, there will still be traffic congestion on our roads.
6	D	• Not car-focused • Polycentric urban form • Low GHG emissions • Digitalization	It is not focused on cars. When we think of short distance neighboerhood connections, there is an approach that will turn time losses into gains and increase comfort. It will also be effective in reducing carbon emissions. When you say smart applications, not just smart phones, the technologies we call disruptive innovation will also be included in this. The solutions created with them will also provide further improvement in systems.

ID	Preferred scenario	Why do you prefer this scenario? *	
		Keywords	Comments
7	C	• Public transportation • Active mobility • Environmental awareness	Public transport usage is high. Active transport methods such as bicycles in good shape. Vehicle usage is restricted. Although there are gaps in some places, environmental sustainability awareness is high. I don't think autonomous vehicles are that critical. Maybe it may be necessary for some shared models, but I don't think it is one of the methods that can be used a lot in the city. Because it means that we are continuing with vehicle-oriented transport at some point.
8	D	• Polycentric urban form • Active mobility • Digitalization	I see a transition towards a much more sustainable transportation and a sustainable world. The goal of sustainable transportation is not only to reduce carbon from transportation. One of the most important issues is to have a poly-centric urban form. When we say sustainable transportation modes, walking, pedestrian comfort, cycling, micro mobility, which we work on, are very good in this scenario. It also uses digital technology. I chose D because of factors such as deterring private vehicles, preferring sustainable modes, and being climate resilient
9	D	• Environmental awareness • Carbon tax	It is the most organized city scenario and the most conscious of environmental sustainability. There will be increased compliance due to financial cost in the carbon budget.
10	B	• Digitalization	Technology is utilized to regulate city traffic and chaotic intersections, with IBB providing relief. However, long-term solutions are preferred, as short-term solutions create problems. Smart taximeters are desired, as Uber's pricing is high during rush hour, causing financial loss for travelers.
11	D	• Acessibilility	Balanced metropolis with nature and high accessibility
12	D	• Digitalization • Environmental awareness	High technology usage and environmental consciousness
13	D	• Active mobility • Public transportation • Low GHG emissions	There are bicycle paths, respect for bicycles, and mobility is maintained with its own means instead of public transport or cars. In this sense, I see a more livable and cleaner Istanbul. Low fossil fuel consumption to reduce air pollution is important. There is faster, independent mobility, enabling people to reach desired destinations.
14	D	• Accessibility • Employment opportunities • Low GHG emissions	Accessibiliyty is high, employment opportunities are strong, and GHG emissions are low
15	C	• Accessibility	Prefers small communities with close contact, relationships, and neighborhood culture for a more livable city, promoting participation of disadvantaged groups and increased joy of living.
16	C	• Public transportation • Environmental awareness • Accessibility • Low financing requirement/cost	There is a high level of public transport use, a high level of awareness of environmental sustainability, high accessibility, low financing requirements and costs. This scenario seems more sustainable and more accessible.
17	D	• Low GHG emissions • Parking fee	Greenhouse gas emissions are low, parking fees are high, awareness of environmental sustainability is high, carbon taxation, i.e. expensive use of fossil fuels, congestion taxation.

ID	Preferred scenario	Why do you prefer this scenario? *	
		Keywords	Comments
		• Environmental awareness • Carbon tax • Congestion tax	I choose Scenario D because of the different functions it operates.
18	D	• Environmental awareness • Poly-centric urban form • Digitalization	There is environmental awareness, and a higher level of decentralization. I think decentralization can also directly contribute to these accessibility issues. If carbon budgets are to be in the form of personal carbon allocations and some mechanisms can be implemented to reduce climate injustice between the poor and the wealthy, I see this as important. In fact, this would of course be linked to digitalization to some extent. Just because digitalization can reproduce existing injustices, we should not ignore the fact that it can have positive contributions. Correct use of digitalization may alleviate negative aspects and increase positive contributions to society.
19	D	• Environmental awareness • Carbon tax • Employment opportunities	It provides a more sustainable context environmentally. It includes a better policy in terms of climate because of carbon taxation and also better employment opportunities and the public sector is strong.

* Keywords are ordered by the appearance order in the interview.

Interviewees were asked to identify stakeholders most affected by their preferred scenario and to explain the nature of these impacts. This inquiry aimed to understand the perceived distributional consequences of the proposed mobility transitions. Subsequently, the responses were systematically categorized into two distinct groups: those stakeholders predicted to experience positive impacts and those expected to face negative consequences. This categorization, presented in Table 6.3, reveals a nuanced picture of the perceived distributional effects of the preferred scenarios.

Negative consequences include significant disruption to the automotive industry, characterized by potential economic instability and a decline in industry influence. According to the interviewees, private vehicle owners may face increased financial burdens stemming from higher fuel costs, taxes, and parking fees, alongside potential restrictions on vehicle use. Thus, businesses may encounter increased logistical challenges, higher operating costs due to carbon taxation and Low Emission Zone restrictions, and difficulties accessing city centers. Other potentially affected groups include minibus (dolmuş) operators, taxi drivers, and parking valets. Rentier circles, those who profit from land speculation, may see a decrease in land value dedicated to private vehicle use.

According to Interviewee 7 "*all the stakeholders in the automotive industry including those who produce the seats on the vehicle, those who produce the steel on the vehicle, those who produce the paint on the vehicle, and those who produce the vehicle in its entirety will not want these. But here again, the state's different roles emerge. Now, the use of personal vehicles will decrease, ownership may decrease, but the burden on different areas such as producing more bicycles, producing more scooters, producing more public transportation vehicles, producing buses, producing metro vehicles, producing metro rails and train rails will increase. At this point, the state should make a good plan and not kill the current industry."* Therefore, it is important to consider the potential resistance from the central government due to the economic and political repercussions for the automotive industry.

Furthermore, the many participants highlight the potential for disproportionate impacts on low-income groups, who may face increased transportation costs and limited access to digital technologies. On the other hand, individuals with higher incomes possess the financial capacity to absorb the costs associated with carbon taxation, allowing them to maintain their reliance on private vehicle use. Additionally, if there is increased reliance on digital platforms for mobility, this may disadvantage those who lack access to technology or the necessary digital skills. The elderly and digitally disadvantaged may face reduced mobility and social isolation due to changes in public transportation systems and the increased reliance on digital platforms.

Conversely, the interviewed stakeholders identify also several key groups they expect to be benefiting from the future scenarios. The younger generation, particularly students, stand to benefit significantly from improved public transportation, increased cycling and walking infrastructure, and a poly-centric city structure that enhances accessibility to educational and social opportunities. The working class can expect reduced transportation costs and increased productivity due to shorter commute times. Disadvantaged groups are poised to gain from expanded mobility options, such as increased walking and cycling areas, leading to greater accessibility and reduced social isolation.

All citizens can expect a range of positive outcomes, including reduced stress, improved health, economic growth, and environmental benefits. Reduced commuting times will lead to decreased stress levels. Improved air quality and increased physical activity will enhance overall health and well-being. Furthermore, sustainable transportation systems can stimulate economic growth by creating new job opportunities in both the public and private sectors. Reduced carbon emissions will contribute to a healthier environment and mitigate the impacts of climate change.

If there is relience on high technology, specific groups such as users of electric vehicles, and tech companies will experience positive impacts. The expansion of charging infrastructure, increased demand for digital solutions in the transportation sector, and the emergence of new opportunities in the field of active city planning will create new economic opportunities for these groups.

Table 6.3. Affected stakeholders

ID	Preferred scenario	Who will be affected by this scenario? How?	
		Positively affected	*Negatively affected*
1	D	• **Younger generation** because they are more sensitive to sustainability and climate change • **Elderly population** will benefit from walking and cycling • **Businesses** will benefit form new job opportunities with digitalization	• **Public sector** because of high investment and inspection costs • Private **vehicle owners** • **Minibuses** (dolmuş) will be used less
2	D	• **Low- and middle-income groups** will be supported. • The active movement areas of **disadvantaged groups** are being expanded more	• **Businesses and trade**, mostly due to changed logistics structure. Carbon tax will increase its costs, they will have difficulty entering LEZ zones within the city with higher costs. Roads will narrow for logistics distribution trucks and transportation times will increase.
3	D		• **Rentier circles**, those who earn money from land speculation
4	D	• **All citizens** will be happier in a structure with public transportation because less time will be spent on the road. • **Private businesses who earn their living from public transportation** will look upon and welcome.	• **Auto manufacturers** • **Gasoline companies may** be a little more cautious. • People who are 65 years old plus or who we can call **digitally disadvantaged groups**
5	C	• **All citizens**, thanks to healthy living, environment, economy due to carbon tax	
6	D	• It will bring useful solutions from transportation to distribution, and **public, private companies**, and even **smaller tradesmen** working in the private sector, will benefit.	
7	C		• **Auto manufacturers** will suffer the most. The automotive industry's power over the economy may be disrupted without economic mechanisms being strengthened. • **The central government** may not favor this change. • **Stakeholders in the automotive industry**, including seat, steel, paint, and vehicle production, will not want this change.
8	D	• Poly-centric urban form allows for short travel distances, benefiting **businesses and residents.**	• **Tradesmen** resist high parking fees, causing burden on **residents and workers**. • Carbon taxation and increasing cost of fossil fuels pose challenges for **low income groups**
9	D	• It will affect all of Istanbul (**all citizens**). Maybe people living in the outskirts of Istanbul, away from the center, will benefit less from these. • The most positive impact on **workers** and **students**.	

ID	Preferred scenario	Who will be affected by this scenario? How?	
		Positively affected	*Negatively affected*
10	B		• Shared mobility affects **taxi drivers**. I don't want it to happen. I don't support MaaS (mobility platforms as a service), it steals our bread.
11	D	• **Students** are escaping the constraint of buildings in urban life.	
12	D	• **Users of electric vehicles**. • **Students** and the **working class** will be affected because they use public transportation more.	• **Gasoline vehicle users** will pay more taxes
13	D	• **Private sector** and other stakeholders s will develop user-friendly, low-cost, and smart solutions.	
14	D	• The **younger generation** will be affected because they travel more.	
15	C	• **Disadvantaged groups**	
16	C	• The participation of **the disabled community** in social life will increase. • It affects the lives of **people who spend time on the road.**	• Parking valets
17	D	• If awareness of environmental sustainability is high, **everyone** will benefit	• **Local government** body will struggle as stakeholder in carbon taxation
18	D	• Tech companies because the demand for them will increase. Therefore, their source of income will be expanded. • Potential employment benefits for **young people** in the digitalization market.	• Increased digitalization may negatively impact the **elderly and poor**.
19	D	• **Environmental organizations** due to active city planning and civil society participation. • Ideal for **students** due to a multi-centered city structure for biking and walking.	• **Aging population** may negatively affect employment and production. • High taxation may affect the **private sector,** but financing is necessary.

To gain a deeper understanding of the potential refinements to the preferred scenarios, interviewees were asked to identify areas for improvement. This inquiry aimed to explore potential modifications and enhancements to the proposed mobility transitions based on their perspectives and concerns (Table 6.4).

The analysis of Table 6.4 reveals several key concerns and suggestions for improvement regarding the preferred mobility scenarios. Data privacy and security emerged as a primary concern, with interviewees emphasizing the need for robust data protection measures, user consent for data usage, and clear regulations for data sharing among different actors in the mobility ecosystem. Concerns were also raised regarding the digital divide, highlighting the need to ensure equitable access to and use of digital technologies for all, particularly the elderly and those with limited digital literacy.

Accessibility and inclusion were also emphasized, with interviewees advocating for transportation systems that are accessible to all users, including people with disabilities. Concerns were expressed regarding the impact of an aging population on transportation demand and the need for more balanced demographics. The importance of considering the needs of a younger population, particularly in relation to micro-mobility options, was also highlighted.

Several interviewees emphasized the need to improve the capacity and efficiency of public transportation systems, including investments in rail systems, sea transportation, and feeder bus services. Concerns were also raised regarding the balance between public and private sector involvement in the transportation sector, with some interviewees advocating for a stronger public role while others emphasized the importance of a balanced approach. Technological limitations were also identified as a key concern. Interviewees emphasized the need for further development of autonomous vehicles, real-time traffic management systems, and integrated mobility platforms. However, interviewee 10 had an opposing view saying "*I don't support shared mobility and MaaS. It steals our bread*".

Table 6.4. What the interviewees would like to change in preferred scenarios

ID	Preferred scenario	*What would you change? How?*	
		Keywords	*Comments*
1	D	• Topographic challenges • Sea transportation	Since walking, cycling, and micro-mobility are influenced by the topography of Istanbul, it can be added to the challenges. Sea transportation is not available in terms of the diversity of transportation modes.
2	D	• Digital divide • Data sharing, privacy, and standardization	Increase digital accessibility in public transport, particularly for the elderly, and encourage data sharing, privacy, and standardization.
3	D	• TOD approach	Focus on public transportation with the transit-oriented development (TOD) approach because the 15-minute city and TOD are approaches that solve each other's problems.
4	D	• Public transportation • Data sharing, privacy, and standardization • Shared mobility • Digital divide	Public transportation's capacity increase is not always sufficient to meet demand, necessitating the promotion of alternatives like shared, e-mobility, and micro mobility, eliminating technology access and usage inequalities, and addressing data sharing and standardization issues.
5	C	• Real-time traffic management • Market structure • Employment opportunities	Real-time traffic management systems supporting MaaS is needed. Market structure should be strong company, weak public instead of strong public and weak public. Employment opportunities should be strong, and there should be a young population as the aging population can cause economic difficulties.
6	D	• CAV • On-demand transportation • Renewable energy • Market structure • Accessibility • Population	The model should prioritize connectivity, and autonomous mobility, incorporating cooperative autonomous connected mobility (CAV), on-demand transportation, and renewable energy. The strong public-private company profile should be balanced, ensuring accessibility for people with limited mobility and disabilities. The model should also have a balanced population structure and more controllable demographics.
7	C	• Shared mobility • Real-time traffic management • Market structure • Public transportation • Population	sharing platforms should be developed more. Real-time traffic management systems and services need to support high-level technology use, such as mobility platforms, to pave the way for autonomous vehicles. The strong public-private company profile should be balanced, ensuring accessibility for people with limited mobility and disabilities. The model should also have a balanced population structure and more controllable demographics.
8	D	• Accessibility • Sea transportation • Population • Market structure	Public transportation capacity and rail system accessibility in a city should be improved. There needs to be a sea transportation system that uses smaller, renewable energy ferries and a flexible system. A younger population would be better, as these modes of transportation may not appeal to the aging population. A strong public and strong companies can work better together.
9	D	• Legislation • Digital divide	Istanbul needs to expand zero-emission zones and pedestrian zones, and open data legislation is not yet completed. There needs to be minimal inequality in access to technology.

ID	Preferred scenario	*What would you change? How?*	
		Keywords	*Comments*
10	B	• Shared mobility • Active travel • Data sharing, privacy, and standardization	Shared mobility affects taxi drivers negatively. The urban and geographical structure of Istanbul is not suitable for bikes. Data sharing and standardization issues must be resolved.
11	D	• Data sharing, privacy, and standardization • Population	Data privacy, public transport being in line with demand, young population
12	D	• Free transportation	Transportation should be free for students and the elderly. Older cars should be removed. There should be no tax on electric vehicles, it should be easier to buy a car.
13	D	• Data sharing, privacy, and standardization	Turkey currently prohibits the import of connected cars due to data sharing issues, which are considered open to espionage. This prevents the transfer of data to a server abroad, preventing connected cars from being imported to Turkey.
14	D	• Population	Balanced population structure
15	C	• Accessibility	Technology can create innovative ways for disabled individuals to walk on and off the road, enabling them to walk at work and on the road.
16	C	• Shared mobility	Increasing car sharing platforms to address driving and public transportation issues would be good. Limited parking areas may be sufficient for the current high demand for public transportation, as the number of people using cars will be low.
17	D	• Data sharing, privacy, and standardization	Data sharing and privacy standardization issues have been ongoing and causing problems in the sector. Accessing and sharing data is not easy, and many applications are not user-friendly. To address these issues, data transparency and awareness should be prioritized.
18	D	• Digital divide • Data sharing, privacy, and standardization • Public transportation	Inequalities in access and use of technology could be addressed by designing special programs for this. Data sharing, privacy, and standardization issues should be addressed, and projects for data sharing should be developed. Parking lots are limited and their fees are high, but public transportation should be able to meet demand.
19	D	• Data sharing, privacy, standardization	Data sharing and privacy, standardization in the public sector, should be improved, focusing on the youth population.

6.2. Scenario Expectations

This section examines the discrepancies observed between the interviewees' most preferred scenarios for urban mobility in Istanbul and their expectations regarding the likelihood of these scenarios being realized. An analysis of Table 6.5 reveals significant discrepancies between the preferred and expected scenarios. Interviewees expressed concerns about the feasibility of implementing their preferred scenarios, citing a range of political, economic, social, and technological constraints.

Political and economic factors emerged as major barriers. Interviewees expressed skepticism about the political will to implement radical changes, citing concerns about short-term political gains overshadowing long-term sustainability goals. The influence of powerful lobbies, the dominance of market-based solutions, and the lack of long-term vision in political decision-making were identified as significant obstacles. Economic constraints, such as high investment requirements, limited budgets, and the need for significant economic restructuring, were also perceived as major hurdles, particularly in the face of economic crises and limited public resources. Furthermore, interviewees highlighted the limitations of current governance structures, such as bureaucratic delays, limited decision-making power of local authorities, and the influence of rent-seeking behavior in urban planning processes.

Social and cultural factors also played a significant role. Interviewees emphasized the need for increased public awareness and education to facilitate the acceptance and implementation of sustainable mobility solutions. They highlighted the challenges of overcoming deeply ingrained car-centric habits and fostering a culture of sustainable transportation. Concerns were also raised about the potential impact of an aging population on the feasibility of certain scenarios, particularly those heavily reliant on active transportation modes.

Technological and infrastructure limitations were also identified as key challenges. Interviewees pointed to existing infrastructure limitations, such as inadequate public transportation systems, insufficient cycling and walking infrastructure, and limited access to charging infrastructure for electric vehicles. Concerns were also raised about the potential for technological limitations, such as the slow pace of technological development and the challenges of integrating new technologies into existing urban systems.

The global context also presented significant challenges. The global economic context, characterized by uncertainty and potential crises, was identified as a significant factor that could hinder the implementation of ambitious sustainability goals. Geopolitical factors, such as the rise of nationalism and populism, were also perceived as potential threats to the advancement of sustainable mobility agendas.

Table 6.5. Preferred vs expected scenarios

ID	*Most preferred scenario*	*Expected Scenario*	*Stated reasons on why they are different*
1	D	A	The possibility of implementing scenario D is much longer term compared to others considering the **topography**, and **sample applications,** information and **awareness** work, a huge **infrastructure investment** and **training of manpower** are required. Since a quarter of the construction of Istanbul is under **earthquake risk**, durability is a priority over mobility. Both the demographic structure and usability structure of Istanbul should be taken into consideration. The literacy capacity of the population, priorities should be well analyzed by considering **household income** and poverty. It is difficult to prioritize carbon taxation in a place where poverty is at its highest.
2	D	B	The transition from individual car use to walking will be incomplete. The studies of the Metropolitan Municipality and the Ministry of Transport regarding public transportation in Istanbul are promising, but since I think we will not be able to achieve what we need to do by 2030, we cannot move to D with a similar **governance structure** by 2050. The main factor in this is that the governance structure is not determined, and the **economic conditions of the municipality administration** will be insufficient to meet the 2030 and 2050 targets. It may be difficult for Istanbul to reach 2050 due to the **high investment** in the D scenario and the **limited power in the hands of city administrations.**
3	D	A	**Plans are not currently a roadmap for an urban development strategy**. Urban plans, zoning plans or transportation plans emerge as decisions that **support the dynamics of land and rent in the city**. Reaching C or D requires planning for this, and if it is implemented by an **honest administration** without any serious compromise, I think these stages can be passed in five-year steps. But the current structure is ongoing rent mechanisms, if there are still those who make decisions and they dominate the **decision-making processes**, we will continue at A.
4	D	B	There are **infrastructure problems**. This is a process that should bring about radical transformation and changes. In some studies, there are results indicating that when we replace the current vehicle infrastructure with completely electric vehicles, the city grid will not be sufficient anyway. Without cheap loans, cheap grants, funds, it seems impossible to do these things in this global **economic situation**. There is also such a risk and obstacle. Therefore, our **habits** are of course a big obstacle in front of us. To encourage a person who uses an individual vehicle to use public transportation, first, there needs to be an **infrastructure plan** that will allow them to prefer this without causing any problems when they use it.
5	C	B	We present a vision, but our **practices never match our vision**. This is due to our **individual competence and awareness**. Second, it is due to the **high influence of those with political and economic power on plans**, changes in plans or plans. In other words, it can be due to individuals' own demands rather than the general consensus of society. Let's say there is a zoning situation somewhere. If there is a **profit** issue there by changing the zoning of that place, we can do that.

ID	*Most preferred scenario*	*Expected Scenario*	*Stated reasons on why they are different*
6	D	C	**Bureaucracy inevitably delays things a little**. I expect things in the public sector to be a little faster, but that's not just about us. It's progressing this way all over the world, unfortunately. In other words, the public sector is a little slower, but the private sector can immediately implement the feedback it receives from the public. The private sector expects a little more speed from the public.
7	C	B	Based on my observation and evaluation of current policies, and my evaluation of local and central authorities, I think B will happen more than C. We need to see that the solution is simple and that there is no **concern for votes in politics and a strong scrutiny**.
8	D	C	Scenario D requires **public awareness** raising due to Istanbul's **cosmopolitan structure**, which may make it **difficult to implement technology applications and carbon taxes**. The majority of the population lives in Bahçelievler, Gaziosmanpaşa, and Sultanbeyli. To reach everyone, the next step is to develop technology in 2050, reaching out to the city's 20 million population.
9	D	C	Scenario C may be more possible than scenario D due to factors such as **population, changes in settlement areas due to some environmental problems**, and retreating further inland from the coasts.
10	B	B	-
11	D	B	Population is not directly proportional to the **economy**
12	D	B	Depends on the **political environment**
13	D	A	The main issue is a **lack of vision and perspective** on work, which is crucial for transforming Istanbul or Turkey within a strategic plan. The situation is **complex, time-consuming, and requires a serious budget.** Turkey's populist environment aims to manipulate people for **short-term results**, making it unlikely that long-term benefits will be achieved through idealistic implementation.
14	D	D	-
15	C	B	Trump was the last elected to power and that early elections in Germany may see **nationalist and rational socialists** emerge. They plan to work hard in 2050 to maintain their current mindset. Activism can help the potential for change in society.
16	C	B	The main issue is the **lack of demand** to make this issue more visible. The **economic crisis** has made discussing these issues less common, and it doesn't seem to be on the agenda of policy makers. The **municipality has limited power and competence** to make bigger political decisions.
17	D	B	Zoning plans are often destroyed, causing a **disconnect between land use and transportation network planning**. In cities like Istanbul, **where land value is high, car-first cities are more prevalent.**

ID	*Most preferred scenario*	*Expected Scenario*	*Stated reasons on why they are different*
18	D	A	We should focus on solutions that everyone agrees on but **current market-based solutions are the most common.** Because that's the general system of the world, we can't change them much. Therefore, it is difficult for D to happen. Also, **urgency** may limit the exploration of alternative paths. The **conflict between short-term interests and long-term interests** brought about by democracy generally appeals to long-term interests rather than thinking of alternatives outside of these market-based mechanisms. I think that one of the reasons why market-based mechanisms can somehow become mainstream is because it is generally the path that best satisfies people's short-term interests, and therefore it is difficult to overcome.
19	D	B	The city's **economic and general planning** needs to be shaped accordingly, but such a step does not seem to be possible. In fact, this will not be limited to the municipality's planning. It is also very much related to where it is built and what it is encouraged with. The best possibility for **city structuring** within such a walking distance is probably Scenario B. At least, I think that the incentives given to individual car use, the increase in fossil fuels, and the increase in shared mobility or micro mobility with bicycles and scooters are more possible with increasing traffic. Right now, the **trend** seems to be heading that way anyway, so we won't stay in scenario A.

6.3. Governance Preferences

Stakeholder preferences regarding urban mobility governance revealed a spectrum of viewpoints, summarized in Table 6.6. A significant proportion of respondents (IDs 1, 2, 4, 6) preferred a balanced approach, integrating elements of both top-down and bottom-up governance, and recognizing the need for collaboration between public, private, and civil society actors. These participants often emphasized the central government's role in providing guidance, setting policy frameworks, and offering financial or technical support, while simultaneously acknowledging the importance of local adaptation and implementation. For instance, one respondent (ID 1) specifically advocated for a mixed governance model involving public, private, and civil collaboration, with the central government guiding and legislating, and local governments implementing policies with civil society involvement. Another respondent (ID 2) preferred a public-heavy model but stressed the necessity of private sector involvement, advocating for central government oversight to ensure local government compliance.

A significant number of respondents (IDs 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19) expressed a preference for bottom-up governance models. These individuals prioritized local autonomy, community involvement, and participatory decision-making. They often envisioned local authorities as facilitators or leaders, empowering citizens and incorporating their input into planning

and implementation processes. For example, several respondents (IDs 7, 8, 9, 10, 17) emphasized the importance of strengthening local governments and granting them greater power in decision-making. Others (IDs 15, 18) specifically highlighted the potential of cooperatives and neighborhood organizations to lead local governance initiatives. Even within the bottom-up preference group, variations existed. Some (IDs 11, 14) still saw a vital role for government in monitoring, collaborating, and responding to citizen needs, while others (IDs 12, 13) advocated for a more limited government role, focusing on support and incentivization rather than direct intervention.

The preferred role of government also varied. While some respondents (IDs 2, 4, 6) emphasized government's role in ensuring compliance, providing support, or setting regulatory frameworks, others (IDs 12, 13, 14, 15, 17) preferred less direct government intervention, suggesting instead a focus on collaboration, incentivization, or oversight. This divergence in opinions reflects the ongoing debate about the optimal level and nature of government involvement in urban governance.

Table 6.6. Governance Preferences Summary

ID	Governance Preferance	Governance Power	Government Intervention
1	Balanced	Mixed (public, private, civil collaboration)	Central government guides, local governments implement, civil society involved
2	Balanced	Public-heavy with 40% private involvement	Central government ensures local government compliance
3	Bottom-up	Central and local governments focus on sustainable urban policies	Central government sets national policies, aligns with international principles
4	Balanced	Public with citizen advocacy and planning involvement	Central government supports financially and technically
5	Bottom-up	Strong public sector with private sector involvement	Government sets red lines but allows local flexibility
6	Balanced	Central government-led, with local adaptation	Regulatory and incentive-based approaches preferred
7	Bottom-up	Local authorities as facilitators	Central government supports financially and strategically
8	Bottom-up	Central and local governments collaborate	Central government provides financial support and oversight
9	Bottom-up	District municipalities stronger, with metropolitan support	Government intervenes based on urban justice
10	Bottom-up	Local governments with more power	Central government supports local governments
11	Bottom-up	Government-led	Government monitors, responds to complaints, collaborates
12	Bottom-up	Private sector with government support	Government collaborates, avoids over-intervention
13	Bottom-up	Committee of experienced individuals leads	Government incentivizes the private sector
14	Bottom-up	Government-led	Government collaborates, avoids over-intervention
15	Bottom-up	Cooperatives and neighborhood organizations lead	Government provides options, avoids imposing decisions
16	Bottom-up	Participatory governance with city councils	Government collaborates, oversees
17	Bottom-up	Local governments stronger with unified transport authority	Government supports the private sector
18	Bottom-up	Decentralized governance, cooperatives and local governments lead	Government plans and provides financial resources
19	Bottom-up	Public sector with democratic financing and planning	Government regulates and oversees

Table 6.7 focuses on how different stakeholders (experts, government representatives, civil society, and users) prefer governance, decision-making, and public-private collaboration in urban mobility systems. There is a complex interplay of perspectives, highlighting key themes related to central versus local governance, the role of public-private partnerships (PPPs), the importance of participatory governance, and the consideration of sustainability and inclusion.

A prominent tension emerged between advocates for centralized and decentralized governance models. Experts and government representatives (IDs 1, 2, 5, 6) generally favored centralized governance with local adaptation, emphasizing the need for national standards, strategic planning, and consistent policy implementation. This top-down approach, they argued, ensures efficiency and coherence across different regions. Conversely, local government representatives (IDs 4, 8), civil society organizations (IDs 18, 19), and some expert consultants (IDs 3, 7, 9) supported decentralized governance and local leadership. They stressed the importance of empowering local authorities to tailor solutions to specific community needs and fostering greater citizen engagement. This bottom-up approach, they contended, promotes responsiveness, flexibility, and a deeper understanding of local contexts. The Marmara Municipalities Union representative (ID 4), for instance, specifically called for local government leadership with central government support, highlighting the practical challenges faced by local entities in balancing citizen needs with limited resources. This divergence in perspectives underscores the ongoing debate regarding the optimal balance of power between central and local authorities in urban governance.

While most stakeholders acknowledged the potential benefits of PPPs in leveraging private sector expertise and resources (IDs 1, 2, 3, 4, 6, 10, 13, 17), significant concerns were raised regarding transparency, accountability, and the potential misalignment of public and private interests. Experts from consulting companies (IDs 1, 5) emphasized the need for structured collaboration and financial incentives to encourage successful PPPs, particularly in complex urban transformation projects. However, other stakeholders, particularly those representing civil society (IDs 17, 19) and local government (IDs 4, 8), expressed reservations about the potential for private sector dominance and the challenges of ensuring public accountability in such partnerships. The transportation consultants (IDs 3, 7, 9) specifically highlighted the potential conflicts between private sector profit motives and broader public goals. These findings suggest that while PPPs are viewed as a necessary tool for urban development, it is crucial to consider the design and implementation of these partnerships to safeguard public interests and ensure transparency.

The importance of participatory governance and community involvement was a recurring theme, particularly among civil society organizations (IDs 18, 19), users (IDs 11, 12, 15, 16), and local government representatives (IDs 4, 8). These stakeholders emphasized the need for bottom-up decision-making processes that incorporate the voices and needs of diverse communities. The user representatives, including an elderly citizen (ID 11) and a person with disabilities (IDs 15, 16), highlighted the importance of government responsiveness and accessibility in urban governance. However, some experts (IDs 2, 3, 7, 9) acknowledged the cost and time implications of participatory processes, suggesting a need to balance the desire for inclusivity with the practical constraints of project implementation. This tension highlights the challenge of designing participatory mechanisms that are both effective and efficient.

Also, there are varying perspectives on the integration of sustainability and inclusion into urban governance. Environmental NGOs (ID 19) advocated for public sector leadership in promoting sustainable development, emphasizing the need for democratic financing and planning processes. Accessibility activists (IDs 15, 16) stressed the importance of inclusive governance that prioritizes the needs of marginalized groups and ensures accessibility for all. While private sector representatives (IDs 10, 13) acknowledged the importance of these considerations, their primary focus tended to be on innovation and profitability, sometimes creating potential conflicts with broader sustainability and inclusion goals.

Table 6.7 Key Governance Insights of Different Stakeholders

ID	*Description*	*Key Governance Insights*
1&5	Expert, Consulting Company Representative	Advocates for a **mixed governance model** involving public, private, and civil society collaboration. Emphasizes the importance of **central government leadership** in setting laws and policies, while local governments handle implementation. Highlights the need for **financial incentives** to encourage collaboration among stakeholders. Suggests that **public-private partnerships (PPPs)** are challenging but necessary, especially in urban transformation projects.
2	Expert, Smart City Consultant	Prefers a **public-heavy model** with significant private sector involvement (at least 40%). Advocates for **collaboration between central and local governments**, with central government ensuring local governments fulfill their obligations. Highlights the **cost and time implications** of participatory processes but does not dismiss their importance.
3,7,9	Expert, Transportation Consultant	Stresses the importance of **bottom-up decision-making** and **community involvement** in transportation planning. Advocates for **central government setting national policies**, with local governments adapting them to local needs. Highlights the **challenges of public-private partnerships**, especially when private sector interests' conflict with public goals
4	Local Government, Marmara Municipalities Union Repr.	Advocates for **local government leadership** in governance, with central government providing financial and technical support. Emphasizes the importance of **citizen participation** in decision-making processes. Highlights the **challenges of public-private partnerships**, especially in ensuring transparency and accountability.
6	Government, Ministry of Transportation and Infrastructure	Prefers a **centralized governance model** with local adaptation. Advocates for **regulatory and incentive-based approaches** to governance. Highlights the importance of **long-term planning** and **thorough feasibility studies**.
8	Local Government, Istanbul Metropolitan Municipality Repr.	Advocates for **strong local governance**, with local authorities acting as facilitators. Emphasizes the importance of **slow and deliberate decision-making** for long-term sustainability. Highlights the role of **academia and civil society** in providing input and monitoring governance.
10	Sector Repr., İstanbul Taxi Professionals Chamber	Advocates for **local government leadership** in governance. Emphasizes the importance of **collaboration between central and local governments**. Highlights the need for **government support** in addressing local challenges.
11	Elderly User, Retired	Prefers **government-led governance**. Advocates for **bottom-up decision-making** and **community involvement**. Highlights the importance of **government responsiveness** to citizen needs.

ID	*Description*	*Key Governance Insights*
12	Gen Z User, University Student	Prefers **private sector-led governance** with government support. Advocates for **bottom-up decision-making** and **community involvement**. Highlights the importance of **government collaboration** with the private sector.
13	Business, Car Company Representative	Advocates for **private sector involvement** in governance. Emphasizes the importance of **transparency** and **collaboration** in public-private partnerships. Highlights the need for **incentives** to encourage private sector participation.
14	Minibus Driver	Prefers **government-led governance**. Advocates for **collaboration between government and private sector**. Highlights the importance of **citizen involvement** in decision-making.
15&16	Users with Disability, Accessibility, Activists	Advocates for **participatory governance**, with city councils bridging the gap between municipalities and citizens. Emphasizes the importance of **accessibility** and **inclusion** in governance. Highlights the role of **civil society** in monitoring and advocating for citizen needs.
17	Expert, Sector NGO Representative	Advocates for **local government leadership** in governance, with a unified transportation authority. Emphasizes the importance of **transparency** and **collaboration** in public-private partnerships. Highlights the need for **incentives** to encourage private sector participation.
18	Civil Society Repr.– Urban Planning NGO	Advocates for **decentralized governance**, with cooperatives and local governments leading. Emphasizes the importance of **participatory governance** and **community involvement**. Highlights the need for **government support** in addressing local challenges.
19	Civil Society Repr. – Environmental NGO	Advocates for **public sector leadership** in governance, with democratic financing and planning. Emphasizes the importance of **sustainability** and **environmental protection** in governance. Highlights the role of **civil society** in monitoring and advocating for environmental goals.

7. DISCUSSION

The stakeholder preferences regarding urban mobility scenarios reveal a strong and consistent prioritization of sustainability, often coupled with an appreciation for smart technologies, but only insofar as they contribute to broader sustainability goals. The overwhelming preference for Scenarios C (Sustainable but not Smart) and D (Smart and Sustainable), with a near-total rejection of Scenario B (Smart but not Sustainable), underscores the critical insight that technological innovation, while valued, is insufficient without a foundational commitment to environmental stewardship. However, the fact that the expectations are not Scenario C and D, but generally Scenario B (and sometimes Scenario A) shows that people are aware that the main driver determining the future is not environmentalism. The primary driver is technology. Scenario B is the most expected scenario, as it is the future in which stakeholders who benefit from this technology can more easily access it.

Based on this main finding, it is possible to conduct the discussion through three different streams. The first is a stream on the discourse paths employed by interviewees to articulate their preferences and expectations. Subsequently, a second stream will discuss the interviewees' cognitions and perceptions concerning transformation and transition in relation to various future scenarios. Finally, the third stream will discuss the articulation of different governance issues.

7.1. Discourse paths

Considering the preferences and expectations of the interviewers, along with the factors they regarded as significant or insignificant during the interviews, a representation I propose to call as “discourse paths”, Figure 7.1 can be created. This figure indicates that individuals may adopt either technologically optimistic or pessimistic discourses when shaping their desires and expectations, or they may engage in discourses that concurrently emphasize environmental or economic considerations. Numerous interviewees employ these discourses in a hybrid manner, rendering it impractical to categorize them distinctly; however, three principal discourses can be identified as "ideal types" that emerged from the interviews: technologically optimistic and environmentalist, technologically pessimistic and environmentalist, and technologically optimistic and corporatist.

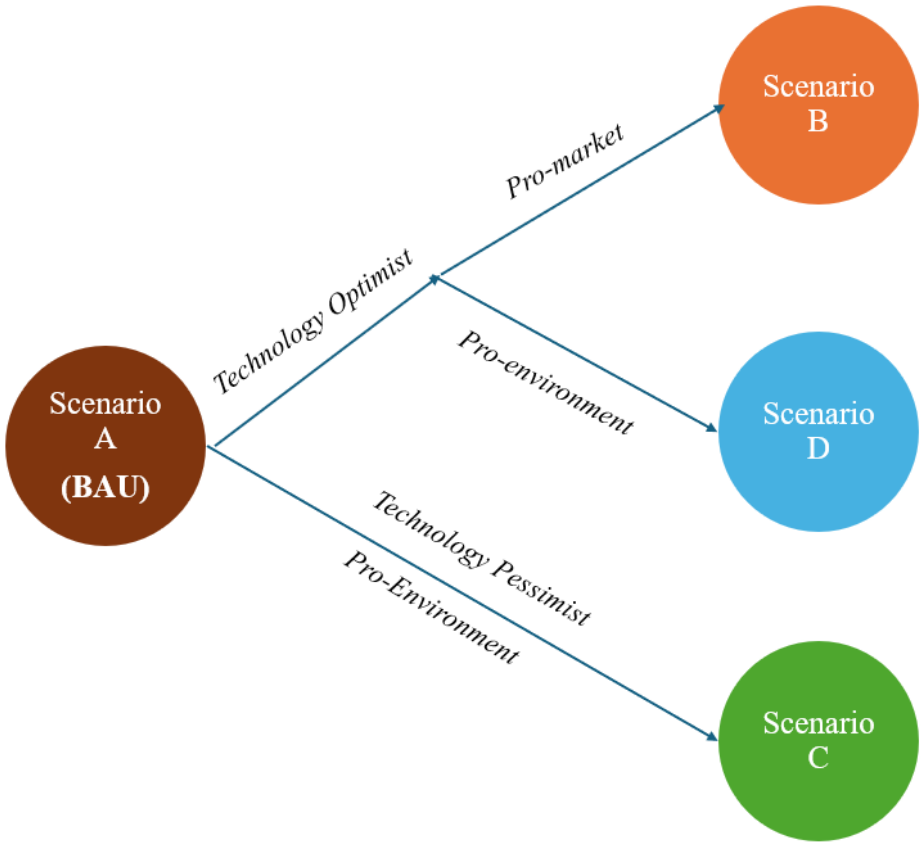


Figure 7.1. Interviewee orientations based on their characteristics regarding technology and environment

The conceptual framework presented, as depicted in the figure, can be analyzed via the perspective of unique "discourse paths." The first "Scenario A (BAU)" shows a baseline state. From that point, other futures branch out based on different views on technological development: the "Technology Optimist" and "Technology Pessimist" pathways.

The "Technology Optimist" approach represents a viewpoint that believes that new technologies will help us deal with problems that will come up in the future. This positive outlook then splits off into other branches, each showing what is most important to each person. Scenario B arises when the "Technology Optimist" view is joined with the "Pro-market" view, creating a discourse path, in which technology is primarily used in a market-driven way. Scenario D is chosen when an individual identified as a "Pro-Environment" concurrently subscribes to the belief in "Technology Optimism", creating a discourse path wherein the objective of technological progress is to enhance environmental sustainability.

On the other hand, the "Technology Pessimist" pathway shows a more cautious view of technology's possible harmful effects or benefits. This viewpoint results in Scenario C, which is also marked by a "Pro-Environment" stance, corresponding with a distinct discourse path where, because people are worried about the overall negative effects of technology on the environment, they may need to use less technology-based solutions and focus more on environmental sustainability.

Determining the precise placement of each interviewee within these paths is not always possible; however, the majority can be categorized based on their preferences, expectations, and perceived significance of various factors that emerge during qualitative data collection methods, such as interviews. These categories, though not conveying powerful directives, represent the perspectives individuals tend to favor.

7.2. Tension points: Preference for Sustainability vs. Expectation of Technological Dominance

The findings of this research indicate a significant mismatch between stakeholder preferences and expectations. While sustainability-oriented futures (particularly Scenario D: Smart and Sustainable) were the most preferred options, most stakeholders expected Istanbul's mobility future to evolve towards Scenario B (Smart but Not Sustainable). This divergence reflects broader debates in the literature on urban transitions and smart cities, where technological innovation is often prioritized over social equity and environmental sustainability (Cardullo & Kitchin, 2019b; Hollands, 2008; Shelton et al., 2015).

The expectation for a Smart but Not Sustainable future (Scenario B) emerges as a result of both stakeholder perceptions and deeper structural constraints reinforced by both the empirical findings of this research and the literature. While stakeholder interviews express individual preferences, the dominance of Scenario B as an expected scenario to happen in 2050 is driven by entrenched regime lock-ins, asymmetric power structures, the presence of influential technological alliances, and external pull factors in Istanbul's mobility governance.

From the literature, regime lock-ins refer to the stabilization of socio-technical configurations, where dominant infrastructures, vested interests, and cultural norms limit the possibility of systemic shifts (Geels, 2011). In Istanbul, lock-ins are visible in fragmented governance structures (Canitez, 2019), entrenched car-dependent urban design (IMM, 2022), and the dominance of technocratic planning culture. Even though landscape pressures such as climate change and digitalization are

acknowledged (Geels, 2011; Hickman & Banister, 2014), structural inertia constrains transformative change. Stakeholders (Interviewees 4, 6, 8, 10) consistently favored technological upgrades (ITS, digital platforms) over systemic mobility transitions, echoing tendencies in other global cities (Cowley et al., 2018).

Power dynamics, as visualized through the power-interest matrix developed in this dissertation (Table 5.1), reveal a highly asymmetrical governance structure in Istanbul's urban mobility system. High-power, high-interest actors—such as metropolitan authorities (IMM), the Ministry of Transport, private digital mobility firms, and national agencies—dominate decision-making processes and consistently align around a technocentric vision of urban futures. These actors stand to gain materially and politically from the expansion of digital mobility infrastructures, international visibility through smart city branding, and increased access to external funding streams (Interviewees 1, 4, 6, 10). This reflects how smart city governance frequently operates through corporate storytelling, framing technological progress as inevitable and universally beneficial, while obscuring the deeper socio-environmental complexities of urban transitions (Söderström et al., 2018). In contrast, low-power but high-interest stakeholders—such as NGOs, urban commons advocates, academic institutions, and user groups—promote alternative narratives focused on social equity, accessibility, and decarbonization (Interviewees 18, 19). However, they remain largely marginalized within dominant mobility governance structures, echoing findings from transition studies on incumbent resistance, where entrenched actors perpetuate existing regimes through control over resources, narratives, and decision-making forums (Shove & Walker, 2007; Klauser et al., 2014).

The presence of local tech alliances further strengthens the techno-managerial trajectory. In Istanbul, private technology developers and local mobility start-ups actively lobby for smart mobility projects (Interviewees 1, 2), creating coalitions with municipalities and international vendors. These alliances contribute to a self-reinforcing system where technological solutions are prioritized due to their political appeal, economic returns, and alignment with global smart city branding (Kitchin, 2014).

Financial pull factors also accelerate the drift towards Scenario B. The availability of international funding for smart mobility, EU-supported pilot projects, and the relative ease of deploying technological fixes compared to implementing socially transformative policies creates an ecosystem where decision-makers prefer incremental technical improvements (Interviewees 3, 4, 7). The literature confirms these tendencies, with studies indicating how urban innovation policies are

often shaped by funding availability and institutional capacities rather than sustainability imperatives (Mora et al., 2019).

These findings are consistent with broader international experiences regarding smart city developments. In North America, particularly in the United States, smart city initiatives have been critiqued for being heavily market-driven, with a strong reliance on corporate technology partnerships, leading to concerns over surveillance capitalism and exacerbation of urban inequalities (Greenfield, 2013; Shelton et al., 2015). Similar critiques exist in Asia, where cities like Singapore and Seoul are known for technocratic, top-down smart governance models that prioritize efficiency and control but provide limited space for citizen participation or social justice agendas (Chourabi et al., 2012; Lee et al., 2020). In contrast, certain European cities, especially in the Netherlands and Scandinavia, have made more deliberate efforts to integrate participatory processes and sustainability goals within smart city frameworks, although risks of depoliticization and dominant market logics persist (Karvonen et al., 2019; Joss et al., 2019).

In summary, Scenario B is an expected to occur because of structurally reinforced through regime lock-ins, the interests of dominant actors, coalitions of local tech allies, financial pull factors, and asymmetric power dynamics that marginalize alternative pathways as also observed in the literature (Cowley et al., 2018; Söderström et al., 2018; Klauser et al., 2014). In Istanbul, the presence of local tech alliances, such as consultancy networks, smart infrastructure providers, and startup ecosystems, further consolidates the preference for Scenario B. These coalitions promote scalable, market-friendly solutions that align with existing governance structures and financial pipelines but frequently sideline transformative urban agendas. This intersection of institutional, economic, and discursive power structures explains the systemic bias towards a Smart but Not Sustainable future pathway.

7.3. Transition and Transformation Dynamics

The transition to sustainable urban mobility in Istanbul reflects a deeply embedded socio-technical challenge that goes beyond infrastructure upgrades or the deployment of smart technologies. Empirical findings from this study reveal a fragmented governance landscape involving high-power institutions (e.g., IMM, Ministry of Transport), operational agencies (e.g., IETT, BELBIM), civil society organizations, academic institutions, private companies, and marginalized groups (e.g., taxi drivers, minibus operators, elderly users). This fragmentation aligns with socio-technical transition

theories, which emphasize how transitions are shaped by power asymmetries, institutional path-dependencies, and cultural norms (Smith et al., 2005; Geels, 2011).

Drawing on the Multi-Level Perspective (MLP), the research identifies strong landscape pressures—including climate change, digitalization, and demographic shifts (Geels, 2011; Hickman & Banister, 2014). Despite these pressures, the findings reveal that Istanbul remains locked into a dominant regime shaped by car-dependence, fragmented governance, and technocratic planning (Canitez, 2019; IMM, 2022), where emergent niche innovations such as shared mobility and active transport are constrained by institutional inertia (Hickman & Banister, 2014).

The power-interest asymmetry is a defining feature of Istanbul's governance landscape. Low-power but high-interest stakeholders (e.g., NGOs, academic institutions, user advocacy groups) possess critical insight into the social, ecological, and ethical dimensions of transition but remain largely excluded from formal decision-making (Interviewees 18, 19). On the other hand, many high-power actors lack alignment with long-term sustainability goals (Interviewees 4, 6, 10). This power-knowledge misalignment raises the risk of greenwashing where superficial technological adoption masks continued environmental and social injustice (Söderström et al., 2018).

Also, stakeholders highlighted several distributional risks. Minibus and taxi drivers face potential economic displacement if transitions are not accompanied by targeted support—e.g., training, access to credit, and vehicle electrification incentives (Interviewees 10, 14). Similarly, the digital divide—where elderly, low-income, or less tech-savvy users are excluded from app-based systems—risks reinforcing mobility inequality (Interviwees 11, 16). The emphasis on digital mobility services must be tempered by universal design principles and inclusive access options to prevent exclusion.

Tensions over the nature of transformation also emerged around the respective roles of the private and public sectors. While technological advances like AI-enabled traffic systems and platform-based services were acknowledged for their efficiency potential, stakeholders cautioned against technological solutionism and opaque data governance. Concerns over algorithmic bias, data privacy, and corporate monopolization highlight the need for transparent, citizen-centered mobility ecosystems grounded in democratic oversight.

Cultural and behavioral dynamics compound these challenges. Car-dependency in Istanbul is not just infrastructural but also symbolic, associated with freedom, status, and modernity (Canitez, 2020).

Interviewees emphasized that cultural change must accompany physical and digital infrastructure investments. Long-term public awareness campaigns, participatory design processes, and the creation of walkable, human-scaled urban environments are critical to foster modal shift.

From a Transition Management perspective, Istanbul's case underscores the need for inclusive, multi-stakeholder platforms that allow for co-creation, experimentation, and iterative learning. Scenario planning, adaptive policy tools, and shared visioning can build coalitions that bridge institutional divides and empower underrepresented actors. Moreover, just transition frameworks must be adopted to ensure that transition costs—whether financial, social, or emotional—are not disproportionately borne by vulnerable groups. This includes policies on retraining, social protection, and progressive pricing (e.g., sliding-scale congestion charges) (Rotmans et al, 2001).

7.4. Governance Issues

Governance has emerged as a significant challenge for Istanbul's pursuit of sustainable urban mobility. Governance encompasses not only the establishment of institutions but also the distribution of authority, coordination of actions, and balancing of diverse stakeholders' interests (Geels, 2011). Empirical research from Istanbul indicates that fragmentation, power disparities, bureaucratic planning, and inadequate avenues for stakeholder engagement complicate the governance of mobility in a manner that benefits all parties involved.

The stakeholder mapping in Chapter 5 illustrates a highly fragmented governance landscape characterized by numerous entities, such as the Istanbul Metropolitan Municipality (IMM), the Ministry of Transport and Infrastructure, the Istanbul Electric Tram and Tunnel Company (IETT), and the Transport Coordination Center (TCC). Many authorities operate concurrently but do not consistently collaborate well. The problem is not the multiplicity of actors, but the absence of a well delineated hierarchy and coordination framework that specifies roles, responsibilities, and authority within each organization. This results in duplications, contradictions, and delays in the implementation of mobility projects.

This study revealed a conflict between central and local authorities about the governance of mobility in Istanbul. IMM is legally required to formulate and execute urban transport strategy, however the government makes many significant decisions, particularly with substantial investments and infrastructure. The TCC has accountability to IMM and the Ministry of Interior, which can cause power disputes. Canitez's (2020) research on Turkish metropolitan governance indicates that

centralized authority impedes the autonomy and responsiveness of local governments. Interviewees indicated that the restricted discretionary power of municipal institutions hindered the planning and implementation of the Sustainable Urban Mobility Plan.

Institutional frictions illustrate broader themes in sustainability transitions literature, specifically regarding regime resistance and path dependency. As Geels (2011) argues, socio-technical regimes are stabilized not only by infrastructure but also by institutional norms, vested interests, and governance structures. The ongoing dominance of car-centric planning in Istanbul, despite the adoption of sustainable mobility discourse, reflects a system entrenched in historical practices and influenced by powerful stakeholders resistant to change. High-power stakeholders, including IMM, TCC, and taxi/minibus associations, frequently emphasize operational efficiency or economic interests at the expense of environmental or social objectives, leading to a selective application of sustainability-oriented strategies.

The power-interest analysis of the stakeholders and actors (Table 5.1.) in Chapter 5 further illustrates the asymmetrical distribution of power. Civil society actors, including environmental NGOs, academic experts, and citizen advocacy groups, often possess high levels of interest yet they are often excluded from decision-making. This dynamic reflects what Avelino and Wittmayer (2016) call “transformative power asymmetries,” where niche actors pushing for change are marginalized by dominant regime actors that control resources and narratives. Despite the promise of participatory governance frameworks, such as those suggested in the SUMP, the findings show that consultation mechanisms remain ad hoc, lacking consistent influence on policy formulation.

Interview findings also revealed a spectrum of governance preferences among stakeholders. Some, such as experts and national government representatives, advocated for centralized governance models focused on strategic planning and standardization (IDs 1, 2, 5, 6). Others—particularly civil society, local government officials, and urban consultants—favored bottom-up approaches emphasizing local empowerment and participatory processes (IDs 4, 8, 9, 18, 19). A third group proposed hybrid models that integrate central oversight with local implementation and civil involvement, reflecting a desire for multilevel collaboration (IDs 1, 3, 7). These preferences indicate a persistent tension in Istanbul between uniformity and flexibility, and highlight the need for context-sensitive governance design.

A further challenge in governance pertains to the utilization of technology in the planning of Istanbul's urban transportation. In recent years, the prevalence of intelligent transport systems (ITS),

digital ticketing platforms, and various "smart" mobility tools has increased significantly. There are significant issues regarding the governance of these technologies. Some individuals expressed concerns regarding the alignment of these projects with broader objectives related to transportation and land use planning. One participant noted, "each unit develops its own digital tools, but there is a lack of central coordination" (Interview 6), while another remarked, "ISBAK implements ITS projects without consideration for urban planning priorities" (Interview 12). Such observations indicate that individuals perceive technology as being utilized within distinct institutions rather than through a comprehensive planning process that includes all stakeholders. This trend parallels previous critiques of "smart city" initiatives that prioritize efficiency and innovation while neglecting democratic discourse and inclusivity (Hollands, 2008; Söderström et al., 2014).

Some private sector actors acknowledged the importance of sustainability but focused primarily on profitability and innovation (IDs 10, 13), creating occasional misalignments with broader public goals. In contrast, civil society and user groups (IDs 15, 16, 19) emphasized accessibility and equity. These competing priorities echo critiques of smart governance where economic logics override inclusive planning (Karvonen et al., 2019).

The absence of formal mechanisms for collaborative governance significantly impedes the formulation of inclusive and adaptable policy. According to Ansell and Gash (2008), effective collaboration necessitates continuous communication, mutual trust, and collective accountability. These elements are not well established in Istanbul. Several interviewees indicated that attempts had been made to engage civil society and academia; nonetheless, they frequently characterized these efforts as "symbolic" or "tokenistic" (Interview 4; Interview 9), asserting that they lacked any substantive influence on decision-making or continuity. Consequently, mobility planning continues to neglect the needs and perspectives of many user groups in their daily activities.

The importance of participatory governance was frequently highlighted by user representatives and civil society organizations (IDs 11, 12, 15, 16, 18, 19), who emphasized the value of responsive local governance. However, several experts (IDs 2, 3, 7, 9) raised concerns about the administrative and financial burdens of extensive participation, underscoring the challenge of balancing inclusivity with implementation efficiency (Fung, 2006).

Another tension lies in the governance of Public-Private Partnerships (PPPs). While many stakeholders recognized the potential of PPPs to harness private sector capabilities (IDs 1, 3, 4, 6, 10, 13), concerns were expressed regarding public accountability, equity, and transparency (IDs 8, 17,

19). Civil society actors in particular warned against excessive private sector influence in core service delivery. These concerns align with broader debates about PPP governance and democratic control in urban development (Swyngedouw, 2005).

Interviewees indicated a deficiency in feedback and transparency overall. Respondents indicated that strategic documents such as the SUMP are primarily created to comply with regulations rather than to facilitate implementation (Interviews 3 and 7). Although evaluation mechanisms exist, such as performance monitoring and reporting, they are often seen as formalities lacking direct influence on policy revision or implementation**.** The governance issues—decentralization of power, conflicts between central and municipal authorities, and insufficient public engagement—impede Istanbul's ability to implement long-term, sustainable modifications to its transportation system. Addressing these issues requires more than improved infrastructure or advanced technology. It is essential to fundamentally rethink the mechanisms of power, collaboration among individuals, and avenues for participation, as emphasized in the transition literature.

7.5. Synthesis

As I reflect on the above discussions surrounding Istanbul's urban mobility, a clear and somewhat contentious picture emerges: while stakeholders overwhelmingly prefer futures centered on sustainability, inclusivity, and equity (particularly Scenarios C and D), their expectations are oriented toward a future shaped primarily by technological dominance with limited sustainability outcomes (Scenario B). This divergence, as I have come to understand, does not arise from ideological opposition to sustainability, but from a widespread belief that existing governance structures and institutional dynamics are unlikely to support transformative change required for reaching Scenarios C and D.

My analysis reveals three interconnected insights that illuminate this complex landscape:

- First, the discourse analysis in Section 7.1 demonstrates that stakeholder narratives cluster around distinct paths—some rooted in ecological values and equity, others combining technological optimism with sustainability goals, and a smaller group prioritizing digital innovation over environmental concerns. These discursive positions are not just rhetorical; they reflect deeper institutional identities, interests, and worldviews, shaping how stakeholders envision and justify urban mobility futures. The

diversity of these narratives highlights the contested nature of transition pathways and the difficulty of forging consensus across sectors.

- Second, Section 7.2 illuminates a central tension between stakeholders' normative preferences and their expectations for how Istanbul's mobility system will evolve. While sustainable and inclusive scenarios are broadly desired, many interviewees perceive them as politically and institutionally unlikely. Instead, they anticipate technocentric, incremental change driven by dominant actors and legacy infrastructures. This reflects broader patterns of regime resistance and path dependency, where niche innovations—such as shared mobility or pedestrian-oriented design—struggle to scale in the face of structural constraints. Stakeholders' low expectations do not stem from a lack of ambition but from realistic assessments of limited policy coherence, weak participatory mechanisms, and centralized control over funding and infrastructure.

- Third, governance challenges identified in Section 7.3 exacerbate this divergence. Istanbul's mobility governance is marked by institutional fragmentation, overlapping mandates, and limited coordination between central and local authorities. While tools like the Sustainable Urban Mobility Plan (SUMP) exist, they are often used for compliance rather than meaningful planning. The stakeholder mapping and power-interest analysis reveal that influential actors—such as the IMM, TCC, and certain associations—drive strategic agendas, while civil society and marginalized user groups remain underrepresented. Efforts to include wider stakeholder input tend to be ad hoc or symbolic, weakening accountability and public trust. Additionally, the growing emphasis on smart technologies has not been matched by inclusive governance or integrated planning, further reinforcing technocratic tendencies.

In sum, Istanbul's mobility future, as I perceive after this lengthy investigation, is shaped by the convergence of discursive pluralism, institutional lock-ins, and power asymmetries. Stakeholders aspire to a sustainable, inclusive mobility system, but they expect a future dominated by technology and centralized decision-making. This misalignment highlights the limitations of current governance and planning approaches. Bridging the gap between preferred and expected futures will require not only investment in infrastructure or technology, but a fundamental rethinking of governance models—one that empowers diverse actors, fosters participatory processes, and aligns innovation with long-term sustainability goals.

8. CONCLUSION & FURTHER RESEARCH

This dissertation embarked on an investigation into the intricate interplay between technological innovation and societal transformation in shaping sustainable urban futures, specifically through the lens of urban mobility in Istanbul. The core objective was to understand how different stakeholders perceive Istanbul's mobility futures (Business as Usual, Smart, Sustainable, Smart & Sustainable) and what governance models and socio-technical strategies are deemed effective for enabling transitions to desired futures.

A central and compelling finding of this research is the near unanimous prioritization of sustainability among stakeholders. The overwhelming preference for Scenario D (Smart and Sustainable) and Scenario C (Sustainable but not Smart), alongside a near-total rejection of Scenario B (Smart but not Sustainable), clearly demonstrates that technological advancement is insufficient without a fundamental commitment to environmental stewardship and social equity. This preference, however, stands in contrast to the prevailing expectation that Scenario B (Smart but not Sustainable) or even Scenario A (Business as Usual) is more likely to occur. This significant discrepancy highlights that while stakeholders aspire to a greener, more human-centered mobility system, they are strongly aware that current political, economic, and social realities—often driven by technological trends—may steer Istanbul towards less desirable, car-centric and potentially unsustainable outcomes.

The analysis of the transition process further illuminated this gap. Istanbul's journey toward sustainable urban mobility is not a straightforward technological upgrade but a complex socio-technical transformation. The stakeholder mapping revealed a diverse network of actors with varying levels of power, interest, and capacity. High-power, high-interest entities, such as the automotive industry and rentier circles, often act as systemic rigidities, sustaining car-dependent infrastructure and market-driven solutions. This aligns with the Multi-Level Perspective, where the existing socio-technical regime resists pressures from niche innovations and broader landscape changes, leading to a risk of "greenwashing" where superficial technological adoption masks a lack of substantive change. The research revealed the danger of unequal distribution of benefits and burdens, with vulnerable, low-power but high-interest groups like informal transport operators and digitally disadvantaged populations facing potential economic displacement and exclusion if "just transition" principles are not actively embedded in policy design. The tension between private sector innovation and public

accountability, along with deeply ingrained car-centric cultural and behavioral norms, further complicates this transition.

The study's exploration of discourse paths offers a crucial lens for understanding these dynamics. The emergence of "technologically optimistic and pro-environment," "technologically pessimistic and pro-environment," and "technologically optimistic and pro-market" discourses among stakeholders reveals the underlying frameworks through which individuals interpret and articulate their preferences and expectations for Istanbul's mobility future. The dominance of a "technologically optimistic and pro-market" discourse in expected scenarios, despite the preference for "environmentalist" outcomes, underscores the pervasive influence of market-driven approaches and highlights the challenge of aligning diverse worldviews. These varied discourses demonstrate how different actors conceptualize the role of technology (as a solution or a potential threat) and their primary objectives (environmental sustainability or economic gain), ultimately shaping their engagement with, and perception of, the urban mobility transition.

The relative prominence of keywords in interviewee discussions, categorized by STEEP (Social, Technological, Economic, Environmental, Political) dimensions, further reveals these underlying priorities. Political factors emerged as the most frequently discussed theme, underscoring stakeholders' deep concern with power distribution, institutional functionality, and the capacity for effective governance. Technological themes followed as the second most prevalent, reflecting a broad consensus on technology's potential to either facilitate or hinder future mobility shifts. Interestingly, despite the strong preference for environmentally favorable scenarios, environmental issues received minimal explicit attention in the discussions. This suggests a potential inconsistency between expressed scenario preferences and the actual subject of discussion, highlighting a need for stronger integration of environmental discourse within practical policy conversations. Social and economic dimensions were discussed with roughly similar, though secondary, frequency, indicating a balanced but less dominant emphasis compared to political and technological considerations.

Regarding governance, a spectrum of viewpoints emerged, yet a strong preference towards more balanced and participatory models was evident. While some stakeholders favored centralized, top-down approaches for efficiency, a significant majority advocated for decentralized, bottom-up governance that empowers local authorities and fosters community involvement. Concerns were widely expressed about the transparency and accountability of Public-Private Partnerships (PPPs), emphasizing the need to safeguard public interests against potential corporate dominance. The importance of integrating sustainability and inclusion into governance frameworks was consistently

highlighted, with civil society organizations and user groups advocating for democratic financing, planning processes, and systems that prioritize marginalized communities. This highlights a desire for governance structures that are not only efficient but also equitable, responsive, and legitimate.

In essence, Istanbul's urban mobility future is fundamentally a contentious isuue. While there is a shared vision for a sustainable and human-centered city, achieving this requires confronting powerful vested interests, navigating complex governance fragmentation, bridging digital and social divides, and fostering profound cultural shifts. The success of this transition depends on actively empowering marginalized voices, building cross-sectoral collaborations, and ensuring that policy decisions prioritize long-term equity and environmental well-being over short-term gains or purely technocratic solutions.

Further research should investigate the persistent mismatch between stakeholders' preferred futures—centered on sustainability and equity—and their expectations of a more technocentric, car-oriented trajectory. Investigating the political, institutional, and economic constraints that hinder transformative change could reveal the mechanisms reinforcing path dependency and vested interests. Longitudinal studies can track how stakeholder narratives evolve in response to external shocks (e.g., economic crises, climate events) or internal reforms, shedding light on the stability of discourse coalitions over time. Comparative research across rapidly urbanizing megacities such as Jakarta, São Paulo, or Lagos could generate valuable insights into shared governance challenges and offer transferable policy lessons for Istanbul. Finally, interdisciplinary approache like spatial justice frameworks could better capture the lived experiences of diverse user groups and enrich future planning processes with bottom-up knowledge.

Ultimately, this thesis finds that sustainable urban mobility is not simply a technical or logistical challenge—it is a deeply political, social, and cultural one. In the case of Istanbul, aligning stakeholder preferences with actual governance trajectories requires not only technical skill but also political will, institutional reform, and cultural imagination. The findings of this dissertation aim to contribute to this critical conversation, offering both analytical clarity and practical insights for urban policymakers, planners, and engaged citizens striving for a more sustainable, inclusive, and resilient urban future.

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APPENDICES

APPENDIX A: SUMP ISTANBUL SCENARIOS

Dimensions / Criteria / Filters /		SCENARIO - 1 Business as Usual	SCENARIO - 2 Sprawl City	SCENARIO - 3 Efficient City	SCENARIO - 4 Resilient-Green City	SCENARIO - 5 Inclusive City
Economy	Economic Trends	Lower prosperity, increased gaps in the regional development in the country, lower household income	Higher prosperity, rebalanced economic development of regions in the country, the rich-poor gap has narrowed, higher household income	Lower prosperity, increased gaps in the country's regional development, lower household income	Higher prosperity, rebalanced economic development of regions in the country, higher household income	Higher prosperity, rebalanced economic development of regions in the country, higher household income
	Production and Consumption	Globalised economy, operating global brands, with localised distribution and supply chains	Globalised economy, operating global brands, with localised distribution and supply chains	Community organised small-scale production and distribution	Community organised small-scale production and distribution	Community organised small-scale production and distribution
Governance		Top-down decision-making, central government plays an important role and has a strong decision-making power over the local municipalities	Top-down decision-making, central government plays an important role and has a strong decision-making power over the local municipalities	Bottom-up decision-making, local authorities gain more power and funding, decentralised governance solutions are preferred	Bottom-up decision-making, local authorities gain more power and funding, decentralised governance solutions are preferred	Bottom-up decision-making, local authorities gain more power and funding, decentralised governance solutions are dominant
Funding		Low ad hoc funding, focus on PPP investments and public money spent on guarantees given to private sector, limited external funding availability	Higher, substantial external funding availability but focusing on specific inititatives (large infrastructure projects)	Limited and targeted towards sustainable policies	High and targeted towards sustainable policies	Higher and better targeted funding with a special focus on zero-carbon, small scale horticulture, local production/ consumption, etc.
Land Use		Polycentric development, employment is confined within existing business and industrial areas, sprawl towards city's forests and water catchment areas, the car-dominant urban model persists, freeways to connect them, parking supply follows demand with no optimal enforcement	Polycentric development, urban sprawl continues, the car-dominant urban model persists, toll roads to connect them, parking supply matches demand with more off-street provisions and better enforcement	More efficient polycentric urban form, compact city, city of short distances, connected neighbourhoods, local centres, decentralisation, supply of parking is limited in order to reduce road congestion, parking price reflects scarcity of parking spaces	More efficient polycentric urban form, compact city, city of short distances, connected neighbourhoods, neighbourhood-centric planning, local centres, decentralisation, supply of parking is limited in order to reduce road congestion, parking price reflects scarcity of parking spaces, low-carbon zones are defined, increased amount of green and public spaces	Compact and polycentric city, city of short distances, connected neighbourhoods, cars are banned in central areas, parking will only be available off-street, car-parks replaced by urban farms or public spaces
Population		Population continues to grow unchecked	Population continues to grow unchecked	People tend to live, play and work in the same locality, government is incentivising population shifts to second- and third-tier cities	People tend to live, play and work in the same locality, government is incentivising population shifts to second- and third-tier cities	Population rebalanced/redistributed and some people move to live and work to other centres and cities
Mobility Trends and Transport Issues	Accessibility	Low level of accessibility	Low level of accessibility	Increased accessibility for all	Increased accessibility for all	Increased accessibility for all
	Mobility Demand	Increased transport demand, traffic congestion, long commutes to centres, increased commuter jams, transport poverty, low-level of public transport as affordable housing in main employment areas is limited	Increased transport demand, high level of car ownership and use, increased commuter jams, emphasis on road, traffic management and parking investments	Reduced transport demand, efficient use of transport infrastructure, making the poor a priority	Reduced transport demand, high car ownership but less car use	Reduced mobility needs, slow city
	Mobility Choice	PT and car mainly, car culture, low awareness of active travel, traditional PT integration, socially acceptable pricing for PT, PT persists but suffers through lack of investment	Low importance of active modes, car culture, shared mobility, mobility management, higher price for better services for PT, innovative mobility alternatives (MaaS, shared mobility and e-mobility)	Emphasis on active modes and place making, innovative mobility alternatives (shared mobility, e-mobility), advanced PT integration, socially acceptable pricing for PT, PT persists but suffers through lack of investment	Emphasis on PT and active modes and place making, active travel culture, innovative mobility alternatives (shared mobility, e-mobility), higher and socially adjusted price for better service	Almost completely car-free, emphasis on active transport modes, advanced and high quality shared mobility supported by the local government
Social Trends	Social Inclusion	Low level of social inclusion	Low level of social inclusion	High level of social inclusion due to active travel culture and PT focus	High level of social inclusion due to active travel culture and PT focus	High level of social inclusion
	Awareness	Low level of public and political awareness of sustainability	Low level of public and political awareness of sustainability	High level of awareness regarding sustainability issues	High level of awareness regarding sustainability issues	High level of awareness regarding sustainability issues
	Inequalities	Inequalities persist, decision makers have no vision for inequalities, civil society is less diverse and vibrant, less protest and political violence	Inequalities persist, decision makers have no vision for inequalities, civil society is less diverse and vibrant, less protest and political violence	Steps taken to reduce inequalities, decision makers have a vision for inequalities	Steps taken to reduce inequalities, decision makers have a vision for inequalities	Reduced inequalities through accommodating different needs of all, under-represented groups
Energy		Traditional energy sources, fossil fuels still dominate, petrol lobby continues to be powerful	Combination of traditional and alternative energy sources with more focus on the first, fossil fuels still dominate	Combination of traditional and alternative energy sources with more focus on the latter, investments focused on reducing energy demand and increasing efficiency	Focus on alternative, clean energy resources, fossil fuel use is becoming a thing of the past	Focus on alternative, clean energy resources, fossil fuel use is becoming a thing of the past
Technology Uptake		Low level of technology uptake	Higher level of technology uptake, but it is single-focused, negative disruption	Lower and ad hoc, private led technology uptake, technological developments focus on efficiency	High but better controlled technology uptake, decentralised innovation, positive disruption, smart technologies everywhere and helps to integrate diverse systems	High but better controlled technology uptake, decentralised innovation, positive disruption, smart technologies everywhere and helps to integrate diverse systems
Resilience to External Factors		Low level of resilience to external factors such as pandemics, climate change and earthquake, decision makers have no vision regarding climate change	Low level of resilience for climate change, high level of resilience for pandemics (more use of private transport means)	High level of resilience due to focus on active travel and shared mobility, climate action emphasises mitigation	High level of resilience due to focus on active travel and shared mobility, climate action emphasises mitigation	High level of resilience due to focus on active travel and shared mobility, climate action emphasises mitigation

APPENDIX B: DETAILED SCENARIOS

Table B.1. Detailed scenarios

Dimension	*Trends*	*Descriptions*	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***	*Scenario 2 -* ***Smart but NOT Sustainable***	*Scenario 3 -* ***Sustainable but NOT Smart***	*Scenario 4 -* ***Smart and Sustainable***
Social	Accessibility	Capacity to access spatially distributed opportunities (desired goods, services, activities, and destinations) regardless of age, gender, disability, economic or social status.	Low level of accessibility	Low level of accessibility	Increased accessibility for all	Increased accessibility for all
Mobility Demand		The amount (e.g. how often to travel - number of trips, what route to take - travelled distance) of travel that people would undertake in specific conditions which can be affected by a variety of factors, such as availability, quality, and cost of alternatives. Source: Victoria Transport Policy, I. Transportation Demand: Evaluating the Amount and Type of Travel People Would Choose Under Specific Conditions. 2015; Available from: https://www.vtpi.org/tdm/tdm132.htm	•Increased mobility demand •Travelling long distances for work and education as affordable housing in main employment areas is limited •Traffic congestion, long commutes to centres, increased commuter jams	•Increased mobility demand •High level of car ownership and use •Increased commuter jams •Emphasis on new technology investments on road, traffic management and parking infrastructure	•Reduced mobility demand •Efficient use of transport infrastructure	•Reduced mobility needs •Slow city

			Dimension
Socio-political acceptance	Awareness	Mobility Choice	***Trends***
The acceptance of a technology or innovative mobility alternative (e.g. e-mobility) by key stakeholders, the public and policy makers Source: Wolsink, M. (2010). Contested environmental policy infrastructure: Socio-political acceptance of renewable energy, water, and waste facilities. Environmental Impact Assessment Review, 30(5), 302-311.	Level of stakeholders' awareness of sustainability	Mobility choices done between different transport modes (ex. active mobility vs. motorized transport, private vehicle vs. public transportation, innovative mobility alternatives like (Mobility as a Service [MaaS], shared mobility, e-mobility) vs. existing modes of transport)	***Descriptions***
•Low level of socio-political acceptance •Low level of awareness, regulatory legal framework, and government standards causes the dependence of conventional energy sources	•Low level of public and political awareness of sustainability	•Focus on private transport: high car dependency and car has an importance showing a status symbol •Public transport with traditional integration and socially acceptable pricing for public transport but suffers through lack of investment •Low awareness of active travel	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
•Low level of socio-political acceptance •Resistance to ride sharing platforms by different stakeholders such as taxi owners, operators, and drivers	•Low level of public and political awareness of sustainability	• Focus on private transport: high level of car ownership and use •Low importance of active modes •Innovative mobility alternatives (MaaS, shared mobility and e-mobility)	*Scenario 2 -* ***Smart but NOT Sustainable***
•High level of socio-political acceptance due to public and political awareness of sustainability	•High level of awareness regarding sustainability issues; however, it is not integrated to digital enablers / technological tools	•Focus on active modes •Changing behaviour towards private car ownership. Average age at which people obtain their driver's license increases	*Scenario 3 -* ***Sustainable but NOT Smart***
•Low level of socio-political acceptance •Although there is high level of awareness regarding sustainability issues, aging population with high digital divide and show some resistance to innovative mobility alternatives	•High level of awareness regarding sustainability issues with high integration of technological tools	•Focus on active modes •Almost completely car-free, changing behaviour towards private car ownership •Advanced and high-quality shared mobility supported by the local government	*Scenario 4 -* ***Smart and Sustainable***

				Dimension
Social inclusion	Population	Digital divide	Inequalities	***Trends***
The process of improving the terms on which individuals and groups take part in society—improving the ability, opportunity, and dignity of those disadvantaged based on their identity. Source: Worldbank, n.d. https://www.worldbank.org/en/topi	The change in the number (i.e. distribution and balance of population growth) due to different factors (e.g. migration) and in the attributes of people (i.e. demographic composition) of living in the city	The gap between demographics and regions that have access to modern information and communications technology (ICT), and those that don't or have restricted access - demographic, economic, and social inequalities regarding	Unequal distribution of travel between social groups in all forms of transport including distribution of transport related resources like car ownership, access to public transport. Source: https://inequalityintransport.org.uk	***Descriptions***
•Low level of social inclusion	•Population continues to grow unchecked •Young population	Low digital divide	•Inequalities persist •Decision makers have no vision for inequalities	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
•Low level of social inclusion	•Population continues to grow unchecked •Young population	High digital divide	•Inequalities persist •Decision makers have no vision for inequalities	*Scenario 2 -* ***Smart but NOT Sustainable***
•High level of social inclusion	•Government is incentivising population shifts to second- and third-tier cities •Aging population	Low digital divide	•Steps taken to reduce inequalities •Decision makers have a vision for inequalities	*Scenario 3 -* ***Sustainable but NOT Smart***
•High level of social inclusion	•Population rebalanced/redistributed and some people move to live and work to other centres and cities •Aging population	High digital divide	•Reduced inequalities through accommodating different needs of all under-represented groups	*Scenario 4 -* ***Smart and Sustainable***

Economic		*Technological*		***Dimension***
Production and Consumption Patterns	Economic Development Level	Data Management	Technology Uptake	***Trends***
The nature of production and consumption patterns (e.g. community organized small-scale production and distribution vs. globalized economy, operating global brands with localised distribution and supply chains)	Prosperity level, household income level and economic development balance between different regions in the country	Data from different partners and formats leading to disruption of collaboration and data sharing problems	The level of technology uptake in mobility (e.g. electrification of mobility, autonomous driving, smart-city technology adoption, seamless and connected/integrated multi-modal mobility)	***Descriptions***
•Globalised economy, operating global brands, with localised distribution and supply chains	•Lower prosperity •Increased gaps in the regional development in the country •Lower household income	•Low level of data sharing and standardisation problems	•Low level of technology uptake •High rate of motorized private and public transport with no new mobility concepts	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
•Globalised economy, operating global brands, with localised distribution and supply chains	•Higher prosperity •Rebalanced economic development of regions in the country •The rich-poor gap has narrowed, higher household income	•High level of data sharing and standardisation problems	•Higher level of technology uptake, but it is single-focused, negative disruption •Autonomous driving in public transportation •Interactive digital networks strengthen connected / integrated	*Scenario 2 -* ***Smart but NOT Sustainable***
•Community organised small-scale production and distribution	•Lower prosperity •Increased gaps in the country's regional development •Lower household income	•Low level of data sharing and standardisation problems	•Lower and ad hoc, private led technology uptake •Technological developments focus on efficiency •No autonomous driving	*Scenario 3 -* ***Sustainable but NOT Smart***
•Community organised small-scale production and distribution	•Higher prosperity •Rebalanced economic development of regions in the country •Higher household income	•High level of data sharing and standardisation problems	•High but better controlled technology uptake •Streamlined innovation, positive disruption, smart technology is everywhere and helps to integrate diverse systems	*Scenario 4 -* ***Smart and Sustainable***

				Dimension
Market Orientation	Uptake of Shared Mobility Business Models	Job creation and employment opportunities	Funding requirement	***Trends***
Key economic relations and actors (e.g. state, metropolitan government corporations, citizens, co-operatives)	Proportion of travel using modes offered through new business models (e.g. Collaborative consumption, sharing economy) (sharing economy vs. possession economy)	Employment opportunities created by the sharing economy with changing work arrangements (ex. part-time employment, flexible work arrangements, work-on-demand)	•Funding requirement level •Key financing (private investment, public investment, public-private-partnerships, etc.)	***Descriptions***
Profit oriented corporations, State, metropolitan government	Weak uptake	•Weak growth of new employment opportunities	•Lowest funding requirement •Key financing from public-private-partnerships	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
Profit oriented multi-national and national corporations	Strong uptake	•Strong growth of new employment opportunities	•Higher funding requirement •Large infrastructure projects' initial start-up costs being financed from mainly private investments	*Scenario 2 -* ***Smart but NOT Sustainable***
Social welfare-oriented local government; co-operatives	Weak uptake	•Weak growth of new employment opportunities	•Low funding requirement •Targeted towards sustainable policies •Community support finance for local projects	*Scenario 3 -* ***Sustainable but NOT Smart***
Social welfare-oriented entrepreneurs	Strong uptake	•Strong growth of new employment opportunities	•Highest funding requirement •Better targeted with a special focus on zero-carbon, small scale horticulture, local production/consumption, etc. •Venture capital	*Scenario 4 -* ***Smart and Sustainable***

Environmental				***Dimension***
GHG Emission	Resilience	Local Environmental	Land Use Pattern	***Trends***
Greenhouse gas emissions depending on the travel mode (i.e. low emission modes such active travel, EVs with a high share of renewable energy vs high emission modes such diesel engines in personal cars) and the amount of travel.	The level of resilience to external factors (e.g. pandemics, climate change and earthquake)	The level of local air pollution (PM, NOx, etc.) and noise	The location and level of spatial accumulation of activities such as retailing, management, manufacturing, or residence generating flows supported by transport systems. Source: Rodrigue, J. P. (2020). The geography of transport systems. Routledge	***Descriptions***
•Very high level of GHG emission •Traditional energy sources, fossil fuels still dominate, petrol lobby continues to be powerful	Low level of resilience to external factors such as pandemics, climate change and earthquake, decision makers have no vision regarding climate change	Very high level of air pollution and noise	•Polycentric development employment is confined within existing business and industrial areas, sprawl towards city's forests and water catchment areas, the car-dominant urban model persists, freeways to connect them, parking supply follows demand with no optimal enforcement	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
•High level of GHG emission •Combination of traditional and alternative energy sources but fossil fuels still dominate •Due to urban sprawl, longer travelling distances	Low level of resilience for climate change, high level of resilience for pandemics (more use of private transport means)	High level of air pollution and noise	Polycentric development, urban sprawl continues, the car-dominant urban model persists, toll roads to connect them, parking supply matches demand with more off-street provisions and better enforcement	*Scenario 2 -* ***Smart but NOT Sustainable***
•Low level of GHG emission •Despite the focus on active travel modes, there is still private car ownership	High level of resilience due to focus on active travel and shared mobility, climate action emphasises mitigation	Low level of air pollution and noise	Compact and polycentric city, city of short distances, connected neighbourhoods, cars are banned in central areas, parking will only be available off-street, car-parks replaced by urban farms or public spaces	*Scenario 3 -* ***Sustainable but NOT Smart***
•Low level of GHG emission due to reduced mobility needs and active travel modes focus	High level of resilience due to focus on active travel and shared mobility, climate action emphasises mitigation	Low level of air pollution and noise	Compact and polycentric city, city of short distances, connected neighbourhoods, cars are banned in central areas, parking will only be available off-street, carparks replaced by urban farms or public spaces	*Scenario 4 -* ***Smart and Sustainable***

Political			***Dimension***
Transparency and corruption	Political implementation effort	Governance (Decision Making)	***Trends***
Public abuse for private gains effecting the functioning of public services (e.g. misuse of funds) and legislative transparency	Time and resources needed for the effective implementation of the governance mechanisms (e.g. higher time and effort in participatory mechanisms)	The nature of governance (e.g. participatory vs closed decision making, bottom up vs. top-down mechanisms, level of stakeholder participation in decision making)	***Descriptions***
•Low level of transparency and high level of corruption leading to less confidence in public institutions •Budgets are inefficiently spent	•Low political implementation effort	•Top-down decision-making •Central government plays an important role and has a strong decision-making power over the local municipalities	*Scenario 1 -* ***Business as Usual Neither Smart nor Sustainable***
•Legislative transparency is improved but still there is corruption •Environmental and social awareness are ignored •There are problems with the management of the long-term	•Low political implementation effort	•Top-down decision-making •Central government plays an important role and has a strong decision-making power over the local municipalities	*Scenario 2 -* ***Smart but NOT Sustainable***
•High level of transparency and low level of corruption •Rather than the media needs of the politicians, the needs of the citizens are paid more attention in the investments	•High political implementation effort •Time-consuming and costly	•Bottom-up decision-making •Local authorities gain more power and funding •Decentralised governance solutions are preferred	*Scenario 3 -* ***Sustainable but NOT Smart***
•High level of transparency and low level of corruption •Whistle-blowers are protected, and all citizens can safely report wrongdoing safely	•High political implementation effort for smart and inclusive governance oriented large projects •Longer and complicated procedures, time-consuming and costly •Joint working is needed between different sectors, especially transport and land-use	•Bottom-up decision-making •Local authorities gain more power and funding •Decentralised governance solutions are dominant	*Scenario 4 -* ***Smart and Sustainable***

APPENDIX C: SCENARIO CARDS

Senaryo A

Otomobil öncelikli kent modeli var.
Şehir kentin çeperlerine yayılmış, iş ve eğitim imkanları ise şehrin merkezinde toplanmış durumda.
İnsanlar şehrin çeperlerinden özel arabaları ile işlerine ve okullarına gidiyorlar.
Toplu taşıma yeterli değil, teşvik edici fiyatlandırma sistemi yok.
Bireysel araba kullanımı yüksek.
Bisiklet yolları yok, kaldırımlar yetersiz.
Araba sahibi olmak toplumda prestij meselesi sayılıyor.
Kent ulaşım altyapısı otonom araçlara uygun değil.
Trafik sorunu bir ölçüde yeni inşa edilmiş otoyol, tünel ve köprüler ile rahatlamış durumda ama hala trafikte oldukça uzun zaman harcanıyor.
Yer altı ve yer üstü çok sayıda yeni otopark alanları inşa edilmiş durumda.

Erişilebilirlik	Düşük
Nüfus yapısı	Genç Nüfus
Finansman gerekliliği / Maliyet	En Düşük
İş ve istihdam olanakları	Zayıf
Piyasa yapısı	Şirket ve kamu kurumları dengeli
Sera gazı emisyonları	En yüksek





Senaryo B

🚗 Otomobil öncelikli kent modeli var.
🏙️ Şehrin kentin çeperlerine yayılarak büyümesiyle seyahat talebi artıyor.
🔋 Elektrikli bireysel araba kullanımı yüksek.
🚌 Toplu taşımada optimizasyon gibi akıllı mobilite çözümlerinin kullanıldığı iyileşmeler olmasına rağmen hala yetersiz.
🛴 Paylaşımlı hareketlilik, e-hareketlilik, mikro mobilite vb. hareket alternatifleri dijital altyapı kullanılarak yapılıyor.
🚲 Elektrikli bisiklet ve scooter kullanımı yaygın.
💻 Teknolojiye erişim ve kullanım konusunda eşitsizlikler var.
🛡️ Yüksek düzeyde veri paylaşımı, gizlilik ve standardizasyon sorunları yer alıyor.
🅿️ Yer altı ve yer üstü çok sayıda yeni otopark alanları inşa edilmiş durumda.

Erişilebilirlik		Düşük
Nüfus yapısı		Genç Nüfus
Finansman gerekliliği / Maliyet		Yüksek
İş ve istihdam olanakları		Güçlü
Piyasa yapısı		Güçlü Şirket, Zayıf Kamu
Sera gazı emisyonları		Yüksek





Senaryo C

Kısa mesafelerle bağlantılı mahallelerden oluşan çok merkezli kentsel form var.
Yürümek, bisiklete binmek gibi aktif ulaşım türleri ağırlıklı olarak kullanılıyor.
Karbon vergilendirmesi nedeniyle fosil yakıt kullanılan ulaşım biçimleri pahalı.
Merkezi bölgelerde/mahalle merkezlerinde otomobil kullanımı sınırlandırılmış durumda.
Toplu taşıma kullanımı yüksek düzeyde.
Kısıtlı miktarda yerel şirketler tarafından geliştirilen araç paylaşım platformları kullanılıyor.
Çevresel sürdürülebilirlik konusunda farkındalık yüksek düzeyde.
Otonom araçların kullanımı, gerçek zamanlı trafik yönetim sistemleri ve hizmet olarak mobilite platformları gibi yüksek düzeyde teknoloji kullanımı desteklenmiyor.
Otopark alanları sınırlı ve ücretleri yüksek.

Erişilebilirlik	Yüksek
Nüfus yapısı	Yaşlanan Nüfus
Finansman gerekliliği / Maliyet	Düşük
İş ve istihdam olanakları	Zayıf
Piyasa yapısı	Güçlü Kamu, Zayıf Şirket
Sera gazı emisyonları	Düşük





Senaryo D

Kısa mesafelerle bağlantılı mahallelerden oluşan çok merkezli kentsel form var.
Yürümek, bisiklete binmek gibi aktif ulaşım türleri ağırlıklı olarak kullanılıyor.
Karbon vergilendirmesi nedeniyle fosil yakıt kullanılan ulaşım biçimleri pahalı.
Toplu taşımada yüksek kapasite artırımı olmasına rağmen yine de artan talebe ayak uydurulamıyor.
Akıllı telefon ve çeşitli uygulamalarla devlet tarafından herkese tahsis edilen kişisel karbon bütçesine uymak zorunlu.
Paylaşımlı hareketlilik, e-hareketlilik, mikro mobilite vb. hareket alternatifleri dijital altyapı kullanılarak yapılıyor.
Çevresel sürdürülebilirlik konusunda farkındalık yüksek düzeyde.
Teknolojiye erişim ve kullanım konusunda eşitsizlikler kısmen devam ediyor.
Veri paylaşımı, gizlilik ve standardizasyon sorunları kısmen devam ediyor.
Otopark alanları sınırlı ve ücretleri yüksek.

Erişilebilirlik	Yüksek
Nüfus yapısı	Yaşlanan Nüfus
Finansman gerekliliği / Maliyet	En Yüksek
İş ve istihdam olanakları	Güçlü
Piyasa yapısı	Güçlü Kamu, Zayıf Şirket
Sera gazı emisyonları	Düşük





APPENDIX D: INTERVIEW QUESTIONS

I. Kendini tanıtma

Merhaba, ben Begüm Aydın. Boğaziçi Üniversitesi Çevre bilimleri Enstitüsü'nde doktor adayıyım. Bu görüşmenin amacı, 2050 yılında İstanbul için hareketlilik senaryolarına ilişkin tercihlerinizi ve bakış açılarınızı anlamak.

II. Senaryoların sunumu

Senaryolarla ilgili sorunuz var mı?

III. Senaryo tercihi

1) Senaryolardan en çok hangisini tercih edersiniz? Neden? Hangi kriterlere göre değerlendirdiniz? (Her şeyin gerçekleşebileceğini varsayarak tercih ediniz)
2) Bu senaryonun hangi paydaşları (kimleri) daha fazla etkileyeceğini düşünüyorsunuz? Nasıl etkileyecektir?
3) En çok tercih ettiğiniz senaryo dışında diğer senaryolar arasında da tercih sıralaması yapar mısınız? (İki senaryoyu aynı oranda tercih edebilirsiniz.)
4) En çok tercih ettiğiniz senaryoda değiştirmek istediğiniz bir şey var mı? Nasıl olmasını istersiniz? Neden?

IV. Senaryoların gerçekleşme beklentisi

5) Peki bu senaryolardan en çok hangisinin gerçekleşeceğini düşünüyorsunuz? Neden?
6) **"Tercih ettiğiniz" ve "gerçekleşme beklentisinin en yüksek olduğu" senaryolar farklıysa** – neden tercih ettiğiniz senaryonun gerçekleşmeyeceğini düşünüyorsunuz? Tercih ettiğiniz senaryonun gerçekleşmemesinin önündeki en önemli neden nedir?
7) Diğer senaryoların gerçekleşme olasılığı neden daha düşük?

V. Yönetişim tercihi

8) Tercih ettiğiniz senaryoda yönetim (gücü?) kimde olmalı?
9) Tercih ettiğiniz senaryoya nasıl bir yönetim modeli ile gidilebilir? Karar verme süreçlerinin yukarıdan aşağı (merkezi yönetimin yerel yönetimler üzerinde güçlü karar verme yetkisinin olmasını) mı yoksa aşağıdan yukarı (yerel yönetimlerin yetkisinin yüksek olduğu, merkezi olmayan/dağıtılmış yönetim çözümlerinin) olmasını mı tercih edersiniz?
10) Devlet müdahalesinin gerekli olduğunu düşünüyor musunuz? Neden? Evet ise ne kadar gerekli? (Minimum, orta, önemli veya kapsamlı) Nasıl bir müdahalenin daha etkili olacağını düşünüyorsunuz? (Örnek müdahale tarzları: düzenleyici, teşvike dayalı, işbirlikçi, planlama, komuta ve kontrol)
11) Katılımcılığın yüksek olduğu aşağıdan yukarı karar verme süreçlerinin daha çok zaman istemesi ve maliyetlerinin daha yüksek olması tercihinizi etkiler mi?
12) Farklı paydaşların (örneğin devlet, özel sektör, sivil toplum, akademi) nasıl bir rol oynaması gerektiğini düşünüyorsunuz?

Opsiyonel

13) Bu paydaşlar arasındaki iş birliğinin en etkili şekilde nasıl olacağını düşünüyorsunuz?

14) Kamu-özel ortaklıklarının özellikle avantajlı veya zorlayıcı olacağına inandığınız belirli alanlar var mı?
15) Ne tür düzenleyici yaklaşımları tercih edersiniz?
    - Standartlar ve uyumluluk (örneğin emisyon standartları, güvenlik düzenlemeleri)
    - Teşvik Temelli Yaklaşımlar (örneğin mali teşvikler- istenilen davranışları veya yatırımları teşvik etmek için sübvansiyonlar, vergi indirimleri veya hibeler, piyasa mekanizmaları-emisyonları düzenlemek için karbon fiyatlandırması veya emisyon üst sınırı ve ticareti sistemleri gibi piyasaya dayalı araçları kullanılması, trafiği ve emisyonları azaltmak amacıyla sıkışık alanlarda araç kullanmaya ilişkin mali ücretler)

VI. Son Eklemeler

İstanbul'da hareketliliğin geleceği veya yönetişimi hakkında eklemek istediğiniz başka bir şey var mı?

VII. Teşekkür

Değerli zamanınızı ayırdığınız ve değerli görüşlerinizi paylaştığınız için teşekkür ederim.