

UNIVERSIDAD POLITÉCNICA DE MADRID
Escuela Técnica Superior de Ingenieros de Caminos, Canales y Puertos



**An adaptive scenario-building approach
to address disruptive futures
in land use and transport planning**

DOCTORAL THESIS

Submitted for the degree of Doctor by:

María Amor Ariza Álvarez

Ingeniera de Caminos, Canales y Puertos

Madrid, 2024



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Doctoral Degree in Civil Engineering Systems

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Under the supervision of:

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Madrid, 2024

Title: An adaptive scenario-building approach to address disruptive futures in land use and transport planning

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Agradecimientos

La realización de esta tesis ha sido posible gracias al apoyo y la colaboración de muchas personas, a quienes me gustaría expresar mi más sincero agradecimiento.

En primer lugar, quiero agradecer a mis directores de tesis, el Dr. Julio Soria y la Dra. Rosa Arce, por el enorme privilegio de contar con su apoyo en todo momento. Julio, gracias por confiar tanto en mí y por las innumerables horas que me has dedicado en estos años. Tu orientación, incansable dedicación e infinita paciencia han sido pilares fundamentales para el desarrollo de este trabajo y para inspirar en mí el cariño hacia esta bonita y desafiante profesión. Rosa, gracias por tus valiosos consejos y por brindarme la oportunidad de realizar esta investigación bajo tu supervisión. Siempre recordaré la manera en la que ambos habéis sabido equilibrar la exigencia académica con vuestra cercanía humana, haciendo de este proceso una experiencia mucho más gratificante.

Agradezco a la Universidad Politécnica de Madrid, al Departamento de Ingeniería del Transporte, Territorio y Urbanismo y, en especial, al Centro de Investigación del Transporte (TRANSyT) y a todas las personas que lo componen por proporcionarme el apoyo, los recursos y el ambiente necesarios para esta investigación. Quisiera recalcar que esta tesis se ha desarrollado principalmente en el marco del proyecto TRANS-URBAN (Plan Estatal de Investigación Científica y Técnica y de Innovación, CSO2017-86914-C2-2-P). También ha sido posible, en parte, gracias al apoyo de los proyectos SPROUT (Comisión Europea, Programa H2020, 814910), DESPACIO (Plan Estatal de Investigación Científica y Técnica y de Innovación, TRA2017-88058-R) e iCITIES (Comunidad de Madrid, M190020074JASL). Mi gratitud también va al Centro de Investigación del Territorio, Transporte y Medioambiente (Citta) de la Universidad de Oporto, y en especial al Dr. Álvaro Costa, por acogerme durante mi estancia investigadora y permitir que esta tesis se beneficiara de un enfoque internacional.

Quiero expresar mi más profundo agradecimiento a mis compañeros de la unidad docente de urbanismo. Cristina, Ramón, Juan gracias por acogerme tan bien desde el primer día y por vuestra generosidad y comprensión, que han sido esenciales para mí en estos años. Me gustaría dedicarle unas palabras especiales a María Eugenia. Desde el primer momento, tu confianza en mí, tu apoyo constante y las numerosas oportunidades que me has brindado han sido fundamentales en mi desarrollo

profesional y personal. Trabajar contigo es una verdadera suerte. A mis compañeros de la “torre”: Miguel, Raúl, Alberto, Manu, gracias por vuestra ayuda constante, por las charlas, las risas y los momentos compartidos en equipo que han hecho de esta etapa algo inolvidable. A Belén, siempre atenta y dispuesta a ayudar. A Aldo, a quien le debo en gran parte mis inicios en la investigación. A todos los miembros y colaboradores del proyecto TRANS-URBAN, en especial a los compañeros de la Universidad de Alcalá: Fran, Montse, Ramón, Niko, gracias por vuestro esfuerzo y dedicación. A todos vosotros, gracias de corazón por ser parte de este camino.

Por supuesto, quiero dar las gracias a toda mi familia. A mis padres y a mi hermano, gracias por estar siempre ahí, dispuestos a escuchar y dar vuestro mejor consejo. Vuestra fe en mí y vuestro apoyo emocional han sido la base sobre la que he construido mis sueños. Espero que, en estos años, pese a la distancia, me hayáis sentido tan cerca como yo os he sentido a vosotros. A Miguel, gracias por cuidarme tanto, por tu comprensión y apoyo incondicional, especialmente en los momentos en los que la tesis ha acaparado gran parte de mi atención. Tu paciencia y tu capacidad para hacerme sonreír en los días más difíciles han sido mi refugio y mi fuerza. No hay palabras suficientes para expresar lo agradecida que estoy por tenerte a mi lado.

Y, finalmente, no quiero olvidarme de mí misma. Gracias por no rendirte nunca. Por cada desafío superado, por cada lágrima y cada risa. Sigue creyendo en ti, sigue persiguiendo tus sueños con la misma determinación y coraje. Esta tesis es sólo el comienzo de muchas más aventuras y logros por venir.

Madrid, junio 2024

Abstract

Scenario-building approaches, which focus on the exploration and development of different possible futures, have proven to be valuable tools in contexts characterized by substantial uncertainty within urban and transport planning fields. Academic literature has extensively delved into the advancement of various methodological and conceptual innovations related to scenario-building. While an increasing number of studies have focused on participatory approaches to scrutinize long-term future scenarios, research gaps persist in this area. To date, there is a dearth of studies that delve into disruptive scenarios, deviating from conventionally predictable or desired trajectories. The potential of disruptive scenario narratives to achieve a more-effective integration of land use and transport has been insufficiently explored, while significant challenges still lie in bridging such scenario narratives with spatial and local realities. Additionally, there is a lack of emphasis on leveraging disruptive scenarios for activating adaptive policymaking mechanisms. This PhD dissertation seeks to furnish innovative methodological solutions and theoretical frameworks with the objective of improving the effectiveness of participatory scenario-building when addressing these challenges.

The PhD dissertation, taking the Henares Corridor (Madrid, Spain) as case study, comprises four interconnected scientific contributions. First, a participatory scenario-building process is designed based on using semi-structured interviews incorporating wild cards (low-probability high-impact events). This innovative approach has proven effective in generating seven 2050 scenario narratives (one desired and six wild card-based) through a participatory process with 129 inhabitants of the Henares Corridor. Secondly, focusing on the integration of land use and transport, it is developed a framework to discern the interactions among actors utilizing disruptive scenario narratives. This framework, validated through three experimental workshops with experts and local stakeholders, effectively identifies interaction layers (global, individual, and internal) that support land use and transport integration. Thirdly, a framework is developed to explore how scenario mapping processes influences the formulation of disruptive scenario narrative. For the three experimental workshops, the framework contributes to the understanding that participatory mapping can complement, expand and modify scenario narratives, by linking them to local and spatial realities. Finally, an adaptive approach is

conceptualised based on using disruptive scenarios as intermediate tipping points. Scenarios are assessed by experts as experimental tipping points, suggesting adaptive policy responses. Overall, this doctoral thesis provides innovative tools and theoretical frameworks that enhance participatory scenario-building, offering practical and adaptive solutions for urban and transport planning.

Resumen

Los enfoques de construcción de escenarios, centrados en la exploración de distintos futuros posibles, se han consolidado como herramientas valiosas en contextos de alta incertidumbre, como es la planificación urbana y del transporte. La literatura académica ha profundizado extensamente en el avance de diversas innovaciones metodológicas y conceptuales relacionadas con la construcción de escenarios. Aunque un número creciente de estudios se ha centrado en enfoques participativos para analizar escenarios futuros a largo plazo, persisten lagunas de investigación en esta área. Hasta la fecha, hay una escasez de estudios que exploren en profundidad escenarios disruptivos, que se desvíen de las trayectorias convencionales o deseadas. El potencial de las narrativas de escenarios disruptivos para una integración más efectiva de los usos del suelo y el transporte ha sido insuficientemente explorado. Además, existen desafíos importantes para vincular estas narrativas con realidades espaciales y locales, así como para su utilización en la formulación de políticas adaptativas.

Esta tesis doctoral busca abordar estos desafíos, proporcionando marcos teóricos y soluciones metodológicas innovadoras para mejorar los procesos participativos de construcción de escenarios. Usando el Corredor del Henares (Madrid, España) como caso de estudio, la tesis presenta cuatro contribuciones científicas interconectadas. En primer lugar, se diseña un proceso de construcción participativa de escenarios basado en entrevistas semiestructuradas que incorporan comodines (eventos de baja probabilidad y alto impacto). Este enfoque ha demostrado ser eficaz en la generación de siete narrativas de escenarios para 2050 (uno deseado y seis basados en comodines) a través de la participación de 129 habitantes del Corredor del Henares. En segundo lugar, se desarrolla un marco para discernir las interacciones entre actores utilizando narrativas de escenarios disruptivos, con el objetivo de integrar los usos del suelo y el transporte. Este marco, validado en tres talleres experimentales con expertos y actores locales, identifica capas de interacción (global, individual e interna) que apoyan dicha integración. En tercer lugar, se crea un marco para explorar cómo los procesos de mapeo participativo influyen en la formulación de narrativas de escenarios disruptivos. Utilizado en los tres talleres experimentales, este marco revela que el mapeo participativo puede complementar, expandir y modificar las narrativas de escenarios, vinculándolas con realidades locales y

espaciales. Finalmente, se conceptualiza un enfoque adaptativo que utiliza los escenarios disruptivos como puntos de inflexión intermedios. Evaluados por expertos, estos escenarios sugieren respuestas políticas adaptativas a los desafíos identificados. En conjunto, esta tesis doctoral aporta herramientas y marcos teóricos innovadores que mejoran la construcción participativa de escenarios, proporcionando soluciones prácticas y adaptativas para la planificación urbana y del transporte.

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1

1 INTRODUCTION

This opening chapter introduces the broader context, aims, and framework of the PhD dissertation. Initially, it offers a concise overview of the research issue and primary research objectives, which are further elaborated upon and enhanced in subsequent Chapters 2 and 3. Additionally, this introductory chapter outlines the dissertation's structure and highlights its key scientific contributions.

1.1. Motivation and research aim

In the last few decades, changes have accelerated at an unprecedented pace, posing increased challenges for long-term urban and transport planning and consolidating the idea that a forthcoming, more disruptive future looms ahead (Marchau et al., 2019; Lyons & Marsden, 2021). The escalating effects of climate change, for example, are causing frequent natural disasters that necessitate costly adaptation measures in urban areas (Banister, 2011). On the technology side, optimistic predictions regarding the arrival of autonomous vehicles have proven premature; however, new breakthroughs, such as artificial intelligence, tele-activities, micro-mobility systems, and smart infrastructures are transforming the way citizens use public space in cities (Mouratidis & Papagiannakis, 2021). Profound sociodemographic shifts, such as the exponential increase in urban population, an ageing society, and forced migration flows due to armed conflicts, are placing growing demand on resources and public services. Most dramatically, the COVID-19 pandemic, has prompted a drastic shift in the way we approach and prioritize health in cities (Giles-Corti et al., 2016; Mouratidis & Papagiannakis, 2021).

The rapid evolution of these contemporary changes, often characterized by short life cycles, poses challenges for cities in terms of assimilation. Moreover, their non-linear behaviours significantly complicate predictability. Therefore, in the present moment, uncertainty is no longer just an occasional and temporary deviation from a reasonable prediction; it has become a structuring aspect of the urban environment. In prevision to the rapid and unpredictable changes, foresight methods have become increasingly indispensable. Among these methods, scenario-building has emerged as

a particularly valuable tool for anticipating and navigating uncertain future developments (Hickman & Banister, 2014). By constructing different narratives of potential futures, scenario-building allows planners and decision-makers to explore a wide range of possibilities and prepare for various contingencies. Participatory scenario-building, in particular, has gained significant attention in recent years. By engaging stakeholders from diverse backgrounds and perspectives, this approach ensures that a broad spectrum of views and concerns are considered in the scenario-building process (Soria-Lara & Banister, 2017; Tuominen et al., 2014).

Moreover, amidst this highly dynamic context, the interconnectedness of land use and transport systems has become increasingly evident (Bertolini, 2017; Banister, 2005). The way land use and transportation networks are planned and designed profoundly influences each other, shaping the quality of life and opportunities of citizens as well as the environmental sustainability of urban areas. Recognizing this interdependence while navigating the uncertain long-term future of cities suppose and important challenge for which current scenario-building methods are not fully equipped.

This PhD dissertation addresses this challenge by providing methodological solutions and theoretical frameworks aimed at adapting participatory scenario-building techniques to confront the dynamic and unpredictable nature of land use and transport systems. Simultaneously, the PhD research adopts an empirical approach, focusing on the Henares Corridor in Madrid, Spain as its case study. This metropolitan area is historically shaped by socio-economic shifts, urban transformations, and a complex network of functional relationships among municipalities. Specifically, the PhD dissertation is structured around three research objectives, each contributing to distinct angles of the overarching goal.

The first research objective lies in enhancing the design of future scenarios within the dynamic and uncertain landscape of contemporary urban and transport planning. Conventional scenario-building exercises, often tethered to business-as-usual¹ (BAU) projections, tends to produce predictable and desired outcomes, potentially overlooking transformative possibilities. In this respect, **the dissertation's first specific research objective is to develop mechanisms for crafting disruptive**

¹ Business-as-usual (BAU) is a concept used for future scenarios where significant changes are not supposed to occur, and societies, technology, and culture evolve along a continuous trajectory from the past to the future.

scenarios that significantly diverge from BAU projections. This objective is addressed in Chapter 4. Through the incorporation of wild cards – low probability, high-impact events – (Barber et al., 2006), the research employs a novel participatory scenario-building process. By breaking free from conventional constraints, this innovative approach offers diverse narratives for the year 2050, encompassing normative (what should happen?) and exploratory (what could happen?) scenarios with varying levels of disruption compared to BAU trends. The obtained scenario narratives emphasize the interplay between land use and transport, unveiling disruptive insights into the evolution of transport systems, land use patterns, mobility dynamics, accessibility issues, and urban activities.

The second research objective focuses on bridging the gap between disruptive scenario narratives and the commonly used spatial language in urban and transport planning contexts. It is inevitable that scenario design exercises, particularly when adopting a qualitative approach, encounter inherent limitations to establish specific communicative mechanisms between planning actors. These exercises often venture into dimensions beyond the urban scale (e.g., climate change, technological advances) or grapple with urban dynamics whose spatial implications are challenging to navigate (e.g., mobility patterns, housing preferences). Under this context, **the second research objective aims to transform disruptive future scenario narratives into spatially relevant instruments for land use and transport planning.**

This second objective is addressed in two different chapters: Chapter 5 and Chapter 6. These chapters employ a participatory mapping process, involving experts and local stakeholders to translate disruptive, exploratory scenario narratives (previously obtained in Chapter 4) into tangible spatial changes in urban land uses and transportation systems. On the one hand, Chapter 5 analyses factors influencing the effectiveness of scenario narratives in triggering interactions between participants and facilitating the integration of land use and transport considerations during the mapping process. On the other hand, Chapter 6 explores whether and how the mapping process can impact the re-formulation of scenario narratives by intricately linking them to local particularities. Globally, these two chapters invite reflection on the transformative potential of participatory scenario mapping as a strategic tool to

enhance the spatial relevance and impact of disruptive scenario narratives in the realms of land use and transport planning.

Finally, the third research objective addresses the instrumental role that scenario-building might play in supporting decision-making processes. The prevailing perspective perceives future scenarios as long-term, desired outcomes achievable through rigid and static policy measures. This has contributed to a lack of attention given to utilizing these scenarios as strategic tools for assisting planners and policymakers in navigating through a spectrum of diverse, uncertain, and potentially disruptive futures. In contrast, this PhD dissertation introduces a new policymaking perspective rooted in the adaptive planning paradigm (Walker et al., 2001). Therefore, **the third research objective is focused on analysing the potential of disruptive scenarios to activate adaptive policymaking mechanisms**. This objective takes central stage in Chapter 7, where an adaptive scenario-building approach is conceptualized, employing disruptive scenarios as intermediate tipping points. The incorporation of these tipping points not only enriches the analytical landscape but also implies a nuanced array of adaptive policy responses. These responses, stemming from the interplay of disruptive future scenarios, signify a departure from the conventional and a strategic recalibration in response to the dynamism inherent in disruptive future scenarios.

1.2. Structure of the dissertation

The PhD dissertation is structured in eight chapters. Chapter 2 details the research background and establishes the main research questions. Chapter 3 describes the methodology and case study. Chapters 4 to 7 address the research objectives and scientific contributions. Chapter 4 examines how incorporating wild cards in scenario-building can create more disruptive narratives. Chapter 5 explores factors influencing the effectiveness of narratives in triggering interactions among participants, aiming to integrate land use and transport. Chapter 6 investigates how participatory mapping can reconfigure narratives by complementing, expanding, and modifying them. Chapter 7 examines the potential for different adaptive policy responses using disruptive scenarios as tipping points. Finally, Chapter 8 summarises the main scientific contributions, discusses the conducted work, and makes some recommendations for practice and future research.

1.3. Scientific contributions

The subsequent scientific contributions were obtained as part of the doctoral project. They have been now re-printed and conforms the main chapters of this PhD dissertation.

- Title: *Participatory visioning for building disruptive future scenarios for transport and land use planning.*
Authors: Soria-Lara, J. A., Ariza-Álvarez, A., Aguilera-Benavente, F., Cascajo, R., Arce-Ruiz, R. M., López, C., & Gómez-Delgado, M.
Journal: *Transport Geography*. Vol 90, 102907
Year: 2021. Journal Impact Factor (2022): 6,1 (Q1).
This paper gathers the information presented in Chapter 4 of this dissertation.
- Title: *Experimenting with scenario-building narratives to integrate land use and transport*
Authors: Ariza-Álvarez, A., Soria-Lara, J. A., Arce-Ruiz, R. M., López-Lambas, M. E., & Jimenez-Espada, M.
Journal: *Transport Policy*. Vol. 101, 57-70
Year: 2021. Journal Impact Factor (2022): 6,8 (Q1)
The information contained in this journal paper corresponds to the content discussed in Chapter 5 of the dissertation.
- Title: *Participatory mapping in exploratory scenario planning: necessity or luxury?*
Authors: Ariza-Álvarez, A., Soria-Lara, J. A.
Journal: *Futures*. Vol. 160, 103398
Year: 2024. Journal Impact Factor (2022): 3,0 (Q2)
The contents of Chapter 6 in this dissertation are summarised in this journal paper.
- Title: *Re-thinking the role of exploratory scenarios for adaptive policymaking: An application for land use and transport planning*
Authors: Ariza-Álvarez, A., Soria-Lara, J. A., & Aguilera-Benavente, F.
Journal: *Futures*. Vol. 149, 103139
Year: 2023. Journal Impact Factor (2022): 3,0 (Q2)
This journal paper compiles the content of Chapter 7 of this dissertation.

2

2 THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

Within this Second Chapter, an examination of the current literature and fundamental concepts relevant to the central themes of this PhD dissertation is presented, establishing its theoretical and conceptual foundations. Section 2.1 and Section 2.2 initially delve into the core concepts of this PhD dissertation: land use and transport integration as well as participatory scenario-building. The subsequent sections (Sections 2.3, 2.4 and 2.5) contribute to identifying research gaps and formulating research questions within the field of study.

2.1. Land use and transport integration

The complex relationship between land uses and transport systems has been a focal point in institutional, professional, and academic agendas over several decades (Bertolini, 2017; Wegener & Fürst, 1999; Banister, 2005; Bertolini et al., 2005; Hull, 2012; Meyer & Miller, 2001; Straatemeier & Bertolini, 2020). Given their interdependent nature and the mutual influence of changes in both domains, it is essential to integrate land use and transport planning strategies, as many authors have argued (Manaugh & El-Geneidy, 2012; Soria-Lara et al., 2016; Van Wee & Handy, 2016). This supportive interconnection has been widely acknowledged as crucial to achieve more sustainable urban developments (Banister, 2005). There is a general consensus that the integration of land use and transport yields substantial benefits to mobility (e.g., improved accessibility to major destinations), while simultaneously mitigating negative consequences (e.g., pollution, congestion) (Bliemer et al., 2016; Curtis et al., 2009; Schwanen et al., 2004).

The so-called land use transport feedback cycle (Meyer & Miller, 2001; Wegener & Fürst, 1999; Bertolini, 2012) is a widely used simplified representation of reality that synthesizes the two-way interaction between land use and transport (Figure 2.1). According to this cycle, the spatial distribution of land uses shapes the location where activities (e.g., residential, occupational, recreational) occur. This distribution of activities, in turn, necessitates the existence of a transportation system that facilitates the movement of individuals and goods between these different activity nodes.

Simultaneously, the configuration of transportation infrastructure, when combined with the land use patterns, generates opportunities for spatial interaction, which can be quantified as accessibility (Wegener & Fürst, 1999). Finally, the quality of accessibility significantly influences the areas where specific land use categories are established, thereby affecting the spatial distribution of activities. This sets off a continuous loop where changes in land use and transport are interlinked and self-reinforced, perpetuating the evolving dynamic of the urban environment (Straatemeier & Bertolini, 2020).

Research aspirations for land use and transport integration have triggered the emergence of wide range of planning concepts in the scientific literature. One of such concepts is the accessibility planning paradigm, focused on developing strategies to improve people's access to significant opportunities (Handy, 2020), predominantly by non-motorized modes of transportation (Banister, 2005; Iacono et al., 2010; Schwanen et al., 2004). Within this paradigm, accessibility-oriented strategies (Deboosere et al., 2018) focus on the elevation of accessibility levels by establishing areas with medium to high-density mixed land use around transit hubs and pedestrian infrastructures (Cervero, 2007; Papa & Bertolini, 2015). The core objective of these strategies is to diminish dependence on automobiles, boost the utilization of public transportation, and promote non-motorized modes by fostering human interaction in public spaces (Curtis et al., 2009). Furthermore, strategies oriented toward creating mobility environments (Bertolini & Dijst, 2003; Soria-Lara et al., 2015; Arranz-López et al., 2017) focus on specific geographical areas where land use and transport are intricately intertwined in ways that foster more sustainable and efficient urban environments.

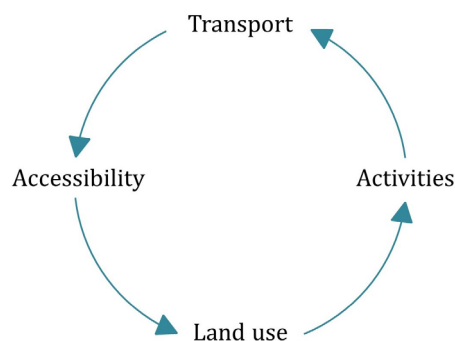


Figure 2.1. Land use and transport feedback cycle

While there is a broad consensus on these theoretical principles among researchers (Anjomani, 2021; Van Wee & Handy, 2016), the understanding of how planning for land use and transport integration could unfold in practice is much more limited (Banister, 2005; Geerlings & Stead, 2003; Hull, 2012; Straatemeier & Bertolini, 2020; Bliemer et al, 2016; Silva et al., 2017). Transport and land use planning seem to operate as distinct domains, each with its own institutions, disciplinary foundations, cultural backgrounds, planning processes, and conceptual frameworks (Straatemeier & Bertolini, 2020). Indeed, one can see many examples of discrepancies between the development of land uses and transport systems. For instance, despite knowledge about the benefits of mixed land use (Cervero, 1996), zoning regulations in urban areas often restrict the co-location of residential, commercial, and industrial spaces. This results in longer travel distances and more traffic congestion. Other example is the persistent issue of low-density urban development's being situated in areas with limited accessibility via public transport. This not only leads to an inefficient use of resources but also perpetuates a culture of car dependency (Banister, 2005; Bruegmann, 2008; Straatemeier & Bertolini, 2020).

Various factors appear to be responsible of this lack of land use and transport integration. For example, institutional barriers represent a critical obstacle that arises from the divergent priorities and interests that persist within urban and transport planning agendas (Stough & Rietveld, 2005; Curtis et al., 2009). Other factors are related to the existence of procedural and conceptual discrepancies between these professional domains, mainly linked to the planning instruments, the information, or the methods used (Te Brömmelstroet & Bertolini, 2008; Boisjoly & El-Geneidy, 2017; Proffit et al., 2019; Hull, 2005).

Aware of these challenges, this PhD dissertation delves into the necessity for shared planning instruments that can facilitate collaboration among transport and land use planners and help them identify more integrated solutions. It emphasizes the importance of addressing this issue from a strategic perspective that consider the inherent uncertainties and complexities of planning processes. In this context, participatory scenario-building is viewed as a forward-looking instrument that could address this need. This PhD dissertation focuses on investigating the potential role of participatory scenario-building in jointly and collaboratively confronting the complex dynamics of land use and transport systems.

2.2. Participatory scenario-building for coping with uncertainty

The design and formulation of future scenarios, commonly referred to as scenario-building, were originated within the expansive realm of futures studies – an interdisciplinary field in social research committed to systematically examining the future (Dator, 2019; Fergnani & Jackson, 2019; Gordon et al., 2020). Central to futures studies is the recognition of uncertainty as an inherent aspect of reality. Consequently, scenario-building rejects the notion of a singular, predetermined, and predictable future, opting instead to embrace the idea of multiple and diverse potential futures (Rowland & Spaniol, 2015; Godet & Durance, 2011). Future scenarios are crafted as internally consistent descriptions of a spectrum of potential future developments and outcomes, enabling the identification of forthcoming challenges and opportunities (Van der Heijden, 2005; Spaniol & Rowland, 2018; van Notten et al., 2003).

Scenarios found early applications in the 1960s, notably within the military through initiatives led by the RAND Corporation (Kahn & Wiener, 1967) and the Royal Dutch Shell (Jefferson, 2012). The emergence of scenario-building approaches during this period was driven by a shift in both public and private organizations, prompted by specific historical moments characterized by instability and uncertainty, such as the 1973 oil crisis (Bradfield et al., 2005; Wilkinson et al., 2013). Traditional forecasting techniques, known for their limitations in accurately predicting the future, were gradually supplanted by foresight techniques (Ramírez & Selin, 2014). The value of exploring alternative future scenarios became evident, providing instrumental in making strategic decisions (Fernández Güell, 2019; Khakee, 1991; Mäntysalo et al., 2023; Ratcliffe & Krawczyk, 2011). Consequently, future scenarios, as a foresight technique, established its own planning paradigm centred on anticipation and contingency in the face of uncertainty – commonly referred to as scenario planning (Bishop et al., 2007). In addition to the actual design of scenarios, scenario planning encompasses the exploration and evaluation of strategies to tackle challenges and leverage opportunities arising from various scenarios (Roberts, 2014; Crawford, 2019; Goodspeed, 2020).

In recent decades, scenario-building has permeated forward-looking initiatives in cities and regions, establishing itself as a strategic tool for navigating the intricate dynamics and uncertainties inherent in the urban landscape (Hickman & Banister,

2014; Soria-Lara & Banister, 2017; Van Drunen et al., 2011; Lyons & Davidson, 2016). The evolution in this field from a traditional focus on forecasting to foresight approaches and scenario-building is highly grounded in a fundamental shift in planning processes from instrumental rationality to communicative rationality (Habermas, 2007). Communicative rationality underscores the significance of dialogue, collaboration, and negotiation among stakeholders as foundational elements on the planning process (Healey, 1993; Willson, 2001). Embracing communicative rationality acknowledges that planning is not a top-down process but rather a collaborative endeavour involving multiple actors, each with their perspectives, interests, and values (Bertolini, 2007, Habermas, 2007, Innes & Booher, 2018).

In this context, participatory scenario-building approaches emerged as a dynamic platform for continuous dialogue and negotiation, fostering the involvement of diverse stakeholders in collaborative exploration of alternative futures (Soria-Lara & Banister, 2017; Tuominen et al., 2014). These approaches have experienced a notable surge in popularity in recent years, marked by an increasing application of participatory scenario-building approaches in the realms of land use and transport (Zimmermann et al., 2012; Wangel, 2011; Hickman et al., 2011; Schade & Schade, 2005; Olsson et al., 2015).

Several participatory scenario-building methods, encompassing both qualitative and quantitative approaches, have been employed to facilitate stakeholder engagement in scenario development. Consequently, the degree and extent of stakeholder involvement exhibit significant variations among different studies. Stakeholders are often engaged in participatory workshops or interviews to glean insights from their experiences, discuss past and current challenges, raise awareness, and delineate future trajectories (Chakraborty, 2011). Through open discussions, stakeholders' interests, values, and tensions emerge and are integrated early on during the initial stages of scenario-building (Soria-Lara & Banister, 2017; Vallet et al., 2020; Wangel, 2011; Tuominen et al., 2014; Banister & Hickman, 2013).

Incorporating stakeholders into scenario development is supported by a compelling array of reasons (Reed et al., 2013; Walz et al., 2007). Firstly, this active involvement aims to integrate a diverse range of viewpoints into the scenario-building process, addressing various needs and concerns and thereby reducing the risk of

marginalizing specific individuals or groups (Reed et al., 2013). Secondly, extensive stakeholder participation frequently brings the exploration of diverse perspectives on potential futures, thereby broadening the spectrum of scenarios (Kok et al., 2007; Reed et al., 2009; 2013). Additionally, involving stakeholders fosters a sense of ownership and commitment to the scenarios developed, enhancing their transparency, acceptance and legitimacy in decision-making processes (Kok et al., 2007; Reed et al., 2013; van Notten et al., 2003).

Building upon this previous knowledge, this PhD dissertation focuses on participatory scenario-building, shedding light on the challenges and opportunities of engaging stakeholders in exploring the future of land uses and transport systems. By employing participatory methods from scenario inception to evaluation and decision-making, this PhD research aims to understand how active engagement and collaboration among diverse stakeholders can enrich the scenario-building process. The goal is to enhance the ability of these methods to anticipate and adapt to the dynamic and unpredictable nature of land use and transport systems.

2.3. Scenario-building: turbulences, bifurcations, and disruptions

The realm of scenario-building contemplates a diverse array of future scenarios, recognizing the nuanced spectrum of likelihood, desirability, and feasibility associated with each scenario. As a result, researchers in the field have consistently engaged in ongoing discussions regarding the “types of futures” (Amara, 1974, 1981; Henchey, 1978; Crawford, 2019; Voros, 2017), reflecting a sustained effort to categorize and comprehend the multifaceted nature of potential future trajectories. Typically, these discussions involve the classification of future scenarios into three distinct categories: probable, preferable, and possible (Börjeson et al., 2006). To visually represent these alternative futures, Figure 2.2 employs the well-established “futures cone” graphical model (Taylor, 1993; Hancock & Bezold, 1994; Voros, 2017). This representation extends from the present on the left into a broader range of alternative futures on the right. The diagram illustrates scenarios as potential futures falling within different regions of the cone.

The segment identified as probable futures, depicted as the narrowest in the diagram (Figure 2.2), encompasses scenarios deemed “likely to happen”. These scenarios typically arise from the continuation of ongoing current trends. Within this realm of

probable futures, certain scenarios are considered more plausible than others, with the one regarded as the most likely often denoted as business-as-usual (BAU). This future scenario represents a straightforward linear extension of the present (Dator, 2019; Godet & Durance, 2011).

The domain of preferred or preferable futures concerns scenarios perceived as future outcomes that "should" or "ought" to occur. Often referred to as desired or normative scenarios, these futures follow a normative foresight approach (Godet & Durance, 2011; Goodspeed, 2020). This approach emphasizes the establishment of specific criteria and values to guide the construction of desirable futures. In the context of strategic urban planning, these scenarios typically emerge during the formulation of the strategic vision. This process involves defining the model of the city that the community desires for the coming years and conceptualizing a desired long-term future to guide the city's spatial, economic, and social development. The primary objective of these scenario exercises is to establish a vision of the future that is as realistic and motivating as possible, fostering consensus and aligning future aspirations. Consequently, desired scenarios often fall within the realm of probable futures, frequently sharing similarities with BAU scenarios.

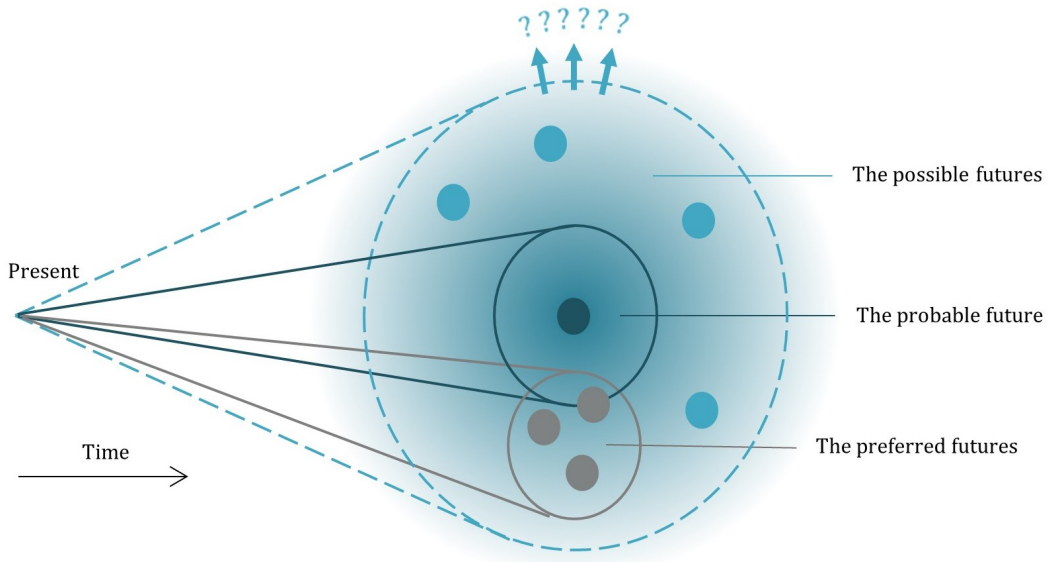


Figure 2.2. The futures cone

The sphere of possible (or potential) futures, depicted as the most extensive in Figure 2.2, covers future scenarios that “might happen”. In addition to incorporating the realm of probable futures, this category is designed to embrace all scenarios that can be conceivably imagined, irrespective of how far-fetched or improbable they may seem. These scenarios adhere to an explorative foresight approach (Crawford, 2019; Roberts, 2014) and are commonly referred to as explorative or exploratory scenarios. They are crafted to address strategic issues characterized by considerable uncertainty (Van der Heijden, 2005), and the desired scenario is typically selected from this spectrum of possible futures.

The rapid pace of contemporary disruptions (e.g., COVID-19 pandemic), swiftly transforming travel patterns and urban environments within a remarkably brief timeframe, is compelling scenario-building to expand beyond the traditional boundaries of probable, preferred, and possible futures (Voros, 2017; Gall et al., 2022). This evolution has given rise to the recognition of scenarios that might initially be perceived as “extremely absurd”, “ridiculous”, “impossible”, or deemed as “never likely” to materialize. This expansion of futures is rooted in the not-so-recent notion that “any useful idea about the future should appear ridiculous” (Dator, 2005), and the science fiction belief that “the only way of finding the limits of the possible is by going beyond them into the impossible” (Clarke, 2013).

This “new” futures region is where some authors situate what they call “black swans” and “wild cards”, concepts widely used in the field of futures studies (Taleb, 2007; Sanhueza-Aros et al., 2022; Voros, 2017; Gall et al., 2022). Black swans are employed as conceptual tools to represent high-impact, low-probability scenarios. Therefore, a black swan scenario is one that is unlikely to occur, but if it were to materialize, it would have a profound and far-reaching impact. Similarly, wild cards are associated with high impacts and low probabilities (Barber et al., 2006; Taylor, 1993). However, wild cards are primarily viewed not as standalone scenarios but as unforeseen events or processes with the potential to dramatically alter the course of future developments (Barber et al., 2006; Gall et al., 2022).

In the realm of urban and regional planning, various participatory attempts have been undertaken to construct scenarios that explore diverse potential futures (Soria-Lara & Banister, 2017; Tuominen et al., 2014; Zimmermann et al., 2012; Wangel, 2011; Hickman et al., 2011; Schade & Schade, 2005; Olsson et al., 2015). However,

prevailing methodologies face challenges in transcending the boundaries of possible or conceivable futures and producing unconventional, disruptive scenarios that significantly diverge from desired or BAU scenarios. There are a couple of key factors responsible for these challenges.

Firstly, individuals involved in scenario-building exercises, particularly esteemed experts and relevant stakeholders, often navigate future possibilities with a tendency to extrapolate developments along predictable trajectories (Hickman & Banister, 2014). Their inclination towards linear thinking is a consequence of years spent refining their skills within established frameworks and disciplinary paradigms, inadvertently narrowing the spectrum of their imaginative vision. Recognizing this limitation, some authors have sought to broaden perspectives by involving younger participants in the scenario-building process, resulting in the emergence of more innovative scenarios (Tuominen et al., 2014; Soria-Lara & Banister, 2017). The heightened ability of younger and non-expert participants to envision disruptive futures has been observed compared to highly experienced professionals, adult, and seniors. Despite these efforts, participants in scenario-building exercises still contend with significant influence from prevailing social and technological trends, posing a persistent challenge to thinking beyond conventional boundaries (Soria-Lara & Banister, 2018).

The other main reason impeding the construction of disruptive future scenarios is related to the type of participatory methods used and their operationalisation. Participatory scenario-building exercises often prioritize achieving consensus among participants, ignoring alternative and divergent modes of thinking (Mason & Alamdari, 2007; Melander et al., 2019; Shiftan et al., 2003; Zimmermann et al., 2012). For instance, Delphi techniques typically construct future scenarios through multiple rounds of questions, where participants are informed about the main agreement reached in past participatory rounds. Similarly, when employing more open participatory methods such as in-depth interviews or workshops, scenarios tend to preserve only frequently shared and common thoughts, limiting the integration of “outside-the-box” thinking (Banister & Hickman, 2013; Hickman & Banister, 2007; Hickman et al., 2009). This poses a significant impediment to the development of scenarios that deviate from conventional and highly predictable BAU trajectories.

Incorporating the low probability and high impact of wild cards into participatory scenario-building processes can effectively dismantle the aforementioned barriers and inspire innovative scenario outcomes. Wild cards have been conventionally employed for multifaceted purposes in the exploration of future scenarios. They are used for exploring unexpected future trends (Barber et al., 2006; Hauptman et al., 2015; Walsh et al., 2015; von der Gracht & Darkow, 2010) as well as for testing the robustness and stability of future scenarios (Steinmuller, 2004; Dammers, 2010). Despite the valuable contributions made by incorporating wild cards into scenario-building, the critical aspect of systematically evaluating the disruptive thinking inherent in each scenario has not received sufficient attention. The unexplored challenge is to measure the disruption introduced by wild cards in future scenarios, representing a crucial avenue for further inquiry in participatory scenario development. Understanding how these low-probability, high-impact elements challenge established norms and stimulate innovative solutions is essential for unlocking the full potential of participatory scenario-building processes.

The identification of this research gap leads directly to the first research question posed in this PhD dissertation. RQ1: *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory scenario-building?* Chapter 4 gains insight into this question.

2.4. Disruptive scenarios and the language of planning

The conceptualization of cities and territories through spatial images is an indispensable element in the realm of spatial planning (Dühr, 2007). This fundamental aspect is deeply integrated in various traditions of spatial planning, exhibiting a prominent presence within European contexts. Spatial planning policy document extensively incorporates visual representations in diverse forms such as icons, diagrams, maps, and other cartographic depictions. These visual representations serve a multifaceted role, functioning not only as essential components within the framework of the planning process but also as powerful tools for effectively communicating and synthesizing key messages inherent in spatial strategies among diverse stakeholders (Dühr, 2007).

Visual representations offer a means of translating complex planning concepts and strategies into accessible and comprehensible formats, facilitating the understanding and engagement of stakeholders with varying levels of expertise and backgrounds. They provide a visual language that transcends linguistic and technical barriers, enabling a shared understanding and discourse among planners, policymakers, communities, and other relevant stakeholders. Moreover, visual representations pay a crucial role in fostering transparency and citizen engagement. By presenting spatial data and planning proposals in visual formats, planners can enhance public participation and involvement in decision-making processes, ultimately contributing to more democratic and inclusive spatial planning outcomes.

As previously discussed in this Chapter, scenario-building stands out as a significant alternative to forecasting methods due to its inherent creativity and adept management of uncertainty. However, it is also recognised as one of the most sophisticated and challenging foresight methods to implement. This is not only due to the unlimited future options it offers, but also due to the generality with which scenarios are described and their frequent lack of quantification.

Typically, scenario-building yields primary outputs in the form of scenario narratives (González-González et al., 2019; Banister & Hickman, 2013; Tuominen et al., 2014; Kok et al., 2006), which utilize simplifications and generalizations to construct coherent and manageable storylines. These narratives primarily concentrate on encapsulating global patterns and trends, spanning areas such as the economy, demography, energy, and technology (Danielis et al., 2022; Dammers, 2010). The process involves a form of artistic expression heavily reliant on imagination and intuition, emphasizing qualitative aspects over quantitative precision. Unfortunately, this level of abstraction tends to neglect specific regional or local dynamics, omitting fine-grained intricacies and context-specific elements, as well as detailed spatial information (Carter et al., 2017).

This omission becomes a significant weakness when scenario-building is intended for use in regional or local planning processes, where decisions often have substantial spatial impacts. Considerations such as land use location or transportation infrastructure developments form part of decision-making, and the lack of detailed, localized spatial information can be a critical drawback. Given these challenges, the compatibility and suitability of scenario narratives with the spatial language of

planning is increasingly being questioned (Bartholomew, 2007; Avin et al., 2022; Chakraborty et al., 2011; Chakraborty & McMillan, 2015; Avin & Goodspeed, 2020).

Therefore, addressing the compatibility challenges between scenario narratives and the spatial language of planning becomes essential for enhancing the practical applicability of scenario-building methods in the realm of spatial planning. This calls for a nuanced approach that considers both the creative and qualitative aspects of scenario narratives and the need for detailed, localized spatial information crucial for effective planning strategies.

To address the aforementioned critique of scenario narratives lacking detailed spatial information, researchers have explored various methods for visually representing scenarios (Tori et al., 2023; Van Berkel et al., 2011; Shaw et al., 2009; Lovett et al., 2015; An & Powe, 2015). Maps are one of the most common mediums (Carter et al., 2017; Duguma et al., 2022). Therefore, numerous examples of scenario-mapping applications populate the literature, covering topics such as land use and land cover changes (Swetnam et al., 2011; Larondelle et al., 2016; Carter et al., 2017; Duguma et al., 2022), urban expansion and population density (Houet et al., 2016), transportation accessibility and the spatial distribution of activities (Fuglsang et al., 2013).

While many studies have traditionally employed quantitative modelling approaches for scenario mapping (Valbuena et al., 2010; Fuglsang et al., 2013), such as GIS methods, agent-based models, and cellular automata models, these approaches often involve complex and intensive data gathering. Consequently, only a limited set of parameters from scenario narratives is considered, and the lack of transparency hampers meaningful engagement with experts and local stakeholders. The resulting maps from these processes frequently lack fine-grained intricacies and context-specific elements crucial to understand local dynamics.

In contrast, some scenario-building processes adopt qualitative mapping techniques approaches based on participatory techniques, such as role-playing games and participatory mapping (Castella et al., 2005; Tolvanen et al., 2019; Rivas-Tavares et al., 2022; Lamarque et al., 2013; Hérivaux et al., 2021). The traditional view of maps as a form of scientific and objective knowledge is increasingly replaced by an understanding of maps as being socially produced and discursively embedded within context of social action and power. By involving both domain-specific experts and

local stakeholders deeply familiar with a local context, these studies enhance the accuracy and relevance of scenario-mapping outcomes, providing a more nuanced and contextually rich understanding of potential future scenarios (Lamarque et al., 2013; Hérivaux et al., 2021). These participatory approaches have proven instrumental in overcoming the limitations associated with spatial and local specificity in scenario-building exercises. However, within this recognized efficacy, two notable research gaps persist.

Firstly, the potential of participatory scenario-mapping to catalyse interaction processes between planning actors with different backgrounds, particularly those involved in land use and transportation planning domains, remains unexplored. There is a discernible lack of empirical investigation into the effectiveness of collaborative mapping in activating effective interaction processes between planning actors that ultimately yields (or not) to the spatial integration of land use and transport planning strategies. This research gap impedes a comprehensive understanding of the factors – both internal and external – that influence planning actors throughout the mapping process and that are crucial when it comes to achieving greater integration of land use and transport issues.

Recognizing this research gap prompts the exploration of the second research question posed in the context of this PhD dissertation. RQ2: *To foster land use and transport integration, which factors influence the effectiveness of disruptive scenarios to trigger interaction processes between planning actors?* This question is addressed in Chapter 5.

Secondly, prevailing studies have often considered the mapping stage as a conclusive step rather than recognizing it as an ongoing and dynamic process for visualizing future scenario narratives (Carter et al., 2017; Duguma et al., 2022; Larondelle et al., 2016). The procedure for arriving at a certain spatial scenario is not always explicitly discussed and maps are mainly treated as an expanded concept of narratives in order to better understand the meaning they communicate. The resultant cartographic outputs are typically regarded as supplementary materials, exerting limited influence on the overall configuration of the scenario narratives. Consequently, insights and feedback generated, especially from participatory mapping exercises, tend to be undervalued, neglecting their potential to significantly enrich the alignment of

scenario narratives with real-life spatial realities. It is imperative to investigate how participatory mapping can transcend its supplementary role and evolve into a dynamic element capable of not only complementing but also expanding and/or reshaping scenario narratives.

The acknowledgement of this deficiency in existing studies motivates the investigation into the third research question presented in this PhD dissertation. RQ3: *To which extent and how can participatory mapping processes contribute to spatially shaping disruptive scenario narratives?* The exploration of this question is a key focus within the Chapter 6.

2.5. Disruptive scenarios and policymaking in challenging times

Addressing the unpredictable and uncertain future of cities and regions demands not only exploring multiple alternative future scenarios but a profound level of flexibility and adaptability from decision-makers and policymakers (Malekpour et al., 2015 Walker et al., 2013). The evolving landscape of urban and regional development necessitates a departure from the conventional “predict-and-act” planning approach, which assumes the ability to anticipate the most likely future scenarios and optimize policies accordingly (van Dorsser et al., 2018). Instead, the paradigm of adaptive planning has given rise to adaptive policymaking approaches, deeply rooted in the field of futures studies.

In contrast to the traditional policymaking approach, adaptive policymaking acknowledges the existence of profound uncertainties and a multitude of potential future scenarios. It recognizes the impracticality of devising a single optimal long-term strategy. The core principle of adaptive policymaking lies in the acknowledgement that policy strategies must be dynamic and capable of evolving in response to changing circumstances over time (Walker et al., 2001). This approach integrates immediate short-term actions with those that actively shape the long-term future, all while maintaining the flexibility needed to adapt to unforeseen changes and disruptions.

Essentially, adaptive policymaking is a forward-thinking strategy that keeps options open and establishes a robust monitoring system to identify trigger points for

contingency actions and adjustments to the initial policy pathways (Walker et al., 2001). By embracing adaptability, policymakers can navigate the complexities and unpredictable futures and proactively respond to emerging challenges. This proactive approach not only enhances resilience but also enables continuous learning and adjustment. As cities and regions grapple with the dynamic and unpredictable forces shaping their future, the concept of adaptive policymaking stands out as an essential tool for decision makers striving to create robust and responsive strategies that can withstand the test of time.

Since the early 2000s, there has been a significant development in the realm of adaptive planning, characterized by the emergence of a family of concepts, analytical frameworks, and tools aimed at addressing the challenges posed by dynamic and uncertain environments (Walker et al., 2001). Notable frameworks from the literature include Adaptation Tipping Points and Adaptation Pathways (Haasnoot et al., 2011; Kwadijk et al., 2010), which focus on identifying critical thresholds and flexible pathways for adaptation in the face of changing conditions. Similarly, the Dynamic Adaptive Policy Pathways approach (Haasnoot et al., 2013) offer a framework to policy development that emphasizes flexibility, learning, and iterative decision-making to navigate complex and uncertain future scenarios.

The utilization of these frameworks has been particularly prominent in various domains, reflecting their versatility and applicability. For instance, they have been adopted in long-term planning for large infrastructure projects (Marchau et al., 2019; Jeuken et al., 2015), in ecology and natural resource management (Allan & Watts, 2018), or climate change adaptation (Quay, 2010). However, despite the availability of a range of adaptive frameworks and successful application in adjacent fields, the adoption of adaptive policymaking approaches in urban and transport planning realms remains slow.

In recent years, certain academic voices have put forth the notion that the sluggish acceptance of adaptive planning can be attributed to the entrenched systems of governance, institutional structures, and organizational setups in which urban and transport planning occurs (Marchau et al., 2019; Bosomworth et al., 2017; Lawrence & Haasnoot, 2017). The resistance to the adoption of adaptive policymaking in these domains is often attributed to the persistent influence of established systems of governance and institutional structures. The rigidity in policymaking methods has

been a recurring challenge, hampering the ability of decision makers to adapt to dynamic and unpredictable urban and transport scenarios (Malekpour et al., 2016). Another notable barrier identified is the prevalence of short-term budgetary policies (Lawrence & Haasnoot, 2017). The emphasis on immediate financial consideration can hinder the allocation of resources for long-term investments in monitoring and adaptability. In such circumstances, policymakers may find it challenging to justify and secure the necessary funding for the implementation of adaptive frameworks, which often require sustained financial commitment over time. Furthermore, as previously discussed in this chapter, decision-making processes in land use and transport realms are typically not integrated, which poses challenges for implementing holistic, interdisciplinary, and adaptive policy solutions.

Consequently, the prevailing approach towards future scenarios in urban and transport planning often perceives them as long-term endpoints, and then looks back to determine the policy pathways needed to reach that future. This conventional approach adheres to a static and precautionary or “just-in-case” policymaking scheme (Höjer et al., 2011; Olsson et al., 2015; Soria-Lara & Banister, 2018; Hickman et al., 2011; Zimmermann et al., 2012). Under this scheme, the policy pathways remain inactive until there is a clear intention to achieve expected outcomes from a predefined future state, typically deemed as the most suitable one, i.e., the “desired” or “strategic” vision (Keseru et al., 2021; Soria-Lara & Banister, 2018; Hickman et al., 2013). In this process, there is an inevitable need to choose between various options, thereby committing to specific courses of action and placing others in the background. The policy pathways, once established, become fixed routes in pursuit of predetermined goals associated with specific future states.

In essence, this traditional constrained and inflexible perspective on future scenarios impedes the dynamic adjustments and evolution of policy pathways in response to changing situations and unforeseen futures. It operates on the assumption that the envisioned future state will unfold exactly as anticipated, neglecting the inherent unpredictability of complex urban and transport systems. This static and just-in-case policymaking scheme stands in stark contrast to the principles of adaptive policymaking, which advocate for ongoing adjustments based on continuous monitoring and learning (Walker et al., 2001; Zapata & Kaza, 2015; Chackraborty et al., 2011; Hallegatte, 2009). Therefore, a research gap exists in using scenarios to

embrace adaptive policymaking schemes, as opposed to static and predetermined pathways, in urban and transport planning.

The recognition of this research gap in existing research sets the stage for delving into the fourth research question posed in the context of this PhD dissertation. RQ4: *To what extent it is possible to obtain different adaptive policy responses using disruptive scenarios as intermediate tipping points, rather than using them as independent long-term future endpoints?* Chapter 7 sheds light into this last question.

3

3 RESEARCH DESIGN AND CASE STUDY

This Third Chapter provides with an overview of the research design employed in this PhD dissertation. Additionally, a significant part of this chapter is based on detailing the Henares Corridor (Madrid, Spain), which serves as case study for this research.

3.1. Overall research design

This PhD dissertation focuses on obtaining both theoretical and methodological findings that adapt participatory scenario-building techniques to the challenge of facing the dynamic and unpredictable nature of land use and transport systems. It is structured into four main research contributions, each based on addressing a specific research question from RQ1 to RQ4, as outlined in Chapter 2. These contributions are presented in dedicated chapters spanning from Chapter 4 to Chapter 7.

It is worthy to mentioning this PhD research has aligned to the fundamental stages of design science research (Straatemeier et al., 2010; Van Aken, 2004, 2005). In contrast to research methods rooted on explanatory science, which predominantly seek to explain or understand phenomena, this PhD research focuses on developing and evaluating innovative artifacts – mainly methodologies and theoretical frameworks – to address identified research gaps and questions. The effectiveness and usefulness of these artifacts in addressing the research questions are assessed through empirical evaluations in the spatial context of the Henares Corridor (Madrid, Spain). It is relevant to note that these contributions are not independent but have been intentionally designed to be interconnected, contributing to the overall coherence of the research (Figure 3.1).

RQ1 *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory scenario-building?*

Chapter 4 addresses the first research question (RQ1) by introducing an innovative participatory scenario-building method. This method employs semi-structured interviews that incorporate wild cards, which are elements representing low-

probability and high-impact events or processes. The purpose of these wild cards is to act as catalysts for disruptive thinking. The overall process involves creating a desired scenario and then gradually distorting it through the introduction of wild cards as "what-if" conditions. The goal is to generate disruptive future scenarios that diverge from the originally envisioned future scenario.

The empirical validation of this method is conducted through a participatory process in the Henares Corridor. For answering to RQ1, two different data sources were generated (Table 3.1). Firstly, semi-structured interviews are designed and conducted among the population of the study area. A total of six wild cards are identified and 129 local participants are individually engaged in these interviews, each of which undergoes a systematic process of transcription and coding for subsequent analysis. This analytical approach facilitates the formulation of seven collective scenario narratives, projecting into the year 2050. One of these narratives represents the desired scenario, while the remaining six are exploratory scenario narratives based on the introduced wild cards. The original content of the semi-structured interviews (in Spanish) can be found in Annex 1. Secondly, an ad-hoc questionnaire is designed to evaluate the level of disruption of the seven 2050 scenario narratives. This questionnaire is answered by a selected group of 21 experts in innovation, strategic decision-making, and creative thinking. The original content of this questionnaire can be found in Annex 2.

RQ2 *To foster land use and transport integration, which factors influence the effectiveness of disruptive scenarios to trigger interaction processes between planning actors?*

Building upon the disruptive scenario narratives generated in Chapter 4, the second research question (RQ2) is tackled through the development of a comprehensive multi-layer framework in Chapter 5. This framework is designed to concentrate on the identification and characterization of interactions among planning actors when utilizing scenario narratives, thereby assessing their impact on land use and transport integration. The framework scrutinizes three distinct groups of factors: (i) the *global environment*, encompassing common conditions that influence all planning actors; (ii) the *individual environment*, which is linked to the specificities and professional backgrounds of planning actors; and (iii) the *internal environment*, referring to inherent factors within both scenario narratives and planning conditions.

The research adopts an experimental approach with three designed academic cases, each serving as a co-creation environment with planning actors under tight control by the research team. To operationalize each academically constructed case, a participatory mapping workshop is conducted. 18 participants, 6 in each workshop, including planning experts and local stakeholders, actively engaged in this process using the disruptive scenario narratives derived from Chapter 4. Participants are tasked with identifying and mapping land use and transport changes in the Henares Corridor based on these scenario narratives. Structured observation techniques, following multiple coding rounds, are employed, facilitating the analysis of the factors that influence the achievement or non-achievement of land use and transport integration.

RQ3 *To which extent and how can participatory mapping processes contribute to spatially shaping disruptive scenario narratives?*

Chapter 6 extends the exploration initiated in Chapter 5 by answering the third research question (RQ3). It starts by establishing a theoretical framework that delineates various situations arising as diverse planning actors engage in the process of mapping scenario narratives. This framework categorizes three types of mapping processes: (i) those that *complement* existing aspects of future narratives; (ii) those that *expand* future narratives, incorporating new aspects and perspectives; (iii) those that *modify* future narratives, resulting in alternative scenario interpretations.





To assess the effectiveness of this framework in answering RQ3, the three participatory workshops developed for Chapter 5 are once again analysed with this new purpose. The workshops are segmented into mapping episodes to be analysed using structured observation techniques. An observation schedule is developed to guide the evaluation process. The primary focus of this schedule is to investigate the extent to which participatory mapping episodes contribute to complementing, expanding, or modifying future narratives. Additionally, it aims to identify any patterns or trends in the interaction processes between workshop participants.

RQ4 *To what extent it is possible to obtain different adaptive policy responses using disruptive scenarios as intermediate tipping points, rather than using them as independent long-term future endpoints?*

Chapter 7 addresses the fourth research question (RQ4) through conceptualising and adaptive scenario-building approach. It transfers traditional concepts from adaptive policymaking to traditional scenario-building methods. This approach proposes to simultaneously use disruptive scenarios as intermediate tipping points, identifying situations in which the adopted policy pathways might fail in achieving strategic goals and conceptualising different potential policy responses. It mainly distinguishes between *preserving* and *transforming* policy responses, depending on whether deviations between policy pathways and disruptive scenarios are non-significant or significant, respectively.

Informed by the findings of preceding chapters, an empirical validation is conducted in Chapter 7, following a participatory method and using the Henares Corridor as a case study. To answer RQ4, a second ad-hoc questionnaire is designed (Table 3.1). Through this questionnaire, the same disruptive scenarios used to answer RQ2 and RQ3 are assessed as experimental tipping points for the policy pathways adopted by regional and local authorities in the study area. This questionnaire is individually answered by a total of 25 experts. Its original content can be found in Annex 3.

Table 3.1. Databases used during the PhD research

	Database	Content	Nº responses / participants	Research questions
	Semi-structured interviews	Recordings and transcripts	129	RQ1 (Chap. 4)
	Questionnaire 1	Individual responses	21	RQ1 (Chap. 4)
	Workshops	Recordings and transcripts	18	RQ2 (Chap. 5) RQ3 (Chap. 6)
	Questionnaire 2	Individual responses	25	RQ4 (Chap. 7)

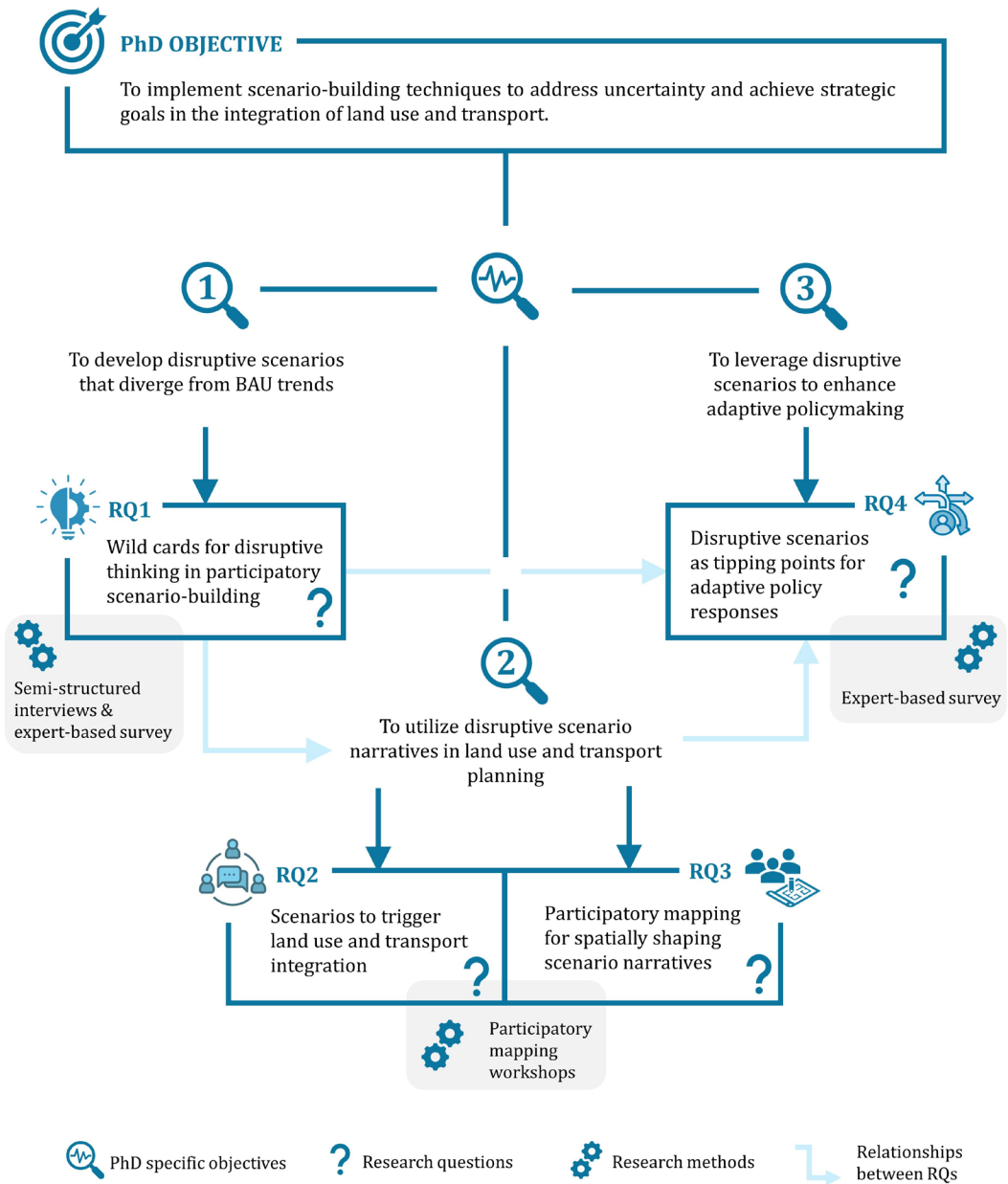


Figure 3.1. PhD dissertation's scheme

3.2. Case study

To empirically address the four described research questions, this PhD dissertation uses the Henares Corridor, located in the metropolitan area of Madrid, Spain, as a case study.

3.2.1. A corridor as case study

The concept of corridor in urban and regional planning has a long and influential history (Whebell, 1969). In the late 19th and early 20th centuries, linear city models emerged as innovative alternatives for the densely populated, radial, and concentric industrial cities of that era. Among the most remarkable of those models is the “Ciudad Lineal”, proposed by Spanish urbanist Arturo Soria y Mata in 1882 (Navascués, 1969; Terán, 1968). This model featured a central avenue approximately 50 metres wide, designed to facilitate transportation through a railway or tram system. The avenue extended the city longitudinally, ensuring continuous and uninterrupted connectivity across all parts of the city. Residential, commercial, public services, and green spaces were evenly distributed on both sides of the avenue, thereby enhancing accessibility and quality of life for residents.

Although not widely implemented, the concepts of linear cities were revolutionary and had a lasting impact on modern planning, especially in Europe (Priemus, 2001; van Duinen, 2013). Since then, many regional plans have advocated for corridors in the form of linear extension of large European cities based on transportation infrastructure. Rather than proposing continuous linear urban developments as in the utopian “Ciudad Lineal”, these plans typically envisioned urban settlement clustered along infrastructure lines (Priemus & Zonneveld, 2003). Notably large-scale examples include the regional plan for Greater Copenhagen in the 1940s, the Dutch Randstad plan in the 1960s, the Rhine-Ruhr region in Germany along latter half of the 20th century, and, more recently, the Spanish Mediterranean Corridor in the 2000s.

Regional corridors represent a complex planning concept, embodying a spectrum of spatial, social, economic, and environmental dimensions (Priemus & Zonneveld, 2003). Primarily, corridors functions as axis of transportation infrastructure, which form the backbone for urbanisation. This infrastructure network directs the development of residential, commercial and industrial activities, thus significantly

influencing the spatial patterns of urban growth. While infrastructure and urbanisation are products of social and economic processes, they also play a critical role in shaping these processes. Areas with high volumes of passenger and freight transport attract businesses, particularly those in distribution and logistics, thereby fostering the development of new urban growth poles. Consequently, corridors should also be considered as axes of economic development, driving regional economic dynamics and spatial organization (van Duinen 2013; Witte et al., 2014; Brand & Drewes, 2021).

The corridor concept is central to the ongoing debate on the sustainability of urbanization patterns and urban spatial structure (Priemus & Zonneveld, 2003; Witte et al., 2014). In the last decades of the 20th century, objections have focused on the fragmentation of natural areas and the destruction of ecological infrastructure caused by corridors. Despite efforts to mitigate these impacts, urbanization has expanded linearly and fragmented extensively, particularly after 1850 when urban densities peaked. To ensure corridor development does not harm natural landscapes, infrastructure networks must be designed to avoid fragmenting and damaging natural areas. Preserving landscape quality, biodiversity, and ecological significance requires prioritizing green and blue networks over traffic routes and urban developments. These environmental implications of corridors significantly contribute to their complexity.

Corridors, as complex hubs of infrastructure, urbanization, and economic development, are ideal subjects for investigation in this PhD research. Their influence on regional spatial and functional dynamics underscores the importance of integrating land use and transport within them for efficient and sustainable development. This aligns with the thesis emphasis on the interface between land use and transport systems as well as on the need for participatory and collaborative methodologies, given the need for coordination among different policy domains and sectors, and meaningful citizen engagement.

In addition of their complexity, it is crucial to emphasize the highly dynamic nature of corridors. Over time, the development of corridors has mirrored technological advancements in transportation modes, beginning with the advent of tram and railway lines and the introduction of electricity, followed by the internal combustion engine and the proliferation of private automobiles. Furthermore, corridors

continually evolve in response to the construction legacy of diverse infrastructure types, including highways, public transit networks, and logistics hubs (Priemus & Zonneveld, 2003). This dynamism is evident not only in technological shifts, but also apparent in the changing residential preferences of households. For example, in some cases the trend of urban sprawl has given way to compact, transit-oriented developments in some areas, promoting higher density and reducing reliance on personal vehicles. Meanwhile, in other regions, suburban expansion continues as families seek larger living spaces and more affordable housing options outside city centres.

Economic factors also play a significant role in the evolution of corridors. Fluctuations in the labour market, such as changes in employment patterns and the rise of remote work, influence where people choose to live and work. The growth of e-commerce and the demand for efficient supply chain have also varied the location preferences of businesses, driving a need for larger land parcels dedicated to logistics near major transportation corridors. Consequently, corridors constantly adapt to changes in technology, infrastructure, and the spatial needs of both residents and enterprises, thereby shaping the built environment and influencing regional development trajectories (Priemus & Zonneveld, 2003).

The inherent dynamism of corridors necessitates the implementation of long-term planning approaches that can effectively anticipate and respond to evolving challenges and opportunities. That second need aligns with the foresight techniques designed and evaluated within this PhD research, which focus on the development and consideration of different future scenarios based of disruptive events. By incorporating these methods, the research aims to create robust framework capable of navigating the complexities and uncertainties inherent in corridors' development.

3.2.2. The Henares Corridor, Madrid, Spain

The case study of this PhD dissertation is the Henares Corridor (Figure 3.2), a well-defined territory in Spain, situated within the eastern metropolitan area of Madrid and extending into the province of Guadalajara. Identified as a natural corridor in the lower valley of the Henares River, it is also a key component of the Madrid metropolitan area. Due to its exceptional accessibility, it has traditionally been considered one of the classic axes of metropolitan concentration and diffusion for the city of Madrid (del Río Lafuente & Rodríguez Moya, 2009). The river's course and, most notably, the layout of road and rail infrastructures along the valley, have historically been the main elements shaping this territory, driving its development and expansion (Díaz Muñoz et al., 2002). Today, the Henares Corridor constitutes an urban-industrial continuum over 40 kilometres long, with an economy based on industry and logistic activities.

While the Henares Corridor is generally understood to span more than 20 municipalities (del Río Lafuente & Rodríguez Moya, 2009; Feria Toribio, 2008, 2011), this PhD dissertation narrows its focus to a specific subset of the Corridor. The research places particular emphasis on 11 distinct municipalities, which collectively house a population of 426,721 residents (Instituto Nacional de Estadística, 2022). These municipalities are strategically distributed across the region, spanning both the central area and the northern and southern margins.

In the central area of the corridor are the municipalities that developed earlier, cantered around the Henares River valley and the road and rail infrastructures. There are three municipalities in this central area: Alcalá de Henares, Torrejón de Ardoz, and Azuqueca de Henares. On the margins of the corridor are the municipalities that have experienced a diffusion of productive activities from the central area, driving their demographic and urban development in recent decades. Five municipalities are located along the northern margin of the Corridor (Ajalvir, Daganzo de Arriba, Camarma de Esteruelas, Meco, and Villanueva de la Torre), while the remaining three municipalities are situated along the southern margin (Villalbilla, Anchuelo, and Los Santos de la Humosa). Together, these municipalities illustrate the dynamic interplay of historical development and modern economic growth that characterizes the Henares Corridor.

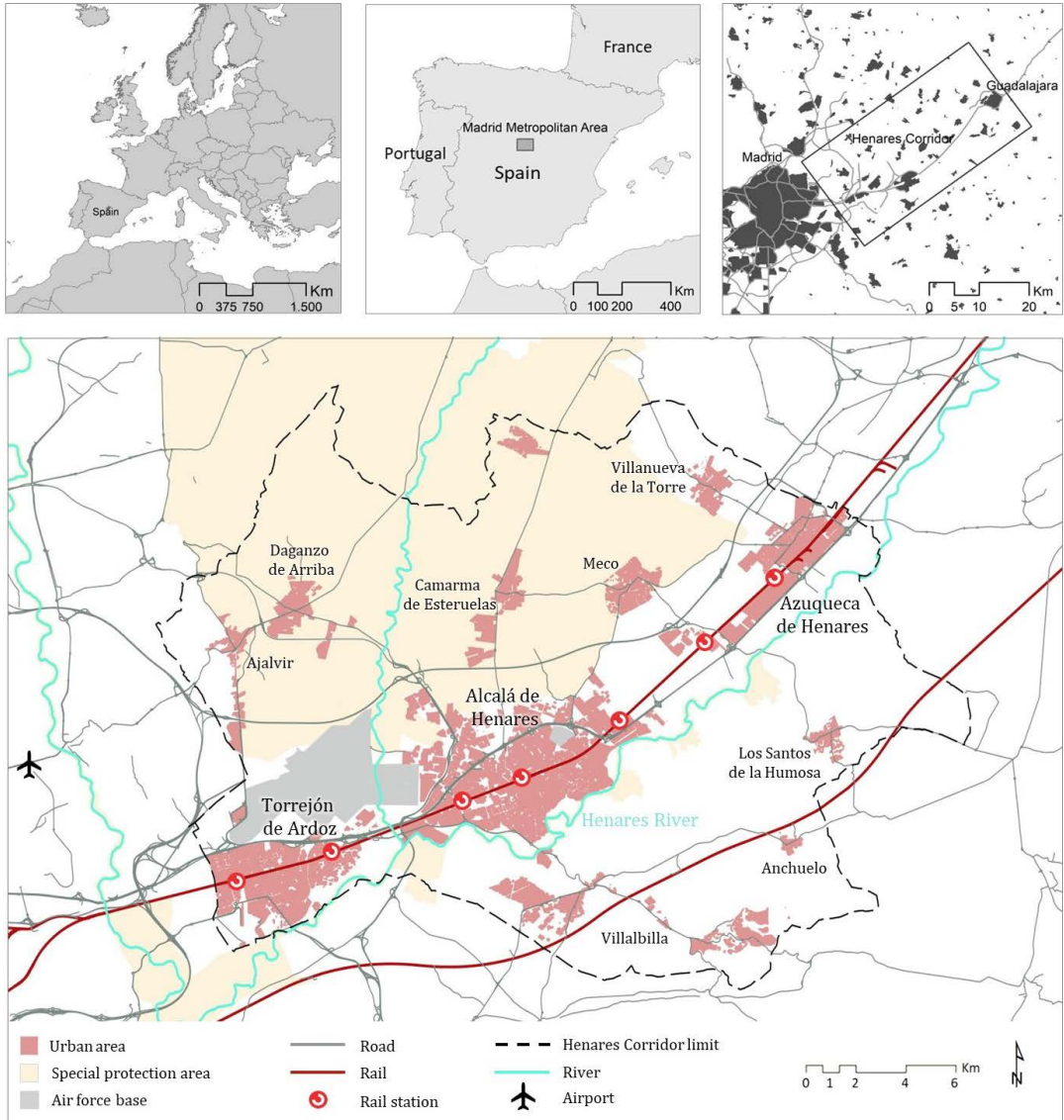


Figure 3.2. The Henares Corridor

3.2.3. The consolidation of the Henares Corridor in the region of Madrid

The historical trajectory of the Henares Corridor within the region of Madrid is intricately tied to the industrial developments that gained momentum in the 1960s in Spain. During this era, industries started to shift away from major urban centres, gradually occupying peripheral regions due to escalating land cost and the availability of labour. During this period, Madrid's development plans (Larrodera, 1976) considered green river corridors as key opportunities for establishing transportation infrastructure and developing industrial and urban areas. This approach dominated the 1960s and early 1970s, a period in Spain where the primary focus of government action was economic development. This perspective influenced the following decades, encouraging the construction of roads and highways through river corridors and valleys around the city of Madrid.

Subsequently, the Henares Corridor emerged as a preferred location for industrial activities (Comunidad de Madrid, 2020; Larrodera, 1976). The original road that connected Madrid and Barcelona (N-2) along with the railway line between these two cities and the airport, made this Corridor an advantageous location for both manufacturing and distributing activities. This industrial evolution not only impacted the economic landscape but also contributed to the changing social dynamics and demographics of the region. The rural exodus created a demand for affordable housing on the main municipalities of the central area of the Henares Corridor, such as Alcalá de Henares, and Torrejón de Ardoz, which witnessed significant population growth during this period (Figure 3.3, Table 3.2). The expansion of residential land use, akin to many Spanish cities during the last quarter of the 20th century, was characterized by the construction of high-rise multifamily residential buildings (Galve Martín, 1991; García Rodríguez & Pérez González, 2014)

As a response to an uncontrolled development trend, which had been causing the degradation of river corridors by occupying ecologically valuable lands for urban and industrial uses, urban planning in the region began to incorporate new criteria for the protection of the natural environment (Gómez Orea, 1976; Rodríguez Espinosa et al., 2015). Thus, a shift began in the tendency to view river corridors as opportunities for urban-industrial development. Urban planning schemes of the municipalities in the Henares Corridor then began to protect the areas near the Henares River and its main tributaries. These lands were designated as non-developable, withdrawing them

from the urbanization process and ensuring their protection. This set of protected areas was fully completed later in the 1990s with the creation of the Natura 2000 network (Council Directive 92/43/EEC; 1992). In the Henares Corridor, this network designates the Henares River basin as Sites of Community Importance and Special Conservation Areas. It also involves the creation of a Special Protection Area for Birds corresponding to the cereal steppes that cover much of the corridor's territory (Figure 3.2).

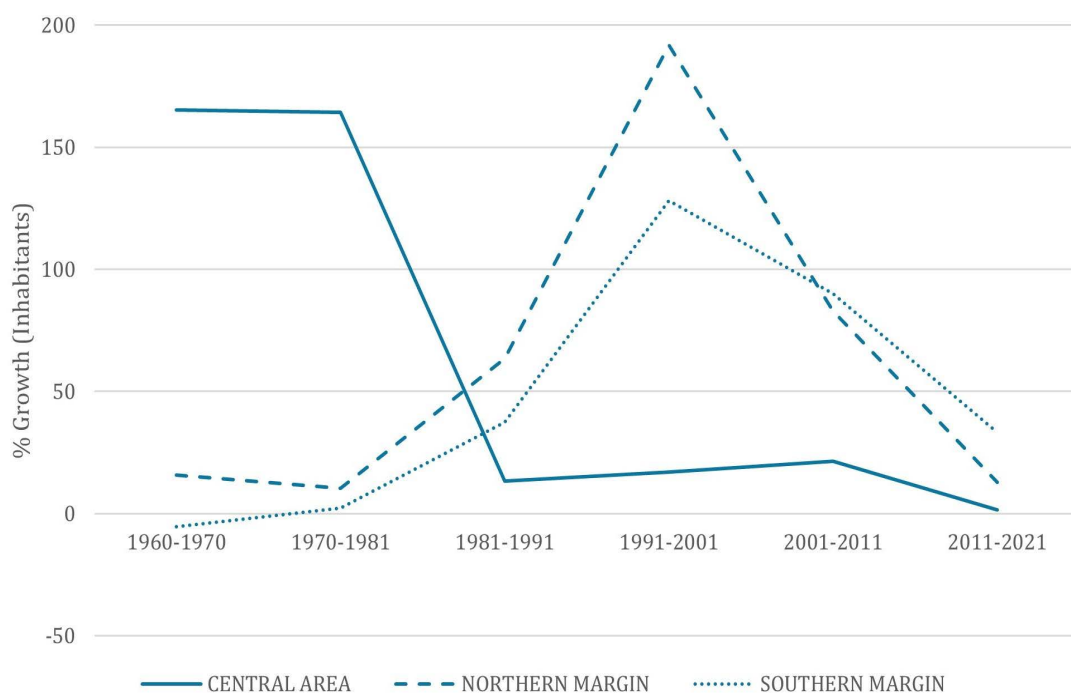


Figure 3.3. Evolvement of population in the study area (1960-2021). % Growth.

Source: own elaboration based on Instituto Nacional de Estadística (INE)

Table 3.2. Evolution of population of the municipalities in the Henares Corridor

Municipality	Inhabitants per year						
	1960	1970	1981	1991	2001	2011	2021
Alcalá de Henares	22069	57354	137169	159355	176434	200505	195570
Torrejon de Ardoz	8011	21031	75599	81072	97887	123213	133377
Azuqueca de Henar.	1636	5788	9789	11624	20673	34572	35119
Central Area	31716	84173	222557	252051	294994	358290	364066
Ajalvir	933	979	965	1309	2479	4126	4793
Daganzo de Arriba	723	770	1068	1627	4755	9472	10528
Camarma de Est.	712	1095	1246	1401	3066	6776	7536
Meco	965	1094	1154	2928	8267	12671	14960
Villanueva de la T.	203	156	84	114	2960	6351	6615
Northern Margin	3536	4094	4517	7379	21527	39396	44432
Villalbilla	877	798	1005	1856	5944	10897	15046
Anchuelo	571	552	518	533	608	1167	1365
Santos de la H.	1043	1010	889	927	1010	2307	2742
Southern Margin	2491	2360	2412	3316	7562	14371	19153
TOTAL	12054	90627	229486	262746	324083	412057	427651

Source: own elaboration based on Instituto Nacional de Estadística (INE)

During the 1980s, the Henares corridor witnessed another profound evolution in its industrial landscape. This transformation was instigated by the restructuring of the industrial sector, driven by its integration into the burgeoning European market. As production tasks became increasingly specialized and compartmentalized, a network of smaller industries emerged within the Corridor. This phenomenon led to a strategic clustering of industrial facilities in more localized zones, particularly within the municipalities in the northern margin of the Corridor. This strategic shift not only redefined the economic dynamics of these municipalities but also precipitated a diversification of the industrial and commercial activities in the corridor, fostering a more robust economic ecosystem.

Simultaneously, this industrial restructuring exerted a profound influence on the spatial distribution and character of residential developments within the Corridor. The high-rise buildings emblematic of the preceding decades gradually gave way to sprawling, low-density residential developments nestled within increasingly homogeneous neighbourhoods. These burgeoning residential enclaves predominantly took place in the municipalities situated along the margins of the Corridor, which experienced a remarkable surge in urbanization and population growth, surpassing the rates observed in the central regions of the Corridor (Galve Martín, 1991; Gutiérrez de Mesa & Núñez Velázquez, 2007) (Figure 3.3, Table 3.2).

These historical shifts in demographic and industrial dynamics exerted a palpable impact on the utilization of land within the Henares Corridor (Figure 3.4). While the period between the 1960s (Figure 3.4a) and 1980s (Figure 3.4b) witnessed a notable expansion of land occupation primarily concentrated in the central municipalities, the landscape underwent a drastic transformation from the 1980s onwards (Figure 3.4c). During this period, land occupation became markedly concentrated along the margins of the corridor, reflecting the burgeoning growth and development that characterized these peripheral residential areas.

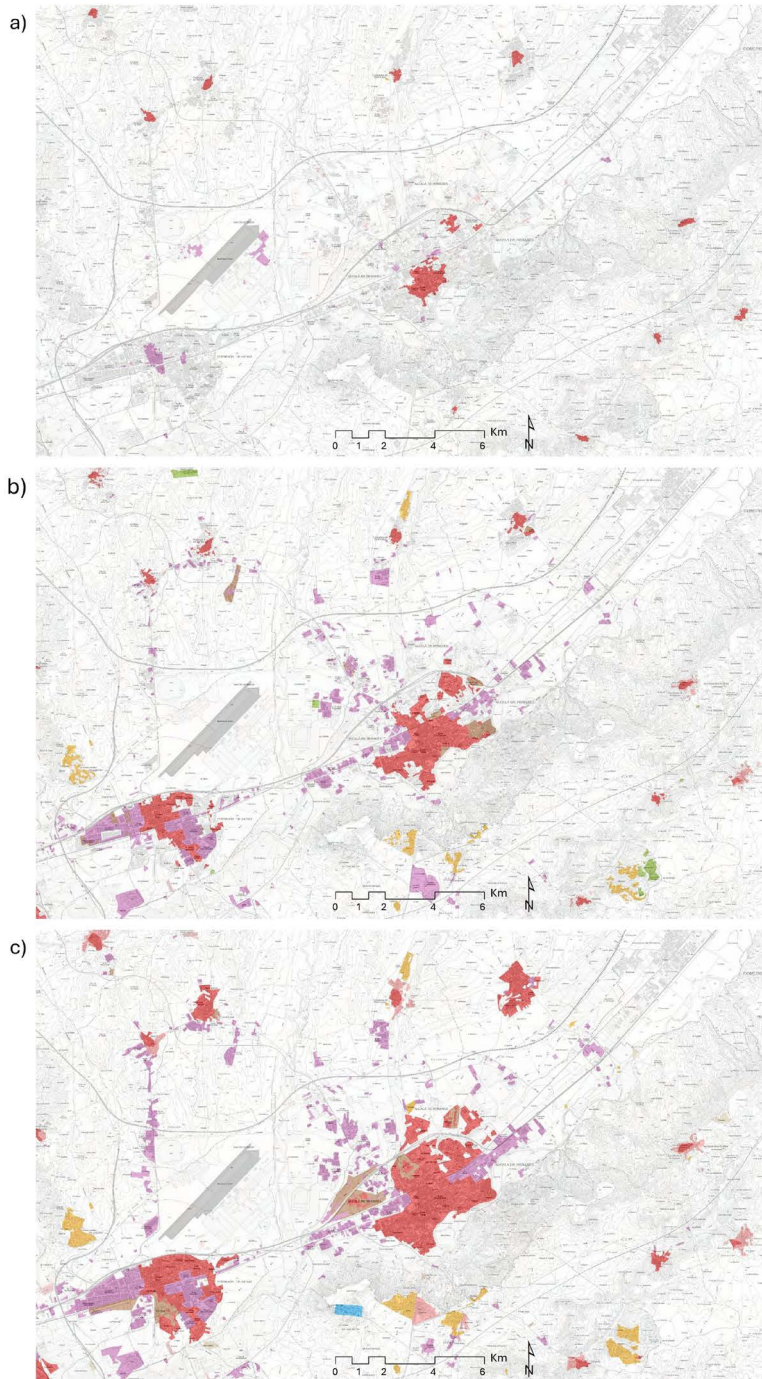


Figure 3.4. Evolution of land use occupation in the Henares Corridor in the years 1956 (a), 1980 (b) and 2000 (c).

Source: Own elaboration based on historical maps of land use occupation in the Community of Madrid

During the 1990s, the evolution of the main types of urban land occupation in the Henares Corridor shows, although with fluctuations, a clear positive trend growth for residential and industrial land uses (Figure 3.5). However, after more than 40 years of development and growth, the Henares Corridor experienced the severe impact of the 2007-2008 financial crisis, whose consequences are still present in the region. Industrial and construction sectors suffered significant deterioration, such as delocalization processes, business closures, and job reductions. The collapse of the housing market significantly slowed down urban growth rates in the region. Indeed, from 2008 onwards, residential-industrial growth slowed down, stagnating an average annual growth rate that rarely exceeded 1% (Figure 3.5). Many residential developments completed before the crisis to meet optimistic housing demands, left a high percentage of homes unoccupied. In other cases, the sharp drop in housing demand led to the suspension of many ongoing real estate projects, resulting in abandoned constructions scattered throughout the Henares Corridor.

The recent impact of the health crisis caused by COVID-19 and the subsequent economic downturn have been significant. These repercussions have been felt across various dimensions in the Henares Corridor, including economic, social, and healthcare aspects (Olmo García, 2020). Primarily, the pandemic severely impacted the local economy, especially affecting key industries such as manufacturing and logistics. Measures like lockdowns and disruptions in the supply chain led to production slowdowns and temporary closures, posing significant economic challenges for businesses and workers in the region. Moreover, the pandemic had ripple effects on the residential sector. Shifts in housing demand and the adoption of remote work trends have influenced housing preferences and property markets in the area. With more people working from home, there has been an increased demand for larger living spaces and a trend towards suburban living as people seek more space and quieter environment away from crowded urban areas.

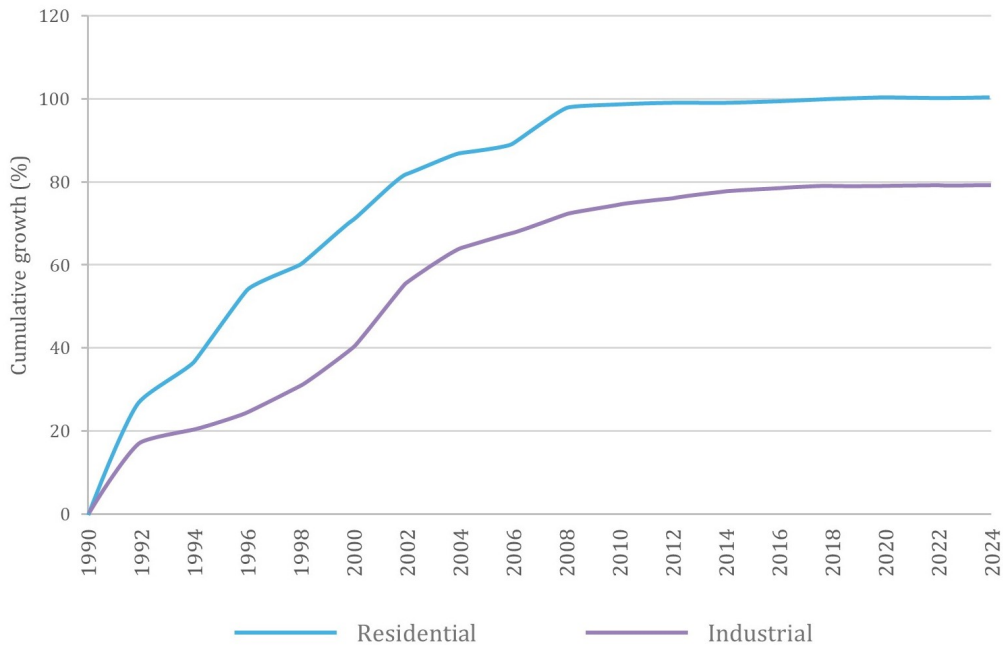


Figure 3.5. Evolution of residential and industrial land use occupation in the Henares Corridor (Cumulative annual growth since 1990)

Source: own elaboration based on cadastral data

Figure 3.6 presents a detailed depiction of current urban land uses within the Henares Corridor, derived from Spanish cadastral data. The figure categorizes each cadastral parcel by its predominant land use, distinguishing between residential, industrial, commercial, public facilities, and green spaces. Various land use patterns are distinguished throughout the length and breadth of the corridor. Notably, in the municipalities along the central axis, particularly Alcalá de Henares and Torrejón de Ardoz, there is a significant mix of land uses. This mixed-use pattern reflects the diverse urban functions that coexist within these central areas, contributing to their complex urban fabric. There is a marked presence of industrial areas across several municipalities. This industrial prevalence, especially in municipalities along the central axis, plays a crucial role in shaping the region's landscape. As previously described in this section, it influences both the physical configuration and the economic dynamics of the region, underscoring the industrial sector's importance in the Henares Corridor's development.

The municipalities located on the northern and southern margins of the corridor exhibit a different land use pattern compared to those along the central axis. With the exception of small industrial areas in the north, single-family residential land use predominates, occupying a significant portion of the total urbanized land in the municipalities of the southern margin (Figure 3.6).

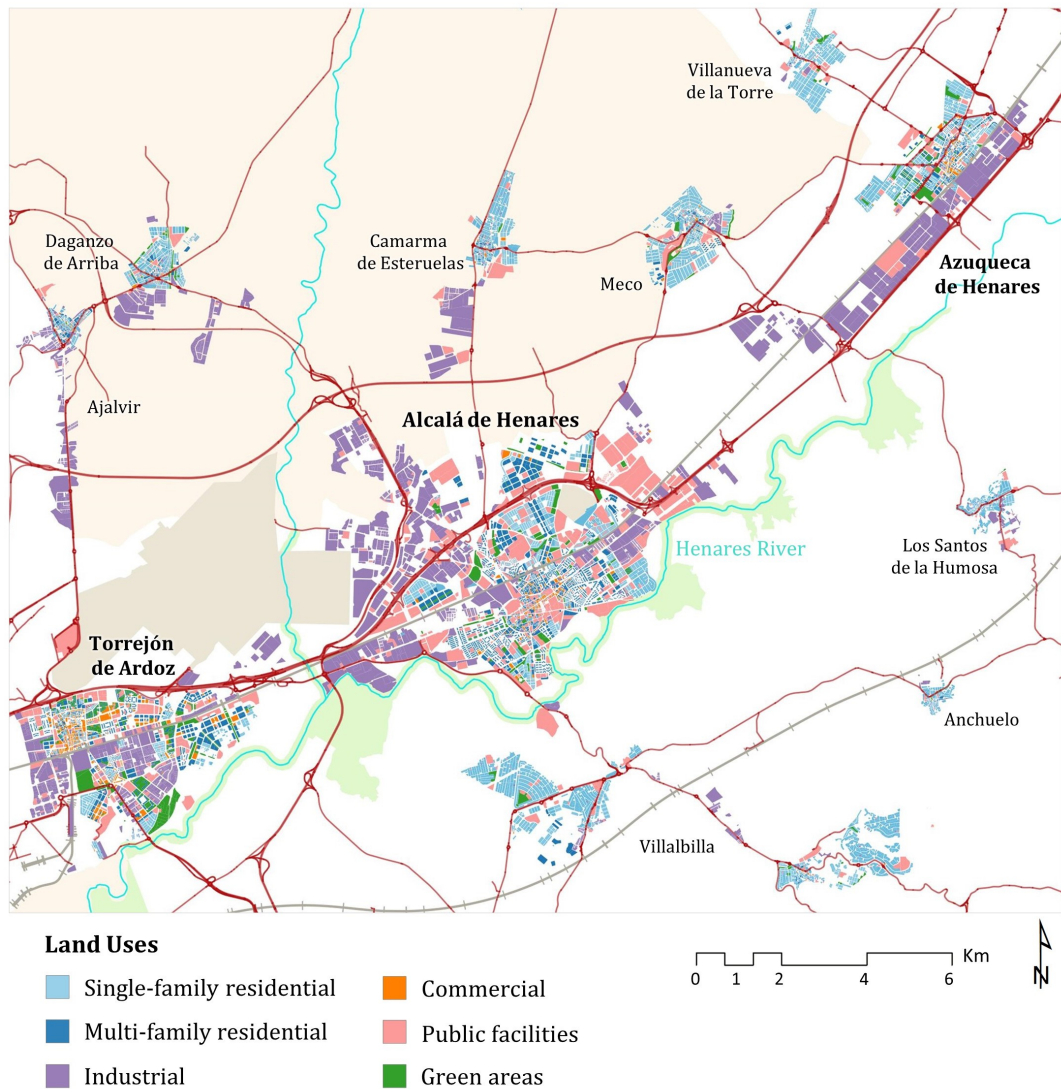


Figure 3.6. Urban land uses in the Henares Corridor

Source: own elaboration based on cadastral data

The described evolution of urban land uses in the Henares Corridor is intricately connected to the expansion and diversification of its transportation infrastructures. Over the years, the original road infrastructures have evolved into the modern A-2 and R-2 highways, facilitating road transportation and articulating the municipalities of the central area of the Corridor. In parallel, the railway network has experienced a substantial expansion, with mid-distance, long-distance, and high-speed lines crossing the Corridor. The municipalities located in the margins were interconnected through a dense network of roads. The growth in population and industrial presence in these margins has also prompted the expansion and diversification of the public transport network. This, in turn, has resulted in increased service frequencies and extended operating hours.

Consequently, the region's dependency on Madrid shifted towards Corridor's municipalities such as Alcalá de Henares and Torrejón de Ardoz. The substantial public investment in transportation infrastructure, combined with the diverse industrial and business landscape and the growth of e-commerce, has consolidated the Henares Corridor as one of the foremost logistic areas in Spain. As a result, mayor logistic hubs, such as dry ports, established in this region. All of these led to the creation of a polycentric territorial model consisting of a set of highly interconnected municipalities through flows of goods and people, where mobility becomes a key component of the territorial structure (del Río Lafuente & Rodríguez Moya, 2009; Díaz Muñoz et al., 2002; Rivera-Blasco & Ruiz-Sánchez, 2021).

Currently, the Henares Corridor exhibits a complex and evolving mobility landscape typical of a polycentric territorial structure. The most recent mobility data, obtained from the Household Mobility Survey (Comunidad de Madrid, 2019), provides valuable insight into regional mobility patterns (Table 3.3). When comparing municipalities within the central area of the Corridor to those on the margins, distinct patterns in daily transportation preferences can be observed.

In central municipalities, namely Alcalá de Henares and Torrejón de Ardoz, around 746,000 trips are generated daily (Table 3.3). Within these municipalities the use of private vehicles and walking as transportation modes is quite balanced, making up roughly 45% and 40% of total daily trips, respectively. Public transport, on the other hand, represents a smaller share, accounting for only 15% of total trips generated. In

this central area, more than a half of daily trips remain within the same municipality, indicating a relatively self-contained mobility structure.

In the municipalities located on the northern and southern margins of the Corridor, there are approximately 146,000 daily trips generated (Table 3.2). In contrast to the central area, on the margins of the Corridor private vehicle usage is dominant, constituting approximately 65% of total daily journeys. Walking and public transport make up 25% and 10% of trips, respectively. The internal trips within these margin municipalities vary from 20% to 35%, showcasing a high degree of dependence on other municipalities. Specifically, there is a noteworthy volume of daily journeys originating from the margins and heading towards the central area, primarily towards Alcalá de Henares, constituting between 10% and 35% of total daily trips, depending on the specific municipality (Table 3.3).

Table 3.3. Daily trips by transport mode in the study area

Municipalities	Transport mode (originated daily trips)							
	Private vehicle		Public transport		Walking		Other	
	Miles	%	Miles	%	Miles	%	Miles	%
Central Area:								
Alcalá de Henares	188	42	60	13	194	43	9	2
Torrejon de Ardoz	140	47	39	13	112	38	4	1
Northern Margin:								
Daganzo, Camarma, Meco	45	60	6	8	22	29	2	3
Southern Margin:								
Villalbilla, Anchuelo, Los Santos	45	63	7	10	16	23	3	4
Total	418		112		344		18	

Source: Own elaboration based on Comunidad de Madrid, 2019. Household Mobility Survey

Looking ahead to the future, regional strategies (Comunidad de Madrid, 2020; Delgado-Jiménez, 2021) are underway to revitalize the economy of the Henares Corridor. These strategies encompass a set of actions aimed at creating an economic, technological, and industrial environment capable of re-attracting investments to facilitate the establishment of new companies and generate employment opportunities. The Corridor's specialization in logistics has intensified and municipalities are expanding the available land to meet the substantial demands for space of these type of activities. Furthermore, in recent years, the Henares Corridor has re-emerged as a residential focal point. Escalating housing prices in Madrid and other municipalities have prompted the resurgence of the Henares Corridor as a thriving residential area. New urban developments are taking into account the evolving needs of the population, prioritizing suburban locations, single-family housing options, and multifamily projects with large private common areas.

The majority of municipalities in the Corridor are in various stages of planning review. There is still land available for urbanization which, depending on its typology, could accommodate significant urban development. That is the case, for instance, of Villanueva de la Torre, located in the norther margin of the corridor. This municipality, despite significant demographic and urban development in recent years, still has over 40% of the developable land designated for residential use remaining undeveloped. Moreover, in certain municipalities among the central area of the Corridor, such as Alcalá de Henares and Azuqueca de Henares, there is still available industrial land for urbanization. Given the Corridor's current specialization in logistic, it is anticipated that new municipal plans will expand urbanizable land to meet the high demands for surface area required by these types of activities.

The potential ramifications of all these actions – and others that may arise – for the corridor's future are highly uncertain. Consequently, it is urgent to abandon short-term and purely speculative projections that have dominated planning decisions in the past. Instead, planning must address the long-term future of the corridor, recognizing that its complexity and dynamism suggest the need to consider not just one but multiple possible futures. Embracing participatory scenario-building techniques becomes paramount in this context, allowing stakeholders to envision and prepare for a range of potentially disruptive outcomes. Additionally, integrated planning and management of the territory become imperative. This holistic approach

must surpass municipal boundaries, viewing the corridor as a unified territorial entity rather than disjointed segments. Priority should be placed on integrating land use and transportation, requiring robust collaboration and understanding among various stakeholders, including regional and local governments, as well as corridor residents. By engaging stakeholders in this way, planners can foster a deeper understanding of the interplay between various factors influencing the corridor's development and enable more informed decision-making.

In sum, the dynamic and unpredictable nature of the Henares Corridor outlined in this section makes it an ideal context for addressing the primary objective of this PhD research: to adapt participatory scenario-building techniques to effectively address the dynamic and unpredictable nature of land use and transport systems. The region's historical evolution reflects a complex narrative of industrial development, urban expansion, and transportation infrastructure growth spanning several decades. This demonstrated capacity for change renders its future particularly uncertain and influenced by multiple factors, creating a dynamic socio-economic landscape ripe for scenario exploration.

4

4 BUILDING DISRUPTIVE FUTURE SCENARIOS FOR LAND USE AND TRANSPORT PLANNING

This *Fourth Chapter* is a reprint of the article “*Participatory visioning for building disruptive future scenarios for transport and land use planning*”, published in the *Journal of Transport Geography* (2021), 90, 102907.

<https://doi.org/10.1016/j.jtrangeo.2020.102907>

Abstract

Participatory approaches in scenario-building can be particularly useful to anticipate and examine unexpected outcomes over long-term future timelines, providing broad legitimacy to today’s decision-making processes. However, the strategic value of participatory approaches is increasingly being contested due to the difficulty to operationalize non-linear thinking, resulting in long-term scenarios similar to business-as-usual (BAU) projections. To address this challenge, this chapter develops and implements a novel participatory scenario-building approach based on using semi-structured interviews. This approach incorporates two types of wild cards – low probability and high impact processes – as disruptive triggers: imaginable and unimaginable processes. A group of experts evaluates the level of disruptive thinking in the generated future scenarios. The Henares Corridor in the Metropolitan Area of Madrid, Spain provides the empirical focus. The results present a total of seven 2050 scenario narratives: one desired common scenario plus six wild card scenarios. Higher levels of disruptive thinking were mainly present in those future scenarios generated by unimaginable processes, as such processes initiate highly diverging participant future views. It was also noted that smaller and specific groups of participants can visualize 2050 futures more disruptively. Conclusions and reflections on the strengths and weakness of the presented approach are drawn.

Key words: participation; stakeholders; strategic; scenario analysis; planning

4.1. Introduction

Cities and transport systems are changing faster than ever, which is a fertile ground for the emergence of sudden, unique, anomalous, and low predictable incidents (Barber et al., 2006; Dammers, 2010). In this apparently changing age, land use and transport planning experiences challenging times, in which instrumental rationality has come under attack (Innes & Booher, 2018) and deep uncertainty must be treated when supporting decision-making (Lyons & Marsden, 2019; Marchau et al., 2019; Navarro-Ligero et al., 2019). Bounded rationality –based on recognising cognitive limitations of human decision-makers (Simon, 1957)- offers alternative descriptions of decision-making (Alexander, 2000; Lyons et al., 2008), but the incorporation of low predictable incidents/processes (e.g. the impact of smart phones on mobility patterns) into decision-making still remains a challenge that strongly limits the options for non-linear policy pathways. Those low predictable incidents/processes are here called wild cards: sporadic events or long-lasting processes that are assumed to be improbable, but would have large consequences for cities, transport systems, and social trends if they finally take place (Mendoça et al., 2004; Smith & Dubois, 2010). Looking back, car dependency and its impact on urban form would have been considered a wild card in early 19th century. Another example is the COVID-19 pandemic, which is drastically altering how people use massive transport systems and experience open places in cities.

Scenario-building is a well-established methodology that can effectively address the challenge of incorporating wild cards in decision-making (Hickman & Banister, 2014; Soria-Lara & Banister, 2017b; Van Drunen et al., 2011). In particular, scenario-building investigates strategic and long-term futures marked by considerable uncertainty (e.g., the role of street space in cities) and/or situations where business-as-usual is no longer appropriate (e.g. transport emissions). It is distinguished by the approach of taking explorative/normative endpoints in the future, and then examining the means and policy pathways that can lead to these outcomes (Akerman & Höjer, 2006; Banister et al., 2000; Lyons & Davidson, 2016). The visioning phase is a crucial methodological step in transport scenario-building, where a series of explorative and/or normative visions are constructed about the city's future and its transport systems (Banister & Hickman, 2013). This methodological phase is seen as a democratic exercise where “all voices” should be heard (Wangel, 2011), engaging

the widest variety of actors: members from the public, practitioners, policymakers, etc. (Soria-Lara & Banister, 2017a; Tuominen et al., 2014).

Although there has been a burgeoning application of participatory scenario-building approaches in land use and transport fields (Zimmerman et al., 2012; Wangel, 2011; Hickman et al., 2011; Schade & Schade, 2005; Olsson et al., 2015), limited attention has been paid to deal with non-linear thinking. Some particular reflections can be made. First, the implementation of participatory scenario-building has usually followed consensus-based techniques (e.g. Delphi methods), which limits the capacity to add outlier views and disruptors into future scenarios (Shiftan, 2003; Melander et al., 2019). Second, experts-guided processes have been predominant in participatory scenario-building exercises, and those experts are usually trained to visualise futures linearly (Hickman & Banister, 2014). Third, visionary participants are also heavily influenced by current social and technological trends, making outside-the-box thinking a challenge (Soria-Lara & Banister, 2018b). If those barriers persist, the social, democratic, and participatory value of scenario-building processes will be curtailed, and their strategic value for decision-making will be drastically reduced, due to the limited capacity to incorporate disruptive views. As a result, linear thinking will continue to dominate, reducing the usefulness of scenario-building in the highly dynamic contexts of today's cities and transport systems.

To address these challenges, this chapter aims to explore the following research question: *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory scenario-building?* To explore potential answers, a specific region in the Metropolitan Area of Madrid (the Henares Corridor) provides the empirical focus (see Section 3.2 in Chapter 3). In a first step, a total of 129 participants were engaged via semi-structured interviews to construct a desirable future vision on transport and land use by 2050. In a second step, the same participants were asked to distort their desired future vision according to six context-based wild cards ("what if" conditions), guiding participants to visualise additional endpoints outside of their comfort zone. The visioning exercise resulted in seven 2050 common scenarios: one desired vision plus six wild card scenarios. Then, the level of disruptive thinking reached during the scenario-building process was evaluated by a group of 21 experts, with expertise on fields related to innovation, strategic decision-making, and creative thinking.

The remainder of the chapter is organised as follows. Section 4.2 outlines the theoretical background and the working hypothesis. Section 4.3 provides details on the research design. Section 4.4 summarizes the main results. Finally, Section 4.5 closes with concluding remarks and reflections.

4.2. Theoretical background and working hypothesis

4.2.1. Barriers blocking disruptive scenario-building processes

Current participatory approaches in scenario-building usually do not generate radical, anomalous, and low predictable scenarios. To address that, a first group of authors (Banister & Hickman, 2013; Hickman & Banister, 2007; Hickman et al., 2009) used workshops and focus groups to stimulate open and deliberative scenario-building processes, rather than implementing more-restricting methods (e.g. questionnaires). However, the obtained long-term scenarios are still very close to the business-as-usual (BAU) projection, being strongly focused on linear thinking. For example, one of the generated scenarios focused on higher oil prices, suggesting a decrease of motorised trips (Hickman & Banister, 2007). In those cases, the participants, mainly experts and stakeholders, were strongly biased by their professional domains and highly trained to visualise futures linearly. To overcome this limitation, Tuominen et al. (2014) involved young participants (15 to 17 years old) during the visioning stage (they are not part of the transport establishment and will be the adults of tomorrow), resulting in more “original” visions. One example is what Tuominen et al., (2014) called the “Urban Beat” vision, a radical future image based on compact cities and extremely high use of ICT. Soria-Lara & Banister (2017a) also evidenced the higher capacity of younger and non-expert participants to visualize more disruptive visions compared to highly experienced professionals, adults, and seniors.

Another reason impeding the construction of future scenarios outside of the “comfort zone” can be related to the type of participatory methods used and their operationalisation. Traditionally, the following methods have been used for participatory scenario-building: Delphi techniques, in-depth interviews, and workshops. The dominance of a consensus-based approach (i.e. long-term scenarios are constructed on agreement of the participants’ thoughts, but divergent ways of thinking are not previously stimulated between participants) limits the chance to

incorporate outliers and divergences. For example, Delphi techniques usually build future scenarios by carrying out several rounds of questions, where experts are informed about the main agreements reached in past participatory rounds (Mason & Alamdari, 2007; Melander et al., 2018; Shifan, 2003; Zimmermann et al., 2012).

When other more open participatory methods are used (e.g. in-depth interviews and workshops), only highly frequent and common thoughts remain in the obtained scenarios, limiting the incorporation of “outside-the-box” thinking into the process (Soria-Lara & Banister, 2018a). For example, Soria-Lara & Banister (2018a) constructed a 2050 future vision for Andalusia, Spain mostly based on public transport promotion and urban compactness, which draws a scenario highly expected for that particular geographical context. Other aspects also impeded disruptive thinking: e.g. the use of BAU projections to orient participants during visioning processes stimulates linear thinking (Julsrud & Uteng, 2015; Piecyk & McKinnon, 2010; von der Gracht & Darkow, 2016); the construction of a single long-term vision instead of a wide range of options drastically reduces the space for exploring divergent futures (Mason & Alamdari, 2007; Schuckmann et al., 2012; Trolley et al., 2001); people are highly influenced by context and dominant trends (e.g. technological innovations), reducing their capacity to think outside their comfort zone (Soria-Lara & Banister, 2017a).

4.2.2. Working hypothesis: Wild cards for thinking disruptively

It is believed that utilizing wild cards –low probability and high impact processes- in participatory scenario-building processes can break down the abovementioned barriers and stimulate inventive, non-traditional outcomes in participatory scenario-building exercises. A long list of labels has been produced by literature to call these low probability and high impact incidents/processes, such as disruptions, structural breaks, discontinuities, surprises, bifurcations, black swans, unprecedented developments, etc. It must be accepted that accurate predictions are not possible about wild cards (Makridakis & Taleb, 2009; Taleb, 2007). However, their (qualitative) consideration in decision-making by using scenario planning can deal with bounded rationality (Wright & Goodwin, 2009), anticipating certain (un)desired strategic pathways (e.g. car free cities in Western world) against the well-known impossibility to consider all potential future alternatives.

Different types of wild cards can be distinguished according to the level of surprise that can originate in societal structures, but in all cases large impacts would be expected. For example, a long-term future in which autonomous vehicles predominate in Western cities would be less surprising than the prohibition of individual car ownership, but both aspects would be turning points in the evolution of cities and transport systems. Wild cards are both scale and context-based, which triggers the need for determining specific wild cards for each particular place. For example, overpopulation is expected in urban context on an European scale, but unexpected in rural contexts on a local scale (United Nations, 2019; OECD, 2015; European Union, 2015). Another example can be the impact of massively influential events like pandemics, which can have different levels of severity across countries and continents due to characteristics of health systems, social-economic standards, and cultural habits.

Traditionally, wild cards have been used to analyse unexpected future trends (Barber et al., 2006) as well as to test the stability of future scenarios in light of external and internal interferences (Steinmuller, 2004). For example, four different wild cards are used to test the robustness of long-term scenarios in the framework of the European Spatial Planning Cohesion Policies (Dammers, 2010). In the particular context of transport scenario-building, Hauphman et al. (2015) explore fourteen technological, geopolitical, and societal wild cards, analysing their likelihood of occurrence and potential effects. Walsh et al. (2015) also use wild cards as a destructive test to evaluate the behaviour of future transportation infrastructure systems. Finally, Von der Gracht & Darkow (2010) extract wild cards from a Delphi process and deploy them to visualise long-term transport logistics futures by using divergent views in combination with desk work. However, the mentioned authors do not test the level of disruptive thinking reached for each scenario.

The basic hypothesis underlying this chapter is that wild cards can be used to stimulate thinking outside of the BAU zone during participatory scenario-building processes. Specifically, wild cards could be useful for interrupting linearity in the participants' views, resulting in more-disruptive outcomes (Figure 4.1). The confirmation of this hypothesis – even partially – can show useful and practical lessons for decision-making and planning processes.

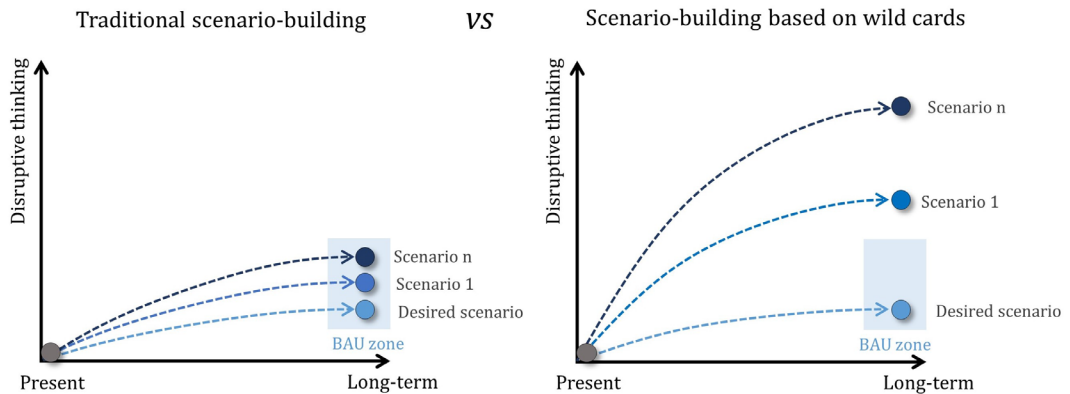


Figure 4.1. Working hypothesis for building disruptive future scenarios

4.3. Research design

An empirical research design has been used to confirm/deny the working hypothesis of this chapter, namely that wild cards can be used to stimulate disruptive thinking outside of the BAU zone during participatory scenario-building processes. The Henares Corridor serves as case study (see Section 3.2 in Chapter 3). A novel participatory scenario-building approach has been designed and implemented, entailing three-stages: (i) Wild cards selection; (ii) Construction of 2050 scenarios; (iii) Evaluation of disruption of 2050 scenarios.

4.3.1. Wild card selection

To address particular problems and expectations on transport and land use in the Henares Corridor, the Madrid regional government and local authorities have been focused on three main drivers to be addressed over the longer term, and this provides us with a 2050 business-as-usual (BAU) projection:

- *Decarbonization and air quality.* A strong reduction of car traffic is expected. The policies implemented by the Regional Mobility Plans (Consortio Regional de Transportes de Madrid, 2013) aim to reduce transport GHG emissions by 10%, limiting the transit of fuel-based vehicles in specific areas of city centres during sporadic events of high levels of air pollutants concentration (Comunidad de Madrid, 2013). That is consistent with some initiatives at local level, focused on pedestrianizing a relevant number of streets in city centres.

- *Travel behaviour and energy savings.* The objective of the Madrid regional government is to reach an evenly distributed modal split in the mid-term – 33% by personal vehicles, 33% by public transit services, and 33% by active modes (Consortio Regional de Transportes de Madrid, 2013). Spurred on by the 2008 financial crisis, the plan “Activa Henares” is also implementing policies to foster new business strategies impacting on travel behaviour and energy savings. For example, placing high priority on attracting technological companies with more flexible working conditions, instead of traditional manufacturing industry. However, no specific measures related to e-working is expected to be taken. Logistics platforms are also promoted in the corridor, operating at national and international levels, which will produce relevant freight transport flows (Delgado-Jiménez, 2021).
- *Demography, economics, and social inequalities.* Demographic projections by 2033 estimate an increase of population in the Henares corridor between 12% (high scenario) and 5% (low scenario) (Instituto Nacional de Estadística, 2022). In all cases, the population >65 years old will increase from 17% in 2018 to around 23% in 2033. Migratory flows are expected to decrease in upcoming decades, as population will be more concentrated in coastal areas. The Madrid regional government has also developed a strategic plan to decrease social inequality levels in the region (Comunidad de Madrid, 2016), fundamentally focused on improving the access to dwellings and jobs for low-income population. Both crime and robbery rates are not expected to increase in upcoming decades.

Based on the described BAU projection for the Henares corridor, a set of context-based wild cards have been identified to confirm/deny our working hypothesis. Specifically, the research team identified wild cards that would disrupt the BAU projections in official planning documents for the case study, being aligned with the three main drivers previously described. A total of 20 potential wild cards were initially proposed and discussed in several systematic review rounds by the research team, ultimately arriving at six (Table 4.1). The level of context-based surprise originated by those six wild cards was also discussed, identifying two different types: (i) *imaginable processes*: possible surprises in the short and long term; and (ii) *unimaginable processes*: highly improbable surprises in both the short and long term.

Table 4.1. Wild cards selected for semi-structured interviews

Drivers	Wild cards
<p><i>Decarbonization and air quality</i></p> <ul style="list-style-type: none"> • Car-oriented society • Consolidation of electric public buses • Medium implementation level of electric vehicles • Pedestrianization of the biggest streets in city centres • Higher accessibility levels brought by active modes • Daily travel distances are not expected to decrease 	<ul style="list-style-type: none"> • <i>Zero-emission vehicles</i> Fossil fuel-powered vehicles will be fully prohibited in the case study, including individual and collective transport modes. Level of context-based surprise: low (imaginable process) • <i>Non-motorized city centres</i> City centres along the corridor will be exclusively limited to active mobility (walking and cycling) and certain collective transport modes. Access to city centres by car will be fully prohibited. Level of context-based surprise: Low (imaginable process)
<p><i>Travel behaviour and energy savings</i></p> <ul style="list-style-type: none"> • Higher diversification of activities • Higher accessibility levels brought by collective transport modes • Number of daily trips will decrease weakly • Individual and car trips will predominate • Number of freight transport trips will increase • Working conditions will be more flexible • Low implementation of e-working 	<ul style="list-style-type: none"> • <i>E-working dominates</i> E-working will be implemented for all jobs where physical presence is not required. Level of context-based surprise: Medium (imaginable process) • <i>Shared motorized mobility dominates</i> Individual car ownership will be fully prohibited, and only shared motorized mobility can be used in the case study. Level of context-based surprise: High (unimaginable process)
<p><i>Demography, economics, and social inequalities</i></p> <ul style="list-style-type: none"> • No drastic variations of population are projected • Low-income people will easily access to dwellings and jobs • The maintenance and improvement of the existing transport infrastructures will predominate • Social inequalities are projected to decrease • Crime and robbery rates are projected to decrease 	<ul style="list-style-type: none"> • <i>Overpopulation</i> Natural disasters triggered by climate change will originate strong migratory movements from other geographical latitudes to European countries, resulting in a 200% population increase in the Henares Corridor. Level of context-based surprise: High (unimaginable process) • <i>High level of insecurity in urban areas</i> The public space will become very insecure due to high social inequality rates. Walking, cycling, and motorbiking are not advisable actions. Level of context-based surprise: High (unimaginable process)

4.3.2. Construction of 2050 scenario narratives

Semi-structured interviews were conducted to construct 2050 scenario narratives on transport and land use, totalling 129 valid interviews. The choice of semi-structured interviews -rather than other open formats (e.g. participatory workshops)- is based on the need for obtaining larger sample sizes. Such larger sample sizes would increase the likelihood to engage people that prioritize different wild cards during the visioning process, triggering higher divergences between participants. Semi-structured interviews offer a participatory scenario-building process where the interviewer not only had a series of general guiding questions, but also latitude to ask more detailed questions in response to what are seen as significant replies (Bryman, 2016). Each interview session was designed to take about 30 minutes. The empirical work was completed during June and July 2018. Each semi-structured interview² was organized into four-time blocks (Figure 4.2):

- In the initial block, participants provided demographic and socio-economic details, encompassing age, gender, educational level, work status, preferred transport modes, household composition, real-estate properties, and travel frequency along the Henares Corridor.
- The second block focused on participants articulating their desired 2050 scenario concerning transport and land use for the case study. They were prompted to visualise an ideal workday (Monday to Friday, excluding weekends) in 2050. In response to this imaginary day, participants openly addressed the following questions: (i) *How do you see covering your daily travels to work, leisure, and shopping on this imaginary day?* (ii) *What modes of transportation would you prefer to utilize?* (iii) *Do you visualize any technological innovations that will significantly impact and transform your daily routines and habits?* (iv) *How do you imagine the appearance and dynamics of the neighbourhood where you will be residing?* (v) *How do you visualize the design and characteristics of public spaces, such as public transport stations and green areas, in this imaginary neighbourhood?*
- The third block of the interview involved distorting the 2050 desired scenario generated in the second block, utilizing the imaginable processes outlined in

² The original content of the semi-structured interviews (in Spanish) can be found in Annex 1.

Section 4.3.1. Participants first selected the most disruptive of the three imaginable processes (Table 4.1) based on their individual opinions. Subsequently, they responded to the same questions from the second block, conditioned by this chosen imaginable process. The imaginable process acted as a “what-if” condition for all interview questions (e.g., *How do you see covering cover your daily travels to work, leisure, and shopping on this imaginary day if e-working dominates employment by 2050?*).

- The fourth block centred on distorting the 2050 desired scenario generated in the second block of the survey, utilizing the unimaginable processes detailed in Section 4.3.1. Participants first selected the most disruptive of the three unimaginable processes presented (Table 4.1) based on their individual opinions. They then responded to the same questions from the second block, conditioned by this chosen unimaginable process. The unimaginable process act as a “what if” condition for all interview questions (e.g., *How do you envision the appearance and dynamics of your neighbourhood in a scenario where urban areas experience heightened insecurity by the year 2050?*)

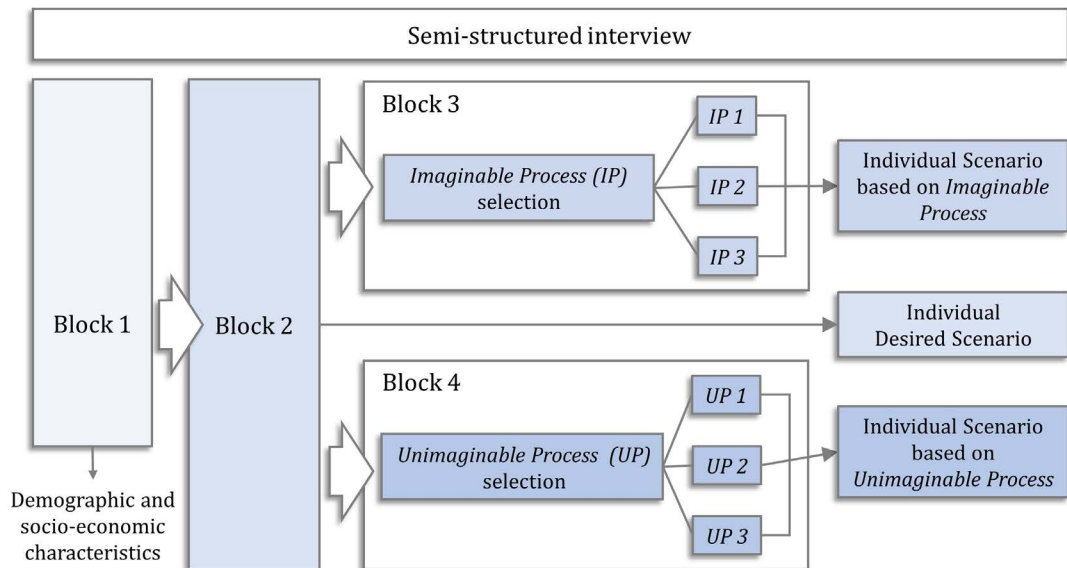


Figure 4.2. Outline of semi-structured interviews

In summary, each semi-structured interview provided a total of three individual scenario descriptions per participant: desired scenario (Block 2); scenario based on one imaginable process (Block 3); scenario based on one unimaginable process (Block 4). Then, those individual scenario descriptions were codified and added to other individual responses to obtain collective 2050 scenarios. In this way, all those views from participants who selected a particular wild card are aggregated to produce a collective summary scenario. Each collective scenario was translated into a specific narrative (Sections 4.4.1; 4.4.2; 4.4.3), with seven narratives in total: the 2050 desired scenario narrative (based on the Block 2 portion) plus six 2050 wild card-based scenario narratives (three narratives based on imaginable processes from the Block 3 and three narratives based on unimaginable processes from Block 4).

Each semi-structured interview was specifically analysed through a systematic process of transcribing individual statements, inductive coding, and several rounds of interpreting those codes (Figure 4.3).

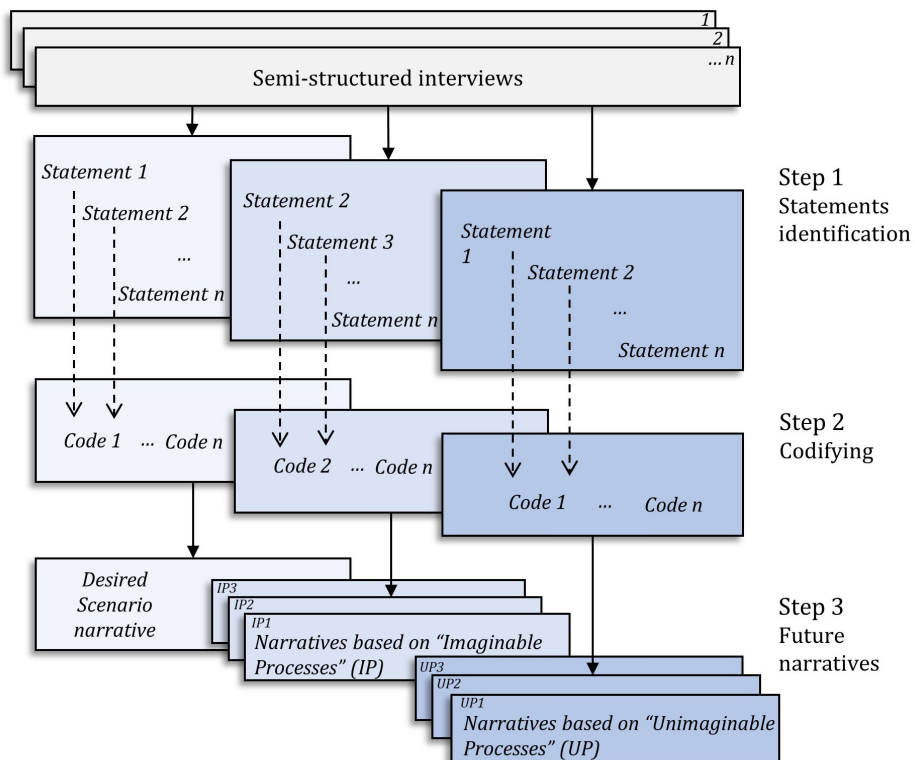


Figure 4.3. Construction of scenario narratives from semi-structured interviews

A total of 10,286 individual statements were identified during the transcribing process. Those statements were then grouped and translated into 5,861 codes according to the different blocks of the interview: (i) demographic and socio-economic issues; (ii) desired scenario; (iii) scenarios based on imaginable processes; (iv) scenarios based on unimaginable processes. For example, statements with a similar message (e.g., decreasing NO_x emissions, healthier ambient air) were grouped under the same code (e.g., improving local air quality). Descriptive statistics were used to analyse the recurrent codes and translate them into the collective 2050 scenarios. The construction of each scenario narrative used at least 75% of codes originated by the respondents for this specific scenario. The other 25% of codes (contradictory aspects, etc.) were not always removed from the research, but most of them were further present in some of the reminder scenarios.

To provide legitimacy over the process, the sample target included members from both the general public and professionals from a wide range of sectors (Wangel, 2011). Since the research's objective is to explore to what extent the use of wild cards stimulates a more disruptive thinking in participatory scenario-building, the study sought to engage those participants proven to have more open and imaginative minds to venture out of their "comfort zone". That would increase the probability to find significant variations of disruptive thinking levels between the constructed 2050 scenarios. Accordingly, all selected participants were younger than 32 years old, i.e. those who would be at most 65 years old by 2050, the visioning horizon.

The narrow population age cohort was selected based on previous academic findings that revealed that these young people usually have more open minds to visualise futures outside of their comfort zone. For example, Soria-Lara & Banister (2017a p.122) compared the future views obtained by different cohorts of participants in a visioning process that combined semi-structured interviews and a Delphi method. The authors found that the most radical future visions came from the youngest participants, while the oldest participants had future visions more similar to the BAU projection. Another example comes from Tuominen et al., (2014), who separately studied and compared the future visions obtained by experts and young participants in transport visioning processes. It was evidenced the importance to include views from younger people against experts' guided processes, as they are not part of the transport establishment, but they can provide a "fresh" vision.

Interviewees were recruited by handing out flyers with a brief description of the research and the main goal of the interview. The selection of the engagement locations guaranteed the right variability of the obtained sample (e.g., popular squares, university campuses, town centres, technological centres, workplaces, and suburban transit stations). All participants consented to recording the interview for transcription. Main sample characteristics can be consulted in Table 4.2.

Table 4.2. Demographic and socio-economic characteristics of the interviewed sample

	N	%		N	%
<i>Gender</i>			<i>Place of residence</i>		
Male	58	45	In the Henares Corridor	97	75
Female	71	55	Outside	32	25
<i>Educational level</i>			<i>Travel frequency</i>		
Low (basic)	1	1	Daily	77	60
Medium	27	21	Weekly	28	22
High (University)	101	78	Occasionally	23	18
<i>Age (in years)</i>			<i>Employment status</i>		
15-19	13	10	Student	54	42
20-24	58	45	Employed student	8	6
25-29	44	34	Employed	57	44
30-35	14	11	Unemployed	10	8
<i>Regular transport mode</i>			<i>Household type</i>		
Car (own)	36	28	Living with parents (on property)	70	54
Car-sharing	10	8	Living with parents (for rent)	5	4
Bus	28	22	Living independently (on property)	6	5
Train/metro	41	32	Living independently (for rent)	48	37
Bicycle	1	1			
Walk	9	7			
Moto	1	1			
Taxi/VTC	1	1			

4.3.3. Evaluation of disruption of 2050 scenario narratives

To analyse to what extent this participatory approach can stimulate non-linear thinking, the seven 2050 scenario narratives were evaluated by a group of 21 experts in innovation, strategic decision-making, and creative thinking. It was ensured that all the selected experts carry out their professional or research activity in the Henares Corridor and that they were aware of existing planning and future trends (BAU projections) regarding transportation and land uses in the case study (see Section 4.3.1). A total of 5 experts worked in technological innovation, 9 came from departments of innovation in the transport sector, 3 belonged to department of innovation in the urban planning sector, and the remaining 4 were researchers. The aim of the evaluation was to grade the seven 2050 scenario narratives according to their disruptive thinking level. The experts were specifically informed about the meaning of “disruption” in the context of this research, ensuring a common understanding. For the context of the research, disruption means “significant divergences with BAU projections on transport and land use for the case study”.

The evaluation was completed via an on-line questionnaire³, based on dividing the seven 2050 scenario narratives into 36 statements that encapsulated the essential components of those future scenarios. Specifically, each 2050 narrative was characterised by 13 to 14 statements, where one statement could be used in representing several 2050 narratives, when appropriated and necessary. Each statement was rated on a Likert scale, asking the expert to indicate whether the statement was: (1) non-disruptive; (2) somewhat disruptive; (3) disruptive; (4) very disruptive; (5) highly disruptive. The answers for all statements that characterised each 2050 scenario narrative were grouped and processed, providing the experts assessment of the disruption potential of each 2050 scenario narrative. Descriptive analysis based on the frequency of responses were used to evaluate the level of disruptive thinking reached by each 2050 scenario narrative.

³ The original content of the questionnaire (in Spanish) can be found in Annex 2.

4.4. Results

4.4.1. The desired collective scenario for 2050

The narrative for the desired scenario was generated by asking participants to visualise their ideal 2050 workday, without considering any wild cards (imaginable and unimaginable processes). Drawing from participants responses (Table 4.3), the narrative for the desired scenario has been designated as “*The Sustainable Urban Oasis*”.

*In **The Sustainable Urban Oasis** narrative, interviewees desire a corridor dominated by sustainable mobility, prioritizing non-motorized transportation. Road and rail infrastructures would be less prominent, replaced by a dense network of green spaces at municipal and metropolitan levels. Locally, there is a desire for mixed-use urban areas to reduce travel distances between destinations such as shopping, leisure, and residences, while work areas would remain separate. Medium-density neighbourhoods with medium-height block buildings, extensive gardens, and ground-floor commercial spaces would predominate. Part of the road network would be repurposed for non-motorized travel, with vehicular traffic confined to peripheral roads, making interior spaces mainly non-motorized. Public transport stations would be more accessible, multifunctional, and integrated with green spaces.*

Public transport use, especially rail, would decrease in favour of non-motorized modes, particularly for commercial trips. Car use would remain significant for work commutes, though the percentage of privately owned vehicles would decline, with a quarter of car trips being shared. The vehicle fleet would largely consist of electric or alternative energy vehicles, with a minority using fossil fuels. Nearly a quarter of the vehicles would be autonomous, requiring infrastructure adaptations. About 10% of the population would shop exclusively online, with most walking to physical stores. Leisure activities would be linked to green spaces, encouraging outdoor activities, though nighttime leisure would still involve motorized transport.

4.4.2. Scenario narratives based on imaginable processes

The 2050 scenario narrative based on the first imaginable process (IP1) “zero-emission vehicles” was collectively drafted by the majority of participants, comprising 50% of the total sample (Table 4.3). These participants held views very closely aligned to the desired collective vision (Section 4.4.1). This scenario narrative has been labelled as “Green mobility”, and is articulated as follows:

*In the **Green Mobility** scenario, interviewees envision a corridor dominated by sustainable mobility habits, including banning non-zero-emission vehicles and increasing space for non-motorized transport. Road and rail infrastructures would diminish in prominence, with green spaces as the corridor's backbone at both municipal and metropolitan levels. Locally, there is a desire for a mix of urban activities to reduce distances between shopping, leisure, and residential areas, while keeping work areas (industrial and technology parks) separate. Urban environments would feature medium-density neighbourhoods with mid-rise buildings, ample green spaces, and commercial ground floors. Some roads could be repurposed for non-motorized travel. Vehicular traffic, no longer causing pollution, would primarily flow through peripheral road axes around main neighbourhoods, leaving interior spaces for non-motorized residential, commercial, and leisure purposes. Public transport stations would be more accessible and multifunctional, integrated with the urban green space system.*

There is a sentiment to reduce public transport usage (mainly rail) in favour of non-motorized modes, particularly for commercial travel. Car use would remain important, especially for work commutes, as teleworking is not seen as a predominant option. The percentage of privately owned vehicles would decrease, with nearly a quarter of car trips being shared. The vehicle fleet would rely exclusively on electric systems or other non-emission energy modes (e.g., hydrogen), with fossil fuel vehicles completely banned. Nearly a quarter of vehicles would be autonomous, requiring road infrastructures to adapt to automated vehicles sharing space with non-autonomous ones. About 10% of the population would shop exclusively online, while most people would walk to stores. Leisure activities would be closely tied to the green space system, promoting outdoor activities like sports and cultural events. However, nighttime leisure would still rely on motorized transport, both public and private.

The second imaginable process (IP2) “*non-motorized city centres*” was selected by 20% of participants during semi-structured interviews (Table 4.3). The 2050 scenario based on this imaginable process has been labelled as “*Car Decline*” and is articulated as follows:

*In the **Car Decline** scenario, interviewees envision a corridor dominated by sustainable mobility habits, with more space for non-motorized modes. Road and rail transport infrastructures would diminish, replaced by a dense network of green spaces at municipal and metropolitan levels. Locally, there is a desire for mixed urban activities to reduce distances between main destinations like shopping, leisure, and residences, including technological and industrial parks. This scenario involves living on the outskirts in medium/high-density neighbourhoods, transforming current technological and industrial parks into multifunctional spaces integrated with other urban activities. Street spaces in town centres would be dedicated to non-motorized mobility, except for logistics and essential services (e.g., health, fire services). This would increase the density of historic centres with high-rise housing alongside commercial and service uses. Limited vehicular traffic would circulate on peripheral roads around urban centres. Public transport stations would become accessible, multifunctional spaces at ground level, well integrated with the green space system.*

Interviewees favour reducing public transport and private vehicle use for commutes, shopping, and leisure, preferring walking and cycling. Teleworking is not seen as a predominant option for the corridor’s future. The vehicle fleet would be small, mainly electric or using alternative energy modes (e.g., hydrogen), with traditional fossil fuels greatly reduced. The level of vehicle autonomy is unimportant due to the residual nature of private vehicles in this scenario, and car-sharing systems would be rarely used. Online shopping would increase, substituting motorized trips and favouring walking to stores. Leisure activities would be closely tied to green spaces, promoting more outdoor activities like sports and cultural events. This vision prioritizes a sustainable, non-motorized urban lifestyle centered around green spaces and multifunctional urban areas.

The third imaginable process (IP3) used to generate a 2050 scenario narrative was the “*e-working dominates*” and it was selected by 20% of respondents. They were mainly young people (studying and working), who travel daily along the case study using collective modes. The 2050 scenario based on this imaginable process has been labelled as “*The Virtual Corridor*”.

*In the **Virtual Corridor** scenario, the interviewees envision a corridor with more sustainable mobility habits, including increased space for non-motorized modes. Road and rail transport infrastructures would lose prominence, with a dense network of green spaces becoming the backbone of the corridor at both municipal and metropolitan levels. Locally, there is a strong desire for a mix of activities in urban areas to reduce distances between main destinations (e.g., shopping, leisure, residence, and work). Teleworking will be established for jobs that do not require physical presence, integrating workplaces with homes and the urban environment, reducing the need for industrial and commercial land. Lower-density neighbourhoods would predominate, with low-rise buildings in town centres and more public space for citizens. The reduction in urban density is related to more people preferring to live in peripheral areas, characterized by single-family homes, while maintaining a mix of activities. Some roads could be repurposed for non-motorized use, with vehicular traffic mainly on peripheral roads around main neighbourhoods, leaving interior spaces for non-motorized uses with residential, commercial, and leisure functions.*

Public transport stations would be more accessible and multifunctional, mostly at ground level and well integrated with the urban environment and green spaces. There is a general sentiment to reduce public transport use in favour of walking. Car usage would decline significantly, with almost 40% of trips being shared. Teleworking would reduce commute times, allowing for more healthy activities like walking. The vehicle fleet would be greatly reduced and mainly electric or alternative energy (e.g., hydrogen), with fossil fuel vehicles being a minority. Nearly a quarter of vehicles would be autonomous, transforming road infrastructure to accommodate fully automated vehicles alongside non-autonomous ones. About 10% of the population would shop exclusively online, with most people walking to stores. Leisure activities would be closely linked to green spaces, increasing outdoor activities, while nocturnal leisure would still involve motorized trips, especially by public transport.

4.4.3. Scenario narratives based on unimaginable processes

The slight majority (52%) of participants selected the “*overpopulation*” as the most disruptive unimaginable process (UP1). They have similar demographic and socio-economics characteristics as the full sample. Based on participant responses (Table 4.3), the narrative titled “*Urban Boom*” has been crafted as follows:

*In the **Urban Boom** scenario, the severe impacts of climate change have led to intense international conflicts, driving significant demographic flows toward the European Union. This influx will substantially increase the population in the study area, leading to a dramatic rise in mobility demands and urban growth. Concerns about these changes will promote sustainable mobility habits, emphasizing non-motorized transport. Consequently, road and rail infrastructures will lose prominence, while a dense network of green spaces will become central to municipal and metropolitan corridors. Locally, there will be a push for mixed-use urban areas to reduce distances between key destinations like shopping, leisure, and residences, including major job centres. This shift will transform current technological and industrial centres into multifunctional spaces. The urban environment will become polarized; low-income populations will densely inhabit historic city centres, while higher-income residents will move to peripheral neighbourhoods and single-family housing areas with diverse activities.*

Road networks might be repurposed for non-motorized transport, with vehicular traffic primarily on perimeter roads, leaving interior spaces for residential, commercial, and leisure purposes. Public transport stations will become more accessible and integrated with the green space system. There will be a strong push to reduce car usage, leading to a significant decline in vehicle ownership, with nearly 50% of car trips made in shared vehicles. Public transport usage will remain stable, favouring rail modes over buses. Commuting by foot or bicycle will gain popularity, while teleworking will not dominate. The vehicle fleet will be mainly electric or based on alternative energy, with fossil fuel vehicles becoming rare. About 10% of vehicles will be autonomous, requiring infrastructure adaptations. Online shopping will rise significantly, reducing motorized trips and promoting pedestrian trips to local stores. Leisure activities will link closely to green spaces, encouraging outdoor activities, though nighttime leisure will still generate many public transport trips.

The scenario narrative based on the second unimaginable process (UP2) “*shared motorized mobility dominates*” is developed by 26% of participants. This group is made up of individuals older than 25 years old and employed, who work in the case study and frequently use public transport modes to reach daily destinations. According to their responses (Table 4.3), the narrative “*Ride together*” has been formulated as follows:

*In the **Ride Together** scenario, interviewees envision a corridor with 100% shared and sustainable mobility, prioritizing non-motorized transportation. Road and rail infrastructures would lose prominence, especially in central neighbourhoods, with a dense network of green spaces becoming the backbone at municipal and metropolitan levels. Locally, there is a strong desire for a greater mix of urban activities to reduce distances between key destinations such as shopping, leisure, and residences. However, work areas like industrial and technological zones would be segregated from residential areas. Urban environments would feature denser neighbourhoods without high-rise buildings and with more public space for citizens. Most people would prefer living in city centres to avoid owning private vehicles, leading to greater growth and densification of central neighbourhoods and a more compact corridor.*

Some roadways could be repurposed for non-motorized uses, with traffic primarily circulating on perimeter roads, limiting non-motorized interior spaces to residential, commercial, and leisure functions. Public transport stations would be more accessible and multifunctional, mostly located at street level and well-integrated with the green space system. There is a general sentiment to reduce private vehicle use, favouring non-motorized modes for work, leisure, and shopping trips. Public transport use would remain important, with a preference for rail modes over buses. Teleworking is not seen as predominant. Private vehicle circulation would be completely banned, with 100% of car trips being shared. New car-sharing platforms would emerge, organized through smartphone applications and similar devices. This fleet of shared vehicles would be exclusively electric or use alternative energy like hydrogen, eliminating fossil fuel vehicles.

The third unimaginable process (UP3), “*high level of insecurity in urban areas*”, was selected by a minority of participants (21%). They are mainly women younger than 25 years old that frequently use collective modes for travelling across the case study. Their collective responses (Table 4.3) have given shape to the scenario narrative titled “*Urban dystopia*”. This narrative is articulated as follows:

*In the **Urban Dystopia** scenario, the interviewees envision a highly insecure corridor due to growing social inequality, making walking, cycling, or motorcycling discouraged. Road and rail infrastructures would gain prominence, with minimal space for non-motorized modes. Locally, there would be low activity mix, and main destinations like shopping, leisure, residence, and work would be spatially segregated. Urban environments would feature low-density neighbourhoods with scarce public spaces. Many would prefer living in peripheral areas and single-family homes, leaving central neighbourhoods for commercial and service uses and housing for lower social strata. Public spaces would be insecure and rarely frequented, making pedestrian and cycling infrastructures unnecessary, giving way to motorized modes. Public transport stations would also become insecure and less frequented. Green spaces would turn into private, fenced areas with extreme security, linked to single-family housing developments.*

Public transport use would decline, especially rail, and non-motorized modes would no longer be viable for most. Car use would increase significantly for work, leisure, and shopping. However, private vehicle ownership would decrease, with almost 40% of car trips made using shared vehicles. The vehicle fleet would primarily consist of electric or alternative energy vehicles like hydrogen, with fossil fuel vehicles being a minority. Additionally, around 20% of vehicles would be autonomous, necessitating infrastructure adaptations for fully automated vehicles coexisting with non-autonomous ones. Although teleworking is not seen as predominant, online shopping would increase significantly, reducing trips to central commerce areas. Leisure activities would be less frequent in public spaces, leading to more privatized forms of recreation.

Table 4.3. Main interviews' codes for each scenario narrative

Codes	% of participants' codes						
	Desired scenario	Scenarios based on Imaginable processes (IP)			Scenarios based on Unimaginable Processes (UP)		
		IP1	IP2	IP3	UP1	UP2	UP3
<i>Transport modes for work trips</i>							
Car	34	34	3	0	15	23	67
Public transport	36	38	13	0	47	51	33
Walk	17	17	42	0	18	17	0
Bicycle	13	11	42	0	13	9	0
Teleworking	0	0	0	100	5	0	0
<i>Transport modes for shopping trips</i>							
Car	28	24	3	29	17	19	56
Public transport	19	24	7	16	24	43	26
Walk	40	42	54	41	37	29	0
Bicycle	3	0	11	8	4	2	0
On-line	10	7	25	6	18	7	18
<i>Transport modes for leisure trips</i>							
Car	29	32	10	20	19	21	73
Public transport	33	31	10	38	37	52	27
Walk	30	31	67	34	31	25	0
Bicycle	5	3	13	8	9	2	0
Other	3	3	0	0	4	0	0
<i>Use of car-sharing services</i>	25	25	-	40	50	100	40
<i>Use of autonomous vehicles</i>	25	25	-	25	10	10	19
<i>Transport energy sources</i>							
Fossil fuels	11	0	-	20	20	0	20
Electric/alternative	89	100	-	80	80	100	80
<i>Residence location</i>							
City centre (C)	47	44	39	38	31	49	40
Periphery (P)	45	45	48	50	59	37	60
Between C and P	8	11	13	12	10	14	0
<i>Type of neighbourhood</i>							
Very high density and high-rise buildings	11	11	13	17	13	5	13
High density and low-rise buildings	16	17	16	10	7	18	10
Medium density and low-rise buildings	54	56	52	43	47	60	43
Low density and isolated urbanization	13	11	13	26	24	15	23

4.4.4. Evaluation of disruptive thinking

The expert evaluation provides new insights into the basic hypothesis underlying this research (Section 4.2.2) – i.e. that different types of wild cards can be used to stimulate thinking outside of the BAU zone during participatory scenario-building processes. This working hypothesis was confirmed when unimaginable processes were used; however, some problems were noted in the 2050 scenarios based on imaginable processes.

The evaluation shows how the most disruptive 2050 scenarios – compared to the common 2050 desired scenario – were those generated by using the following unimaginable processes: “high level of insecurity in urban areas” and “shared motorised mobility dominates” (Figures 4.4 and 4.5). More than 90% of experts find that the 2050 scenario narrative “Urban Dystopia” is disruptive, very disruptive, and highly disruptive. Additionally, almost 70% of experts indicate that the 2050 scenario narrative “Ride Together” is disruptive and very disruptive. However, different results are found for the “Urban Boom” scenario, generated through the unimaginable process “overpopulation”, where only 43% of experts signal the scenario narrative as disruptive and very disruptive. The last is a percentage of experts similar to the obtained one for 2050 desired scenario.

Although multiple reasons can explain the previous results, one relevant aspect should be emphasized. The two most disruptive scenario narratives (“Urban Dystopia” and “Ride Together”) were obtained from smaller portions of the sample of participants who selected those unimaginable processes during the interview process (Section 4.4.3). Moreover, the socio-economic characteristics of these two sub-samples are highly homogenous unlike the population that selected “overpopulation”. For example, employed people older than 25 years who travel daily along the corridor in public transport modes were the group that selected “shared motorised mobility dominates” during the interview. In the case of “high level of insecurity in urban areas”, it was a majority of women younger than 25 years who travel daily along the corridor in public transport modes. In both cases, these sub-samples had divergent opinions regarding those participants selecting “overpopulation” during interviewed. In other words, smaller population sub-groups seem better equipped to generate divergences and disruptive thinking.

In the experts' opinion, the level of disruption reached by those scenarios generated on imaginable processes is more similar to the disruption level perceived for the 2050 desired vision (Figures 4.4 and 4.5). In all the three cases (Car Decline; Green Mobility; Virtual Corridor), only a percentage of experts lower than 52% signal these 2050 scenario narratives as disruptive, very disruptive, and highly disruptive. Even, the 2050 scenario narrative "Virtual Corridor" is recognised as disruptive by a lower percentage of experts (33%) in comparison with the desired scenario (43%).

These assessments can indicate higher probability to generate disruptive thinking among participants when highly surprising factors (as unimaginable processes) are incorporated in the process, as participants are largely used to visualize short-term futures and are strongly affected by linear thinking. Nevertheless, it is worth mentioning that the most disruptive level of thinking has been found for the "Car Decline" scenario generated through the imaginable process "non-motorised city centres", which is selected by a minority of participants during the interview process (20% of participants). That reinforces the findings obtained for the scenarios generated through unimaginable processes, smaller sample sub-groups can have more divergent opinions on transport and land use futures.

The analysis also brought to the fore that certain components of the 2050 visions are more susceptible to be disruptively visualised by participants. In particular, statements that focused on transport issues reached a level of disruption slightly higher than those focused on land use. That can be a consequence of the generalized perception of transport as a more dynamic sector, where technological developments can have higher impacts – both on short- and long-term futures. On the other hand, land use is seen as more static and permanent over the time, and thus less susceptible to be disruptively visualised.

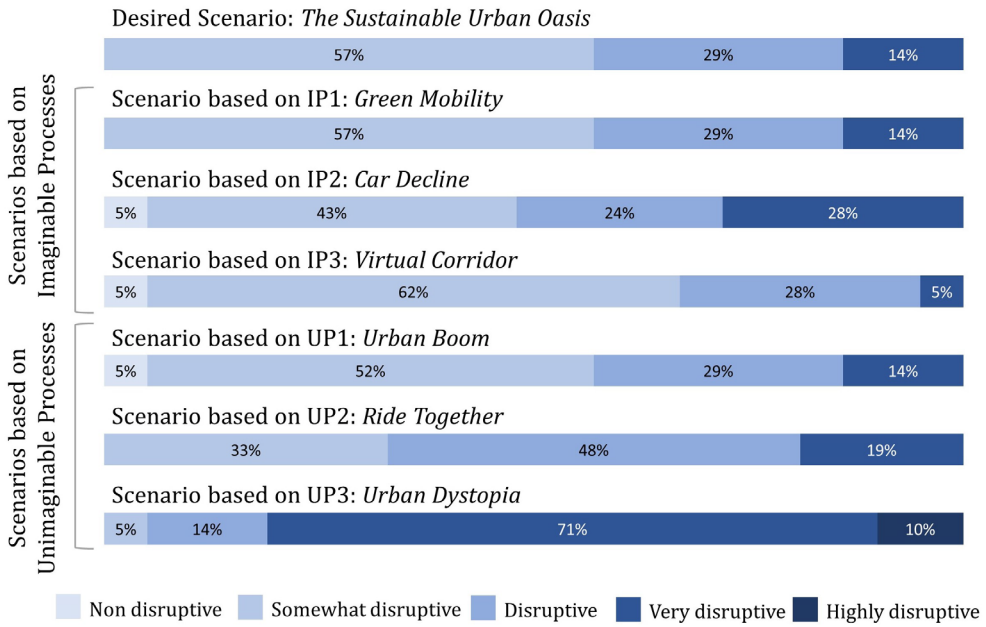


Figure 4.4. Percentage of experts identifying levels of disruptive thinking in scenario narratives

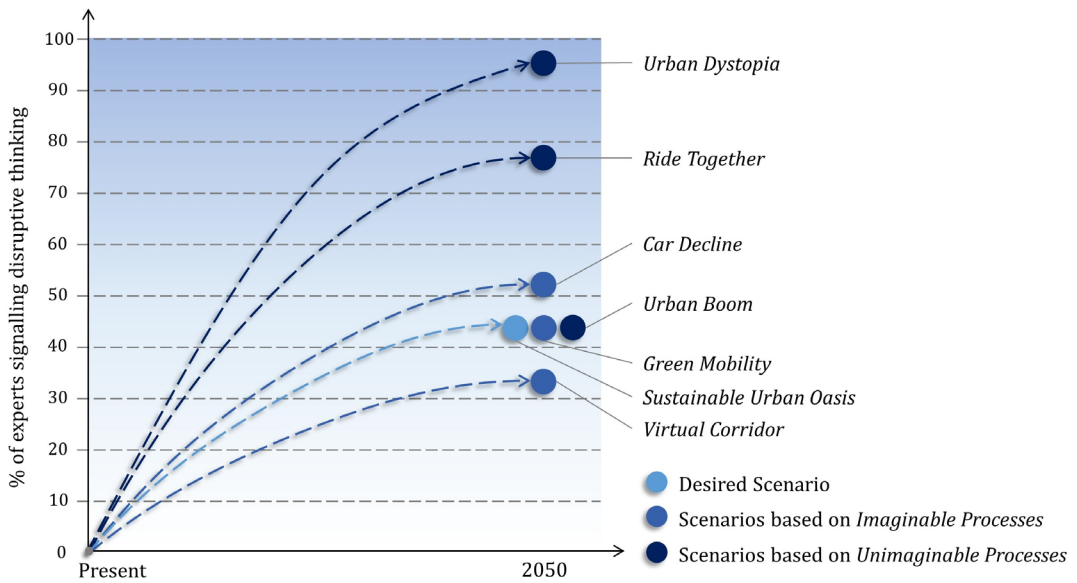


Figure 4.5. Levels of disruption identified by experts for each scenario narrative

4.5. Conclusions and discussion

The chapter sought to answer the following research question: *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory scenario-building?* To provide potential answers, a set of seven 2050 scenario narratives (one desired common narrative and six wild card-based narratives) were constructed by using semi-structured interviews. The Henares Corridor in the Metropolitan Area of Madrid (Spain) served as the case study, with an interview sample of 129 participants (between 18 and 32 years old). Their interview responses were analysed and compared on the level of disruptive thinking in the emerging scenarios for 2050. A group of 21 experts in innovation, strategic decision-making, and creative thinking assessed the level of disruption of each scenario narrative.

In the remainder of this Section, a set of issues, limitations, and emerging questions are presented, discussing which elements of the participatory scenario-building process in the Henares corridor have worked well (or not), and why. The purpose is to comment on what has been learned to distil some “prescriptions” for research and decision-making. Five issues have been identified and each is discussed here in turn:

- *The visionary participants.* They were local people between 18 and 32 years old. This methodological choice was made for two reasons: (i) providing legitimacy over the scenario-building process by engaging the widest variety of participants rather than a traditional experts-guided process (Mattila & Antikainen, 2011; Shiftan et al., 2003; Wangel, 2011); (ii) engaging a narrow cohort of people with documented capacity to think more frequently outside their comfort zone (Soria-Lara & Banister, 2017a; Tuominen et al., 2014). That is a convenience sample (Bryman, 2016) that allows the research team experimenting with a group of participants that can initially have more willingness to visualise futures under wild cards conditions. The limitation is that it would be impossible using the obtained 2050 scenarios in a real decision-making process, because it is unknown of what population this sample is representative. For example, there is a low percentage of the interviewees living as a couple or having children in this research. That incorporates an evident bias in the obtained 2050 scenarios, since other people with less individualized lifestyles might sense some of the more severe downsides and problems with commuting to work every day, which would definitely result in alternative future trajectories.

Another example of possible bias based on the sample composition comes from recent electoral experiences (e.g. UK referendum to leave EU), which show the importance of older voters in decision-making and the divergences with the younger generation. However, this convenience sample -people between 18 and 32 years old- provides the research team with a more controlled environment to prove causality associated with the working hypothesis (te Brömmelstroet, 2015). Of course, further research steps are needed to distil usable “prescriptions” for thinking disruptively in decision-making, in which the control level of the research environment decreases and the visionary participants are engaged according to the canons of probability sampling. To address that, establishing formal collaborations with regional and local governments can be an excellent way to proceed, specifically through the participation in elaborating strategic plans on transport and land use.

- *Sample size* is seen as very relevant issue for increasing the chances to generate disruptive thinking. The research design opted for larger samples, engaging one of the highest number of participants in the field of transport scenario-building (Melander, 2018). Since disruptive thinking has been related to divergences in the selection of imaginable and unimaginable processes by participants (Section 2.4.4), larger samples would facilitate the emergence of smaller groups of participants with divergent views able to select the widest range of wild cards. For both imaginable and unimaginable processes, the most disruptive thinking (compared to the desired common vision) was obtained for those scenarios triggered by wild cards selected by a minority of participants (Section 2.4.2 and 2.4.3), such as “Car Decline”, “Ride Together”, and “Urban Dystopia”.

Moreover, those smaller sample sub-groups have tended in our context to be homogeneous regarding certain socio-economic characteristics. In this respect, most of participants crafting the “Ride Together” scenario were older than 25 years old, employed, and frequently used public transport modes to travel along the case study. However, the “Urban Dystopia” scenario was mostly developed by women younger than 25 years old that frequently use public transport modes to travel along the case study. Larger sample size cannot only facilitate higher capacity to generate smaller sub-groups with divergent opinions, but also to provide a minimum number of participants that share socio-economic

characteristics and thus create unique population groups in the scenario-building exercise. Nevertheless, it must be said that although the sample size is considered crucial, in most cases it is affected by considerations not strictly related to the research themes such as time and cost.

- *Scenario-building methods.* The participatory scenario-building process implemented in this research was based on three crucial methodological choices: (i) the use of semi-structured interviews; (ii) the non-homogenization of responses in one single 2050 scenario; (iii) the comparison of a 2050 desired scenario vs six wild cards scenarios within one single study, rather than running several exercises separately (with and without wild cards). The pursuit of a larger sample strongly marked the first methodological choice: using semi-structured interviews. That choice seemed to be right, as the obtained sample (n=129 participants) facilitated the emergence of divergent and more disruptive future views (see previous discussion on sample size). The main limitation of semi-structured interviews is the null capacity of participants to interact with each other, missing the opportunity to activate learning processes where participants can modulate their discourses by hearing the rest (Soria-Lara & Banister, 2017b).

However, the use of workshops would have drastically limited the capacity to get larger samples. An intermediate via is also possible, in which semi-structured interviews are firstly used to recruit larger samples, and workshop are later used to refine and distil final future scenarios. The way in which those semi-structured interviews were coded, processed, and analysed determined the second key methodological choice: the non-homogenization of responses in one single 2050 scenario. Both the structure and further analysis of semi-structured interviews in different blocks and phases, including multi-options to add several wild cards, facilitated the capture of minority views and their translation into narratives. It was seen how these minority views usually brought by homogenous group of populations resulted in higher level of disruptiveness. The homogenization of responses has been a recurrent procedure in literature to obtain transport future visions (Mason & Alamdari, 2007; Zimmermann et al., 2012), and could be a determinant reason that reduces the probability to obtain non-linear future scenarios.

The interview design, based on distorting the participant's 2050 desired vision through several phases that added wild cards, conditioned the third key methodological choice: the comparison of a 2050 desired scenario vs six wild cards scenarios within one single study. An alternative option is to run several scenario-building exercises separately, some of which had wild cards and some of which did not (control group). That would facilitate to gain additional and stronger insights into the capacity of wild cards to add non-linear thinking, but other limitations would also appear. For example, different groups of participants would take part in each scenario-building exercise, limiting the comparability of the obtained outcomes and generating new bias in the study. Moreover, difficulties to obtain larger samples for each scenario-building exercise would have been also higher, resulting in possible stronger difficulties to reach non-linear thinking.

- *Wild cards.* The use of wild cards proved useful for generating disruptive thinking between participants when unimaginable processes were used. However, imaginable processes provided 2050 visions with similar level of disruption as the common desired scenario. This finding implies that highly surprising factors are needed to generate disruptions and break linear thinking. In this respect, using a wide range of wild cards can be crucial for two main reasons. First, the probability to generate disruption is higher as a larger number of highly surprising factors will be on the table. Second, larger numbers of wild cards can increase the chances to generate divergences between participants. In this respect, it is key that participants are forced to choose between wild cards rather than to visualize futures for all of them (Von der Gracht & Darkow, 2010).

Having to choose between wild cards triggers divergences, as proved during the participatory scenario-building presented in this research. Moreover, the choice of participants between different types of wild cards have served to incorporate outlier views from participants, represented by those wild cards selected by a minority of participants. Another important discussion is how wild cards are identified. In this chapter, wild cards were identified by the research team to break BAU projections from official planning documents in the case study (Section 4.3.1); however, they can also be elaborated by using open participatory processes that also stimulate creative thinking. The recommendation is not to use

consensus-based approaches for identifying such wild cards, but approaches based on brainstorming and radical thinking.

- *Policymaking.* Against the impossibility to consider all alternatives because of people are boundedly rational, this participatory scenario-building provides decision-making with the option to incorporate unexpected incidents or processes but high impact in planning processes. It can contribute to define a more strategic vision of planning goals that include possible threats and/or accelerators originated by wild cards. For example, the COVID-19 crisis during 2020 underlines the importance of incorporating more diverse and non-linear views into decision-making. This participatory scenario-building has demonstrated that some of the more disruptive 2050 scenarios contain thinks which are now in process due to COVID-19, but which were outside of the BAU projections for planners and decision-makers.

A sense check of the obtained scenarios could contribute to determine the usefulness of wild cards, but this sense analysis was not made in the present research. Nevertheless, further steps are still needed to distil useful practice tools by using wild cards (see previous discussion on the visionary participants). This participatory approach that engages the widest range of participants provides legitimacy over planning processes. However, it must be said that each participatory process should be customized for each particular situation, as its success depends on many factors, such as: cost, cultural tradition, time, level of participatory-oriented education, etc. Legal barriers and the low commitment of politicians to those participatory scenario-building exercises are also seen as obstacles to overcome in real practice.

Finally, this chapter presents a participatory scenario-building process aimed at evaluating the capacity of wild cards to stimulate disruptive thinking. The results are encouraging – especially when introducing wild cards that are less imaginable by participants. Further research could inform how to deploy wild cards more effectively used during scenario-building processes. In this respect, new challenges are related to the development of efficient methods to generate and identify wild cards as well as the design of effective mechanisms to assess the level of disruption generated through the scenario-building process.

5

5 EXPERIMENTING WITH DISRUPTIVE SCENARIOS TO INTEGRATE LAND USE AND TRANSPORT

This *Fifth Chapter* is a reprint of the article “*Experimenting with scenario-building narratives to integrate land use and transport*”, published in *Transport Policy* (2021), 101, pp. 57-70. <https://doi.org/10.1016/j.tranpol.2020.11.012>

Abstract

Scenario-building is often used to examine alternative future narratives when there is considerable uncertainty or when business-as-usual is no longer appropriate. However, the potential of disruptive scenario narratives to achieve a more-effective integration of land use and transport in policymaking remains understudied. This chapter analyses groups of factors that influence the effectiveness of scenario-building narratives to trigger interaction processes between planning actors and thus facilitate land use and transport integration. The research uses an experimental approach based on three parallel academically constructed cases -co-creation environments with planning actors tightly controlled by researchers to explore causality. The Henares Corridor in the Madrid Metropolitan Area, Spain serves as case study. The results indicate that higher degrees of land use and transport integration are achieved when the use of disruptive scenario narratives facilitates complex interactions among planning actors, who employ factors from various deliberation layers (internal, individual, and global). However, the degree of land use and transport integration decreases when scenario-building narratives are paired with simpler interactions, where factors from one or two deliberation layers dominate. The chapter closes by examining the implications of the obtained findings for policymaking, including a reflection on the research design validity, its limitations, and potential for application in real-life experiments.

Key words: scenario analysis; urban planning; experiment; stakeholder; future

5.1. Introduction

Land use and transport systems are inseparably interconnected. The main reason to travel is the benefits that people achieve at their destinations, establishing a close link between land use activities and trip generation (Banister, 2005; Bertolini, 2017). Achieving high levels of land use and transport integration -supportive interconnection between both systems- is seen crucial for policymaking. Integrated policies are expected to originate a reduction of travel distances and trips, while maximize mobility benefits by increasing accessibility levels to major destinations (Curtis et al., 2009; Schwanen et al., 2004). However, an effective integration is still lagging behind in practice (Bliemer et al., 2016; Silva et al., 2017) due to institutional obstacles (Rietveld and Stough, 2005; Tang, 2015), discrepancies between professional domains (Te Brömmelstroet & Bertolini, 2008), and divergencies in conceptual approaches (Boisjoly & El-Geneidy, 2017; Proffitt et al., 2019; Hull, 2005). Land use and transport integration should ideally happen in the earliest planning phases, when planning actors interact and deliberate over strategic goals based on long-term visions (Innes & Booher, 2018; Friedman, 1987; Healey, 2006; Habermas, 2007; Willson, 2001).

Scenario-building can help planning actors meet the requirements outlined above (Banister & Hickman, 2013; Böjerson et al., 2006). It is marked by the approach of taking future endpoints in the longer-term (e.g., decarbonized transport system) and then examining the means and pathways to this goal (e.g., priority of access to active modes). The resulting scenarios can be prescriptive, exploratory, and normative. That means they can be assembled from a forecasting, an exploratory, or a backcasting point of view (Vergragt & Quist, 2011). This variety of techniques has been implemented in all segments of the transport sector (Akerman & Höjer, 2006; Banister et al., 2000; Lyons & Davidson, 2016; Melander, 2018). In particular, this research focuses on exploratory scenarios, which examine futures that are regarded as possible to happen from several perspectives. The “visioning phase” is a crucial methodological step for exploratory scenarios; it first establishes a baseline that reflects the business-as-usual projection and then constructs a series of exploratory alternatives for the long term (20-30 years). Participatory visioning approaches are increasingly being deployed, enhancing the legitimacy of the process (Soria-Lara & Banister, 2017a; Vallet et al., 2020; Wangel, 2011).

The conventional visioning outcome are scenario narratives. They usually are a (collective) description of future views that can be used in practice for exploring strategic planning goals. Such narratives mostly consist of a set of storylines, photographic collages, sketches, 2D maps, and 3D scenes that show strategic futures on the city and its transport systems. Examples of narratives can be consulted in González-González et al. (2019), Banister & Hickman (2013), and Tuominen et al. (2014). Since scenario-building narratives are presented in an easily accessible format (e.g., storylines) (Chermack, 2004; Van Drunen et al., 2011), they can be valuable for activating deliberation and interaction processes in decision-making that aspires toward effective land use and transport integration.

However, this potential remains understudied. First, there is a lack of experimentation on the effectiveness and usability of disruptive scenario narratives in planning contexts. That limits the understanding of internal and external factors to narratives, which determine the capacity of disruptive narratives to activate effective interaction processes between planning actors that result in the achievement of strategic goals (e.g. land use and transport integration). Second, the primary concern of most visioning transport studies is rarely the achievement of this integration as a means to other major goals, such as CO₂ reduction targets and equitable access to the transport system (von der Gracht & Darkow, 2016; Hickman et al., 2011; Hickman et al., 2013; Hickman & Banister, 2014; Julsrud & Priya Uteng, 2015; Liimatainen et al., 2014; Soria-Lara & Banister, 2018b).

The chapter aims to address this gap by examining the following research questions: *To foster land use and transport integration, which factors influence the effectiveness of disruptive scenarios to trigger interaction processes between planning actors?* Three groups of factors are examined: (i) global environment, based on common conditions affecting all planning actors (e.g., socio-technological trends, legal framework); (ii) individual environment, associated with the peculiarities and professional training of planning actors involved; (iii) internal environment, which refers to inherent factors in both narratives and planning conditions.

The Henares Corridor in the Madrid Metropolitan Area, Spain provides the empirical focus (see Section 3.2 in Chapter 3). The research is based on an experimental approach, engaging planning actors in three academically constructed cases –co-creation environments with planning actors tightly controlled by researchers to

explore causality – that use disruptive exploratory narratives to achieve land use and transport integration. First, the research briefly presents three 2050 disruptive narratives for the case study previously elaborated by the research team (see Section 4.4. in Chapter 4). Second, the effectiveness of the three 2050 narratives to facilitate land use and transport integration is analysed by applying them in the three mentioned academically constructed cases, thereby uncovering whether such narratives can trigger interaction processes between different planning actors.

In the next section (section 5.2), a literature review of scenario-building applications for the transport sector is conducted, distilling a multi-layer framework for identifying internal and external factors that influence the effectiveness of scenario-building narratives in decision-making. Section 5.3 shows the experimental research design, while Section 5.4 details the main results obtained. Finally, Section 5.5 closes with several concluding remarks and recommendations for further inquiries.

5.2. Using scenario-building narratives: a multi-layer framework

This section presents a review of previous studies that use scenario-building narratives in the transport sector. Its aim is to distil a multi-layer framework of factors that determine the effectiveness of future narratives while they are used by planning actors for specific purposes (e.g. land use and transport integration). These factors focus on identifying and characterising the nature of interactions that take place between actors while using narratives, rather than describing future scenarios themselves and their operationalisation. Such factors, therefore, are not necessarily internal to narratives (e.g. narratives overall length), but also external and linked to the planning environment and the profile of actors involved. Each group of factors moves into a different layer, which is simultaneously overlapped and interconnected to the other layers. In total, three layers are examined (Figure 5.1): (i) the global environment, (ii) the individual environment, and (iii) the internal environment.

Layer 1, the *global environment*, is related to those common boundary conditions affecting all planning actors during the use of narratives: e.g., the legal framework, macro-political system, technological developments, cultural norms (Geels & Schot, 2007; Switzer et al., 2013). Planning actors are usually constrained by factors from Layer 1 to assume that social systems tend to evolve aligned with business-as-usual (BAU) trends. For example, the BAU projections on the macro-political evolution and

the economic market highly conditioned to the visioning process conducted by Zimmermann et al. (2012) for the electric mobility in Germany, resulting in strong limitations for activating deliberation processes to visualize policy pathways outside of the BAU zone. The influence of BAU projections on transport visioning is also high in the study co-authored by Banister & Hickman (2013) in the context of Delhi, impacting on the capacity to adopt non-linear policy options. Together with BAU trends, both the existing legal frameworks and dominant political structures are other frequent global factors impacting on the use of future narratives (Steurer & Bonilla, 2016). The dominant belief is that such legal and political structures will block most of the possible changes suggested by narratives, assuming that current regimes persist through time.

Layer 2, *individual environment*, refers to those factors associated with the individual peculiarities of planning actors engaged in the use of narratives. Beyond the personal character, beliefs, and ideologies, this group of factors is strongly related to the two types of acquired knowledge: explicit and tacit (Collins, 2010; Nonaka & Takeuchi, 1995; Polanyi, 2009; Te Brömmelstroet & Bertolini, 2008, 2010). While explicit knowledge is the formal and systematized kind obtained under the framework of educational careers and professional domains (e.g., scientific formulas, maps, universal principles, etc.), tacit knowledge is informal and qualitative, based on individuals' actions and experiences. For example, Soria-Lara & Banister (2017b) describe how planning actors with engineering backgrounds tend to contest deliberation processes originated by the use of narratives, since the narratives' content is not supported by computer models and numerical data. A similar problem can be seen for those future narratives elaborated by Lyons & Davidsons (2016). On the contrary, planning actors with social science backgrounds are sceptical of deliberation processes originated by narratives that are primarily based on quantitative and sophisticated numerical approaches and include only low levels of public participation (Ashina et al., 2012; Akerman & Höjer, 2006).

Layer 3, *internal environment*, is based on a set of inherent factors in both scenario-building narratives (e.g., length, scope, content, sketches) and the planning conditions in which such narratives are used (e.g., the involved institutions, planning stages, rules for academically-constructed cases, timelines). For example, planning actors found it difficult to reach consensus regarding the social and spatial impacts of

transport future narratives constructed by Soria-Lara & Banister (2018a) in Andalucía, Spain, finding them to be too schematic and not sufficiently goal oriented. Other examples about how the planning conditions can affect the effectiveness of narratives to trigger deliberative processes can be consulted in Tuominen et al. (2014), González-González et al. (2019), and Hickman et al. (2010). These authors conducted academically constructed cases where planning actors had to discuss policy pathways linked to transport narratives. However, the available policy options were limited to a small number by the research team, making it difficult to activate open deliberative processes that consider all potential policy options.

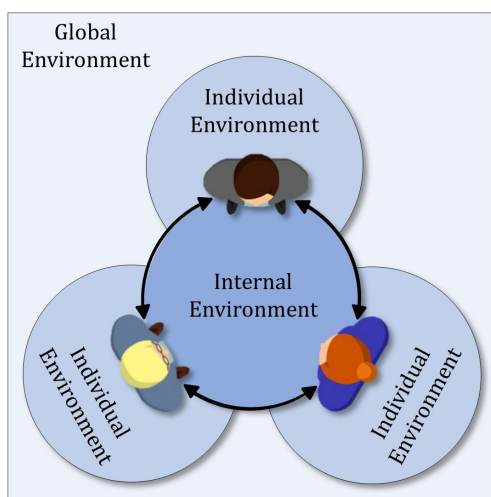


Figure 5.1. Schematic representation of the multi-layer framework

5.3. Research design

This research is based on an experimental approach, engaging different planning actors in three academically constructed cases -co-creation environments with planning actors tightly controlled by researchers to explore causality-. It is inspired by the “experiential research design” approach developed by Straatemeier et al. (2010), with multiple applications in the field of transport research (Beukers et al., 2012; Soria-Lara et al., 2016; Te Brömmelstroet & Bertoini, 2010). This experimental approach recognises both transport research and transport practice as the two sides of a spectrum, rather than a dichotomy. The expected outcomes are a sort of “prescriptions”, previously analysed and tested in academic environments where planning actors and researchers co-create new knowledge.

The methodological design covers three phases: (i) input, three 2050 narratives for the Henares Corridor; (ii) experimentation, three academically constructed cases; and (iii) evidence, the recording, processing, and analysis of information.

5.3.1. Input: Three 2050 narratives for the Henares Corridor

The selection of the Henares Corridor as a case study for this research (see Section 3.2 in Chapter 3) is grounded in the evident commitment of regional government and local authorities to attain substantial levels of land use and transport integration in the long term. This commitment serves as a foundation for several key objectives, including: (i) a targeted reduction of transport-related greenhouse gas (GHG) emissions by 10%; (ii) an enhancement of transport energy efficiency through the modification of travel behaviours and patterns; and (iii) fostering economic growth while concurrently mitigating social inequalities (See Section 4.3.1 in Chapter 4).

As showed in Chapter 4, participatory scenario-building methods were deployed by the research team to create a set of disruptive scenario narratives for the Henares Corridor for 2050, addressing the challenge of land use and transport integration in different ways. Seven 2050 scenario narratives with different levels of disruption and remarkable differences in their contents were developed (see Section 4.4 in Chapter 4). Three of them have been used as inputs for this research: “Car Decline”, “Urban Boom”, and (iii) “Urban Dystopia”. A more concise version is presented below:

Car Decline: *In an ambitious move towards sustainable urban developments, cities within the Henares Corridor have implemented a groundbreaking initiative to create vibrant, pedestrian-friendly city centres by strictly restricting private vehicle access. This bold step encourages and prioritizes walking and cycling as the primary transportation modes to all daily destinations. The driving force behind this transformation is the desire to foster healthier, greener, and more interconnected communities. Cities have focused on integrating various aspects of daily life within accessible distances. By ensuring a rich mix of residential, commercial, leisure, and working sites, residents can enjoy the convenience of satisfying their essential needs within walking or cycling distance. Industrial and business areas are undergoing a profound metamorphosis, transiting into vibrant mixed-use zones. This transformation not only reduces the dependence on private vehicles but also promotes a diverse and*

inclusive urban environment where work and leisure can harmoniously coexist. In addition, green corridors are established throughout the case study, providing residents with a dense network of walking and cycling paths.

Urban Boom: *The Henares Corridor has experienced a significant surge in population growth, leading to transformative changes in urban living and transportation patterns. The main city centres have become vibrant and diverse, characterized by a mix of multi-family dwellings, urban services, and facilities. The rising number of multi-family dwellings accommodates the growing population. Meanwhile, high-income households prefer low-density residential neighbourhoods on the city's periphery. These areas offer a blend of suburban tranquillity and a high land-use mix, providing residents with a balanced lifestyle. The transformation of the city's periphery also involves converting current work areas into multi-functional places, creating lively and dynamic hubs that cater to various needs and activities. Collective modes of transport, such as buses and trains, are increasingly used for work commutes while walking and cycling for shopping and leisure. To ensure the seamless connectivity of the region, a network of green corridors has been strategically designed to integrate active mobility with public transport systems.*

Urban Dystopia: *The Henares Corridor is shaped by a distressing increase in insecurity in urban areas. High crime and robbery rates have led to a drastic shift in the modal split, with private cars becoming the prevailing choice for daily trips, including commuting, shopping, and leisure activities. The insecurity has rendered walking and cycling inadvisable, and public transport is stigmatized and predominantly used by the low-income population with limited alternatives. This grim reality has left the region devoid of green zones and safe public spaces, depriving residents of public spaces for recreation and relaxation. The urban landscape has become highly segregated, with homogeneous areas connected primarily by motorized infrastructures. City centres have been transformed into work destinations, with most employees commuting from the city's periphery, where high-income families reside in private communities. Low-income families are left with limited options, often forced to reside in insecure neighbourhoods in the city centres, exacerbating social inequalities.*

5.3.2. Experimentation: Three academically constructed cases

The experimentation is based on three academically constructed cases. They are co-creation environments with planning actors that are tightly controlled by the research team to explore causal relationships regarding pre-established research questions. In each academically constructed case, planning actors were asked to identify and map the land use and transport pathways to one of the pre-set 2050 narratives. This would activate interaction processes between planning actors, facilitating the analysis of which factors (global, individual, and internal) influence the achievement (or not) of high levels of land use and transport integration.

The three academically constructed cases were operationalized through three workshops where planning actors met face-to-face. Each workshop focused on one of the 2050 scenario narratives presented in Section 5.3.1. A total of 18 planning actors took part, 6 of them in each workshop and none participated in more than one workshop (Figures 5.2, 5.3, 5.4). Planning actors were assigned to different workshops with the aim to cover diverse profiles (Table 5.1): policymakers, property developers, urban planners, transport planners, and environmental consultants. Participants were approached by e-mail –and phone calls when necessary. They were informed about the research objectives and their potential commitment. All participants signed ethical and confidentiality consents.

Table 5.1. Professional profiles of workshops’ participants

Workshop 1	Workshop 2	Workshop 3
“Car Decline”	“Urban Boom”	“Urban Dystopia”
2 Policymakers	1 Policymaker	1 Policymaker
1 Property developer	1 Property developer	1 Property developer
1 Urban planner	1 Urban planner	1 Urban planner
1 Transport planner	2 Transport planners	2 Transport planners
1 Environmental consultant	1 Environmental consultant	1 Environmental consultant



Figure 5.2. Participants in Workshop 1 “Car Decline”



Figure 5.3. Participants in Workshop 2 “Urban Boom”



Figure 5.4. Participants in Workshop 3 “Urban Dystopia”

The workshop’s duration was flexible (approximately 2 hours, including a break). Each workshop consisted of two different phases with interrelated purposes: (i) characterisation of the 2050 narrative, and (ii) mapping land use and transport pathways according to 2050 narrative.

The three workshops were conducted in parallel in the same day, but not at the very same time. In parallel means the results from one workshop were not an input for the next. This methodological choice facilitates simultaneous comparison of similarities and differences in the patterns of factors affecting the effectiveness of the 2050 narratives to facilitate land use and transport integration. The same member of the research team took on the role of mediator in the three workshops, with the others always acted as observers. The mediator, the professional profile of participants, the workshop’s purpose and rules, and the protocol of interpersonal engagements kept constant across the three academically constructed cases. However, both participants and 2050 narratives varied, since the three groups of factors identified in the literature review (global, individual, and internal) are strongly linked to individual participants and the narratives themselves.

During phase 1, “characterisation of the 2050 narrative,” the moderator first described the Henares Corridor baseline situation, and then presented one of the three 2050 narratives: “Car Decline” (Workshop 1), “Urban Boom” (Workshop 2), and “Urban Dystopia” (Workshop 3). Additionally, all participants could consult a portfolio with baseline information from the case study and a description of the 2050 narrative. In each workshop, the planning actors initially discussed on how to identify land use and transport pathways to reach one of the pre-set 2050 narratives. After a period of discussion, the moderator disseminated an individual questionnaire to each planning actor, to capture the specificities of each workshop discussion into specific variables. The questionnaire consisted of two types of questions: the first type, Likert-scale questions, focused on the degree of change in specific land uses (residential, industrial, commercial, etc.) and urban form patterns (compactness vs sprawl, multifunctional places vs monofunctional places). The second type, multi-options questions, prioritized possible changes in the transport systems (e.g., increase of public transport infrastructure, development of multimodal stations). The questionnaires were anonymously processed during the workshop break, with the aggregated results providing inputs for the next workshop phase.

During phase 2, “mapping land use and transport pathways according to 2050 narrative”, the moderator presented the aggregated results from the participant questionnaires, highlighting the following topics: (i) degree of land use changes; (ii) dominant patterns of the urban form; and (iii) prioritized changes in the transport system. The planning actors were asked to collectively map land use and transport changes according to 2050 narrative, following the aggregated responses obtained during the abovementioned questionnaire. For example: the quantity of land use changes mapped had to be similar to the aggregated results obtained in the questionnaires, while the location of land use changes in the map should reproduce the urban form pattern signalled in the questionnaire (e.g., more compact or more sprawl). The mapping process used three different elements: (i) cartography of the 2019 land use and transport baseline; (ii) pushpins to grade the level of changes in land uses (Figure 5.5); and (iii) markers to draw changes in transport systems and infrastructures (Figure 5.6).



Figure 5.5. Workshops' participants using pushpins for grading changes in land uses



Figure 5.6. Workshops' participants using markers for drawing transport changes

5.3.3. Evidence: Recording, processing, and analysing information

The technique of structured observation was used to process the content of planning actors' interaction during the three workshops (Bryman, 2008). Each workshop was video-recorded and two different researchers acted as independent observers to transcript and codify the workshops' information. Several training rounds were conducted to homogenise codification and interpretation criteria, using the workshop 1 as a testing ground. The inter-observer reliability of the codification process was determined by estimating Kappa coefficients (kappa values of 0.21–0.4 indicating fair agreement, 0.41–0.6 moderate, 0.61–0.8 substantial, and 0.81–1.0 almost perfect agreement).

The three workshops were divided into conversation episodes. A conversation episode is here considered as a fragment of workshop in which participants discuss on a specific topic (e.g., infrastructures, city model, lifestyle), there is a similar intensity of interactions (e.g., intense conversation), and the conversation dynamic is recognizable (e.g., confronting arguments, consensus, dead ends, moderator interruptions). The interventions of each participant during the conversation episodes were also identified. An intervention is here considered as the instant in which a participant gives his/her opinion during a conversation episode. Multiple interventions from one participant can be found during a conversation episode. The duration of each intervention does not take part in the analysis. Finally, participants' interventions were codified following two parallel rounds (detailed in the remainder of this section), where one single intervention could be translated into one or several codes.

The first coding round aimed to examine to which extent the interactions between participants effectively integrated land use and transport. The coding rules were based on the so-called transport–land use feedback cycle (Wegener & Fürst, 2004; Bertolini, 2012) (Figure 5.7). The cycle synthetizes the systemic nature of the urban mobility, showing causality connections between land use and transport. In particular, the cycle indicates (Bertolini, 2012 p. 19) that patterns of land use determine the places at which people carry out activities (e.g., where they live, work or do leisure activities); movements between these locations must be taken through the transport system, and transport developments determine the accessibility of locations, which, in turn, is an essential factor of land use change.

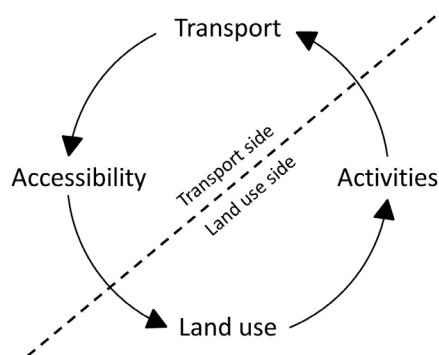


Figure 5.7. Transport-land use feedback cycle

The interventions of each participant, depending on its content and message, was individually coded according to one or several of the four categories of the cycle: transport, accessibility, land use, and activities (Figure 5.8 and Table 5.2). Kappa coefficients for this codification round were 0.86 for workshop 1, 0.87 for workshop 2, and 0.91 for workshop 3. Higher levels of integration would be reached when the four categories of the cycle (transport, accessibility, land use, and activities) were simultaneously discussed by participants during a conversation episode.

A cycle dissimilarity index (0–1) was calculated to estimate the level of integration in each conversation episode. Its calculation is based on the difference between the number of codes from the four categories of the cycle, divided by the total number of codes in the conversation episode under analysis. The minutes spent by each participant discussing about one (or more) of the four categories did not take into consideration for estimating the dissimilarity index, only the number of interventions. Values of dissimilarity index of 0 to 0.2 indicate almost a perfect integration; 0.21 to 0.40 indicate a substantial integration, and >0.41 indicate a low level of integration.

The second coding round focused on identifying which types of factors were brought up by participants during their interactions. The coding rules were based on the multi-layer framework described in Section 5.2. As indicated, potential factors were coded according to three different layers: (i) the global environment, (ii) the individual environment, and (iii) the internal environment. The intervention of each participant, depending on its content and message, was coded according to one or several of the group of factors described (Figure 5.8 and Table 5.2). Kappa

coefficients for this codification rounds were 0.68 for workshop 1, 0.71 for workshop 2, and 0.66 for workshop 3.

To identify if one group of factors dominated over the others, a multi-layer dissimilarity index (0–1) was calculated for each conversation episode. The calculation is based on the difference between the number of codes from the three indicated groups of factors, divided by the total number of codes in the conversation episode under analysis. The minutes spent by each participant using arguments from one (or more) of the three layers did not take into consideration for estimating the dissimilarity index, only the number of interventions. Values of multilayer dissimilarity index of 0 to 0.2 indicate almost an equal use of factors from the three layers; 0.21 to 0.40 indicate a high proportional use of factors from the three layers, and >0.41 indicate that one or two group of factors dominated over the others. Conversation episodes with interaction processes of interest were systematically compared from the three workshops. The comparison was based on both the level of land use and transport integration and the analysis of dominant factors.

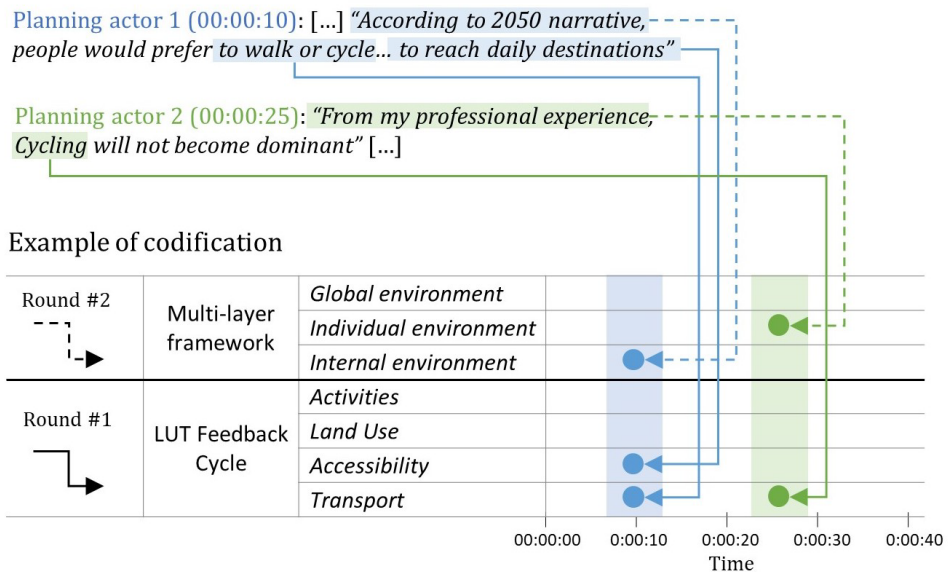


Figure 5.8. Schematic of the two coding rounds

Table 5.2. Codification criteria for participants' interventions

Codes	General criteria for codifying participants' interventions
First coding round (land use and transport cycle)	
Transport	Interventions on: <ul style="list-style-type: none"> - Transport modes (e.g., car, bus, train, metro, public transport, walking, cycling, electric/biofuels/fossil-based vehicles) - Transport infrastructures (e.g., road, highway, railway, motorised corridor, bicycle lane, pedestrian path, multimodal stations) - Movements, trips, mobility patterns, routes, traffic, flows and travel frequencies
Accessibility	Interventions on: <ul style="list-style-type: none"> - Access, reaching places, connecting different locations - Places reachability by specific modes (e.g., away from, close to)
Land Use	Interventions on: <ul style="list-style-type: none"> - Urban land uses (e.g., public facilities, industrial areas, residential places, green areas, environmental protected areas) - Urban form patterns and their locations (sprawl, compact city, periphery, city centre)
Activities	Interventions on: <ul style="list-style-type: none"> - Specific daily activities and their locations (e.g., travelling to work, daily return to home, shopping and leisure activities, learning at school and University, parks) - Industrial and technological activities (e.g., logistics, research & development, manufacturing) - Public facilities and their locations (e.g., health care centres, governmental offices) - Other activities and their locations (e.g., retail, business)
Second coding round (multilayer framework)	
Global	Interventions on:
Environment	<ul style="list-style-type: none"> - Social, cultural, and socio-economic BAU trends - Environmental laws and existing mandatory restrictions - Expected technological developments and their social penetration - Existing legal frameworks, local and regional political systems - Past and expected urban and transport developments
Individual	Interventions on:
Environment	<ul style="list-style-type: none"> - Professional backgrounds, experiences, interests - Systematized procedures - Personal beliefs and ideology
Internal	Interventions on:
Environment	<ul style="list-style-type: none"> - The workshops' rules (e.g., procedures, information available, timing, materials) - The workshops' operationalisation (e.g., baseline information, moderator style, number of participants) - Inherent factors in 2050 narratives (e.g., length, scope, content, complexity, writing style)

5.4. Results

5.4.1. Review of the academically constructed cases

Workshop 1 (Car Decline) took 1 hour and 20 minutes, not including the coffee break, with 6 planning actors and a moderator present: 2 policymakers (policymaker A and policymaker B), 1 transport planner, 1 urban planner, 1 environmental consultant, and 1 property developer. The research team identified sixteen conversation episodes (Figure 5.10), but only six included interactions related to our research aims (Episode 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6). The other episodes were very brief, with a low number of interventions, and merely transitional (Table 5.3). The six conversation episodes registered a total of 274 interventions from the six participants, which were transposed into 651 codes (Figure 5.10). The urban planner was the most active participant with 23.4% of interventions, followed by the transport planner (21.5%), and the policymaker B (20.8%). The other contributions (34.3%) were almost equally split between the remaining participants. All participants interacted with each other; however, bilateral discussion between the urban planner, transport planner, and policymaker B dominated (Figure 5.9).

Regarding the transport–land use feedback cycle, the codes labelled with categories from the transport side (transport and accessibility) dominated (51.4%). The urban planner and the environmental consultant made more balanced contributions, referring more frequently to all categories from both cycle sides. The cycle dissimilarity index was <0.2 for the Episode 1.3 and 1.5, indicating almost perfect land use and transport integration; however, the others had cycle dissimilarity index values of >0.4 (Table 5.3). With respect to the multi-layer framework, 40% of codes were labelled as internal environment, another 40% as individual environment, and 20% as global. Factors from only one or two layers (frequently from the individual and internal environments) dominated half of the conversation episodes, with a multi-layer dissimilarity index of >0.4 . In particular, the conversation episode 1.2 shows the highest multiframework dissimilarity index (Table 5.3).

Workshop 2 (Urban Boom) took 1 hour and 28 minutes, not including the coffee break, with a total of 6 planning actors and a moderator present: 2 transport planners (transport planner A and transport planner B), 1 urban planner, 1 policymaker, 1 environmental consultant, and 1 property developer. The research team identified

ten conversation episodes (Figure 5.11): five were very brief and transitional, while the rest (Episode 2.1, 2.2, 2.3, 2.4, and 2.5) included research-relevant interactions (Table 5.3). Transcriptions recorded a total of 193 interventions, resulting in 422 codes (Figure 5.11). Most interventions (80%) were almost equally distributed between the two transport planners, the policymaker, and the environmental consultant. Collective discussions dominated, while direct replies between pairs of participants were rare (Figure 5.9).

According to the transport–land use feedback cycle, most interventions (62.1%) were related to categories of the land use side (land use and activities). The two transport planners covered the four dimensions of the cycle equally, while the other participants focused on the land use side. Episodes 2.2 and 2.5 had values of the cycle dissimilarity index of <0.2 , and the rest had values of >0.4 (Table 5.3). With respect to the multi-layer framework, 53% of codes were labelled as internal environment, 25% as global environment, and 23% as individual. Episode 2.2, 2.4, and 2.5 presented values of multi-layer dissimilarity index <0.2 , signalling an almost equal use of the three groups of factors studied (Table 5.3).

Workshop 3 (Urban Dystopia) took 1 hour and 33 minutes, not including break time. In addition to the moderator, 6 planning actors participated: 2 transport planners (transport planner A and transport planner B), 1 urban planner, 1 policymaker, 1 environmental consultant, and 1 property developer. The research team identified twelve conversation episodes (Figure 5.12), of which five were very brief and transitional (Table 5.3). The rest (Episode 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, and 3.7) included interactions related to our research aims. Such conversation episodes covered 447 participant interventions, transposed into 846 codes (Figure 5.12). The urban planner was the most active participant, with 36.7% of all interventions. The transport planner A, policymaker, and property developer each provided 16% of total contributions, while the transport planner B and environmental consultant only had 8.7% and 6.9% of the interventions, respectively (Figure 5.9).

With respect to the transport–land use feedback cycle, interventions related to the land use side (land use and activities) dominated (64.7%). Transport planner A addressed aspects from all four categories equally, while the other participants focused on the land use side. Only one episode had a cycle dissimilarity index of <0.2 (Episode 5.7), the rest had values of >0.4 (Table 5.3). Regarding the three layers of

factors detailed in Section 2, 57% of interventions were coded as internal environment, 25% as individual environment, and 18% as global. Only Episode 3.7 had values of multi-layer dissimilarity index of <math><0.2</math>, while the rest had >math>>0.4</math>.

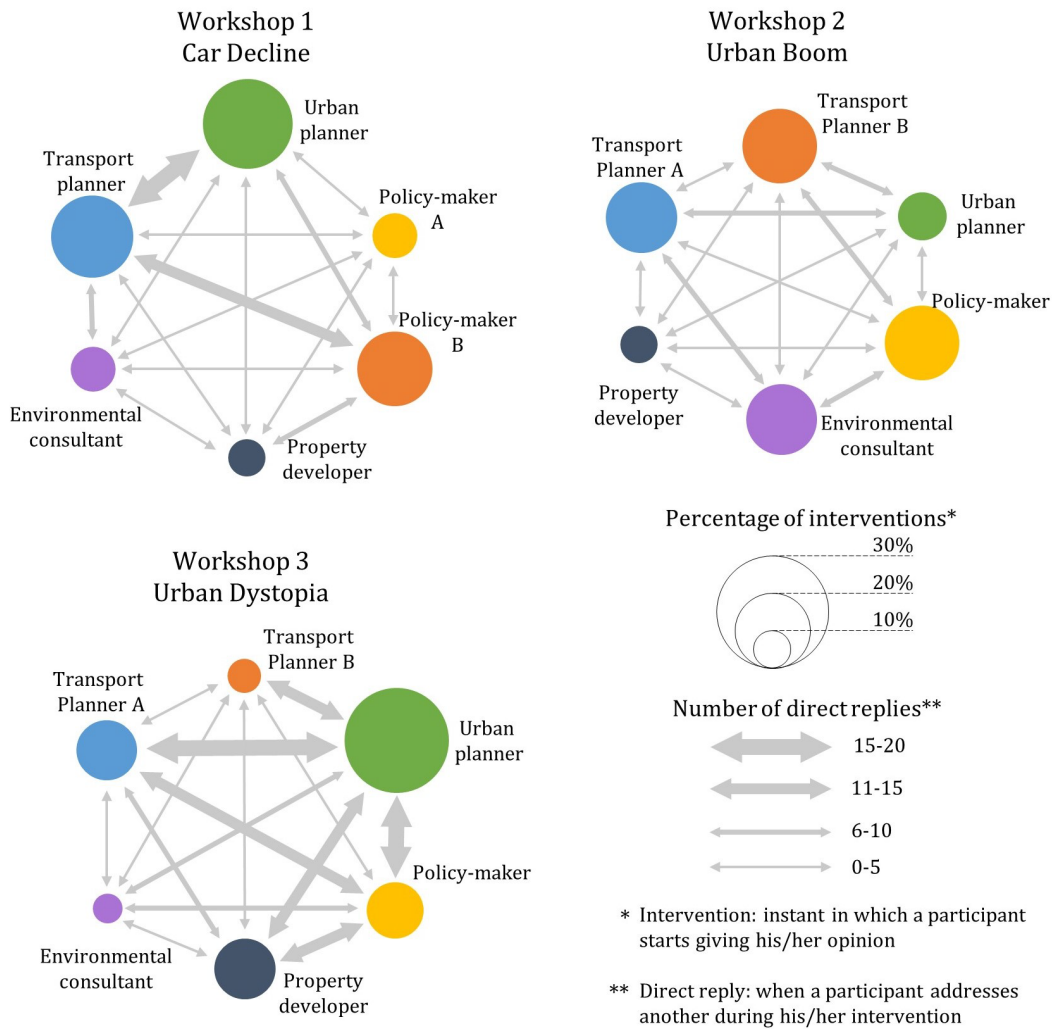
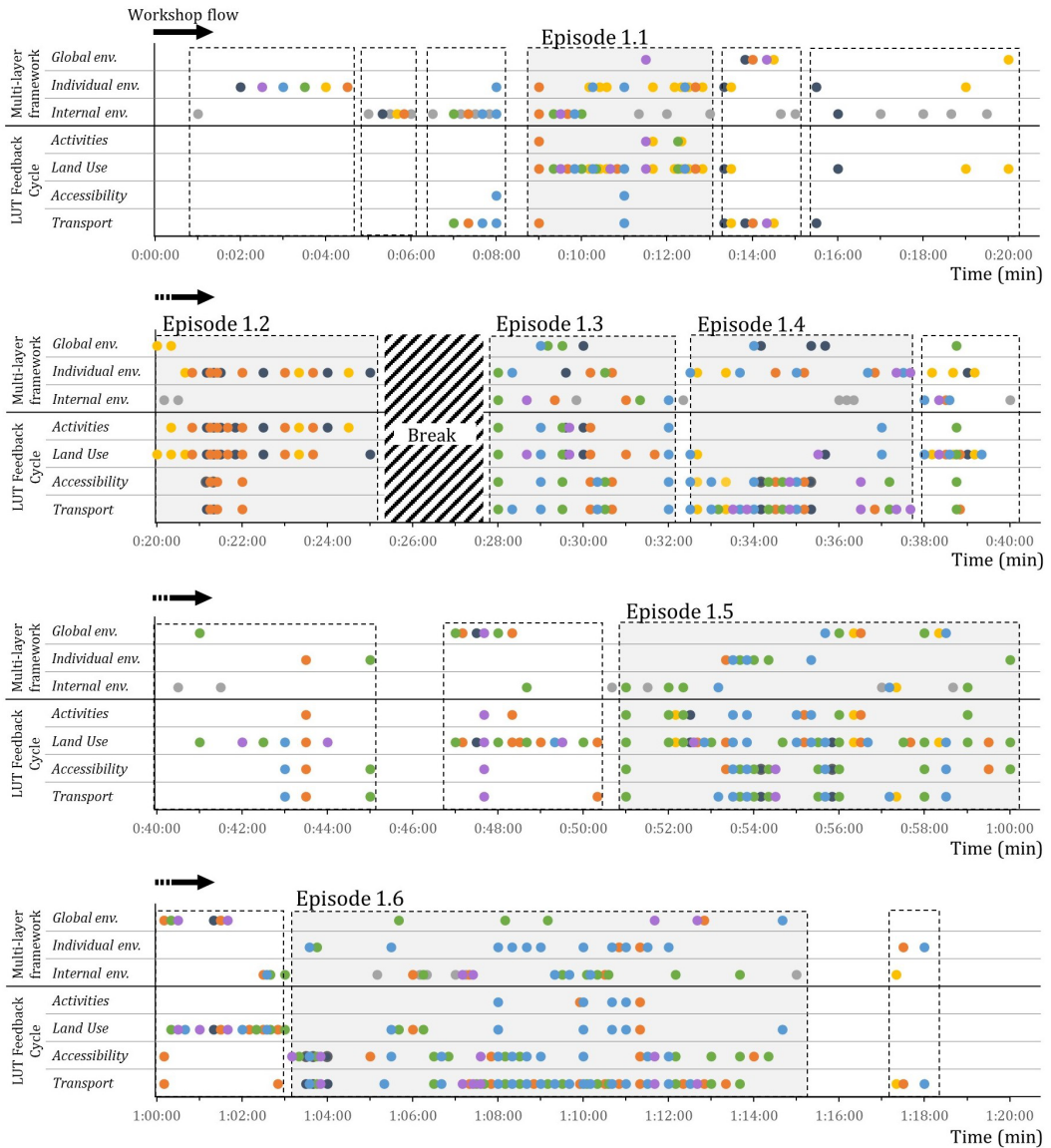


Figure 5.9. Interaction diagrams between workshops' participants



- Codes from participants' interventions*
- Transport planner
 - Urban planner
 - Policy-maker A
 - Policy-maker B
 - Property developer
 - Environmental consultant
 - Moderator

Conversation episodes**

- ▭ Analysed episode
- ▭ Non-analysed episode (transitional)

* Intervention: instant in which a participant gives his/her opinion during a conversation episode. Multiples interventions from one participant can be found during a conversation episode. The duration of each intervention does not take part in the analysis. One single intervention can be translated into one or several codes.

** Conversation episode: fragment of workshop in which participants discuss on a specific topic, there is a similar intensity of interactions, and the conversation dynamic is recognisable.

Figure 5.10. Coding of planning actors' interactions during Workshop 1 "Car Decline"

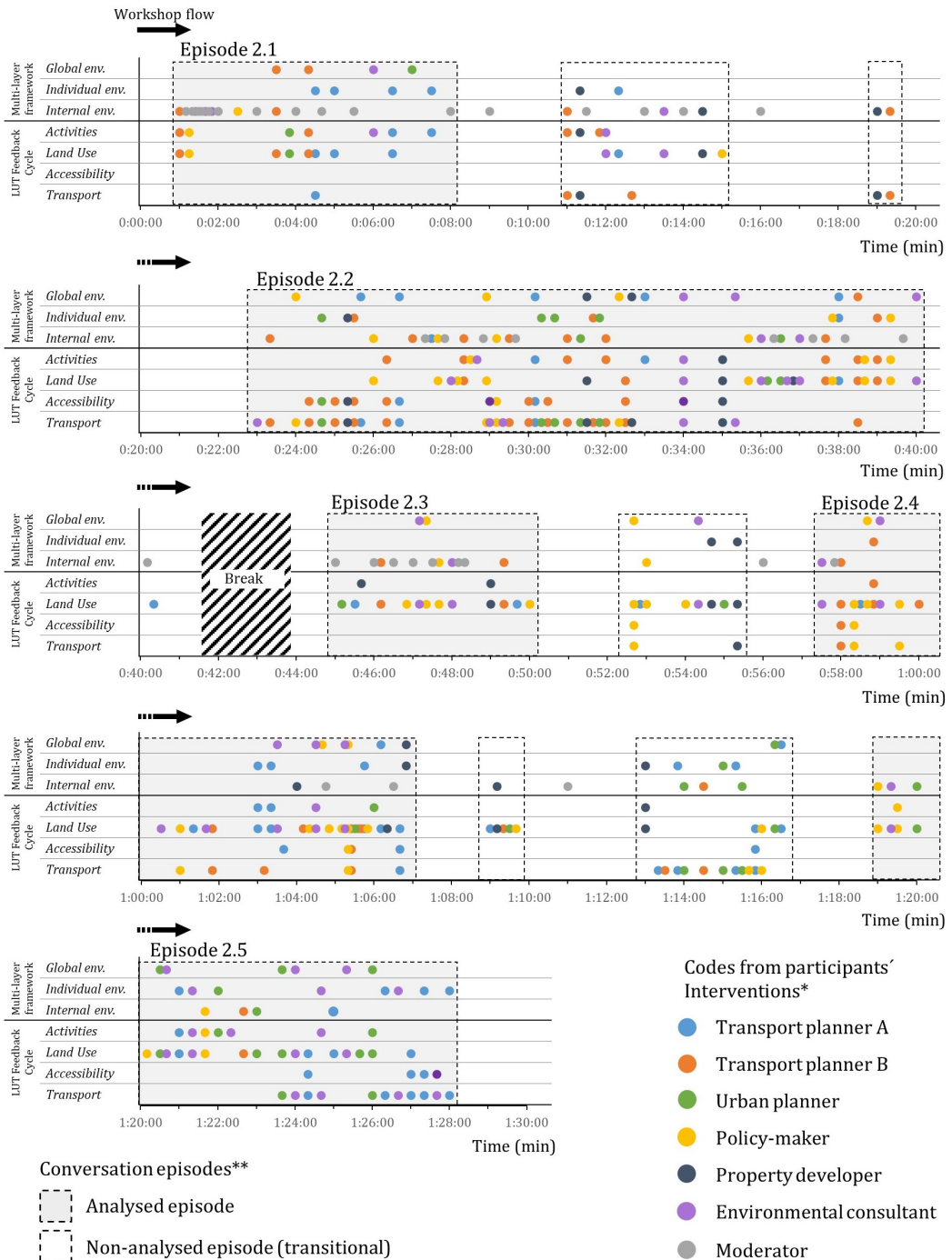


Figure 5.11. Coding of planning actors' interactions during Workshop 2 "Urban Boom"

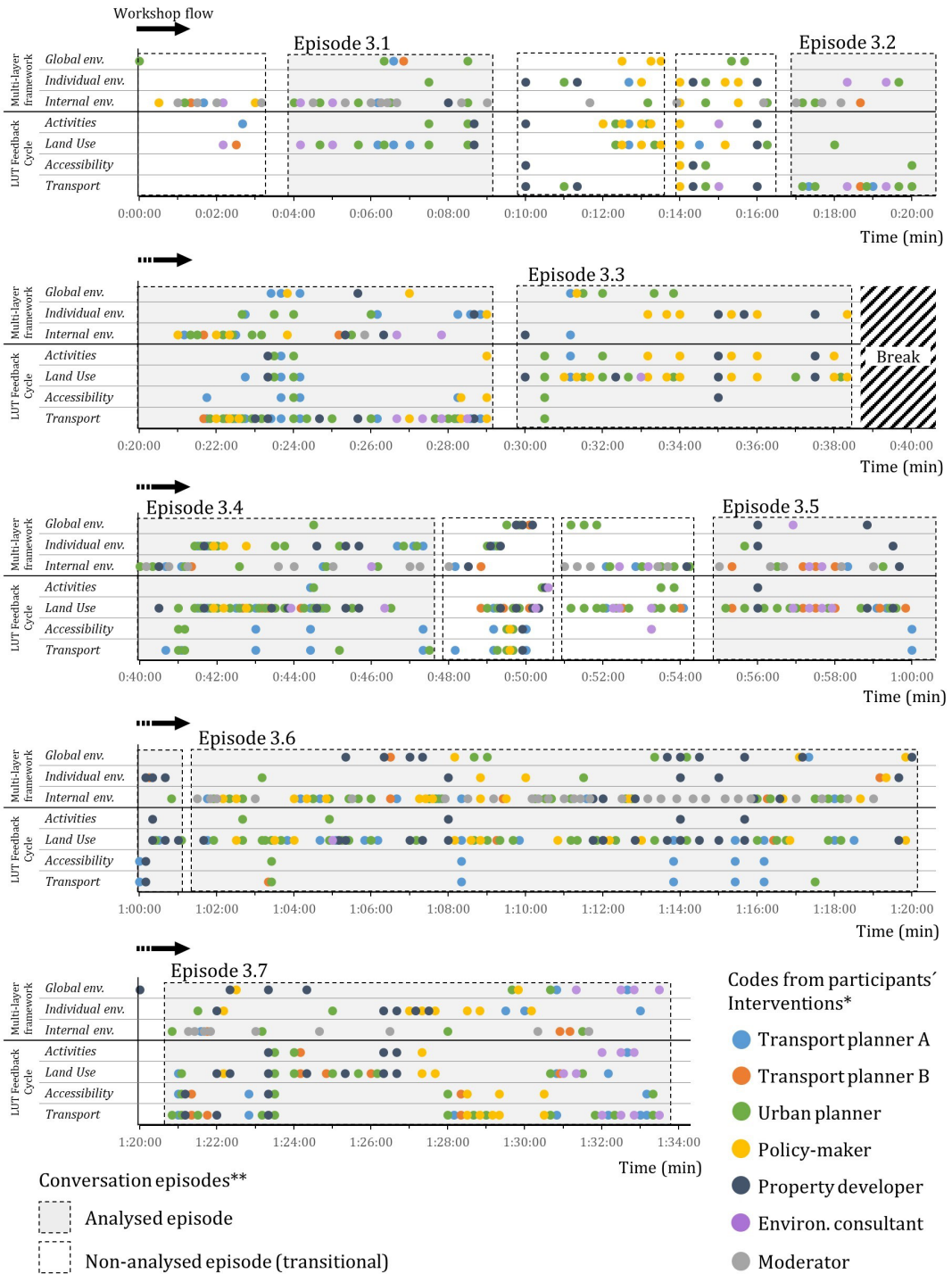


Figure 5.12. Coding of planning actors' interactions during Workshop 3 "Urban Dystopia"

5.4.2. Conversation episodes with high levels of land use and transport integration

In total, five conversation episodes had cycle dissimilarity index values of <0.2 (average value of 0.13): two episodes from Workshop 1, Car Decline (Episode 1.3 and 1.5); two episodes from Workshop 2, Urban Boom (Episode 2.2 and 2.5); and one episode from Workshop 3, Urban Dystopia (Episode 3.7) (Table 5.3). These five episodes represent 27.7% of the total episodes.

In all these conversation episodes, the multi-layer dissimilarity index was <0.2 , with an average value of 0.15 (Table 5.3). The same pattern of deliberation and interaction is noticed: several planning actors used both the content of the 2050 narrative and the workshop rules to support their viewpoints (internal environment). Then, those viewpoints were usually contested and/or supported by others that brought arguments based on their personal and professional experiences (individual environment). Finally, other planning actors continued interacting using arguments based on BAU trends, local habits, and cultural norms from the case study (global environment). This chain of interventions, interspersing factors from the internal, individual, and global environment, provides complex interactions, provoking planning actors to use arguments from all four categories of the transport–land use feedback cycle, in order to effectively reply to their counterparts' inquiries and comments.

Moreover, four of the five conversation episodes lasted longer than 9 minutes (Episode 1.5, 2.2, 2.5, and 3.7), reinforcing the idea that longer discussions increase the probability to originate complex interactions where internal, individual, and global factors come to together, thereby favouring higher levels of land use and transport integration. Similarly, four episodes took place during the second phase of the workshop after the break (Episode 1.3, 1.5, 2.5, and 3.7), indicating higher options to activate complex conversations episodes during mature stages of the workshops.

Episode 1.5 provides a good example of deliberation and interaction. It lasted 11 minutes, at the end of Workshop 1; the cycle and multi-layer dissimilarity index values are 0.18 and 0.16, respectively. The participants addressed the specific objective of increasing the number of multifunctional places in the Henares Corridor, a transformational action mainly focused on the land use side. Almost all planning

actors participated in the discussion referring to the 2050 narrative, reflecting on the possible land use changes according to the workshop rules (internal factors). Then, the transport planner and policymaker brought in their local knowledge and personal experience from the case study (individual factors), to extend the discussion to how new multifunctional places would be reached by population. Their contribution moved the discussion in the direction of transport modes and accessibility issues, linking these to multifunctional places. Policymaker A and B joined the conversation, adding a new element for deliberation. They specifically signalled that the transport modes to access to multifunctional places should be linked to the type of existing activities in those places. In their view, such activities would be technological companies and housing, according to BAU socio-economic trends (global factors). In the subsequent discussions, the planning actors considered all four categories of the transport–land use feedback cycle, before arriving at collective decisions on transformational actions.

Episode 3.7 is another good example. It spanned 13 minutes, at the end of Workshop 3; the cycle and multi-layer dissimilarity index values are 0.12 and 0.09, respectively. During this episode, participants faced the challenge to position a new road that would connect several places in the Henares Corridor. The urban planner and the transport planners A and B started the deliberation and interaction, deciding to map new roads dedicated to private vehicles rather than other transport infrastructures. The content of the 2050 narrative, Urban Dystopia, clearly influenced their choice (internal environment). The property developer and the policymaker disagreed with the location of the new road, bringing in arguments from their professional and personal experience (internal environment). Finally, the environmental consultant added new elements to the conversation, signalling that not only roads are needed but also public transport infrastructure. The environmental consultant supported this argument using the BAU trends in the Madrid Metropolitan Region (global environment), associated with the expected evolution of activities and accessibility issues in single-family residential locations.

5.4.3. Conversation episodes with low level of land use and transport integration

In total, thirteen conversation episodes have cycle dissimilarity index values of >0.4 (average value of 0.73): four episodes from Workshop 1, Car Decline (Episode 1.1, 1.2, 1.4, and 1.6); three episodes from Workshop 2, Urban Boom (Episode 2.1, 2.3, and 2.4); and six episode from Workshop 3, Urban Dystopia (Episode 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6) (Table 5.3). This represents 72% of the total episodes analysed, spanning 40.4% of discussion time during the three workshops.

In these episodes, the planning actors repeatedly brought up arguments based on one or two layers of factors (internal, individual, and global). With the exception of Episode 2.4, the multi-layer dissimilarity index was always >0.2 , with an average value of 0.52 (Table 5.3). The dominance of one or two types of factors strongly reduced the level of complexity in the discussions: it was not necessary to use arguments from the four categories of the transport–land use feedback cycle to effectively reply to issues raised by the other participants. Under this general scheme, three specific interaction patterns were identified.

A first pattern of interaction was identified in Episode 2.1, 2.3, 3.1, and 3.2, which all take place in the first phase of the workshops or the very beginning of the second phase. They are short episodes (5–7 minutes on average), and the planning actors brought in supporting arguments primarily from the internal environment. For example, Episode 2.1 (duration 7 minutes, at the very beginning of Workshop 2) had cycle and multi-layer dissimilarity indexes values of 0.88 and 0.52, respectively. The transport planner B, the policymaker, and the environmental consultant started their interaction by discussing the content of the 2050 narrative and how to operationalize it into transformational actions (internal environment). Specifically, they selected locations for residential and industrial activities only guided by the 2050 narrative. Transport planner A was the only outlier, bringing in arguments from personal experience (individual environment) to contextualize ideas from the 2050 narratives; however, the participation of the Transport planner A was very limited.

The second interaction pattern is related to Episode 1.6, 3.5, and 3.6, where the planning actors also brought in arguments from the internal environment to support their thoughts. These episodes were longer (12 minutes on average) and were always

located in the second part of the workshops. Episode 3.6 is representative of this pattern of interaction. Lasting 18.5 minutes during the second phase of Workshop 3, it has cycle and multi-layer dissimilarity index values of 0.72 and 0.64, respectively. All planning actors interacted in this long conversation episode, including bidirectional replies between each participant, dominated by factors from the internal environment. In particular, all participants systematically consulted the 2050 narrative to discuss where specific land uses must be located and how. When arguments from individual and global environment were brought by planning actors to discuss elements of transport and accessibility linked to land use, they were not taken into consideration by the other planning actors, who prioritized the arguments associated with the 2050 narrative and the workshop's rules.

The third pattern of interaction is notable in Episode 1.1, 1.2, 1.4, and 3.3. These episodes took place in the first phase of the workshops or at the very beginning of the second phase. They are short episodes (5–7 minutes on average), and primarily involved supporting arguments from the individual environment. Episode 1.4 is a good example; it lasted 5.5 minutes during the very beginning of Workshop 1, with cycle and multi-layer dissimilarity index values of 0.72 and 0.47, respectively (Table 5.3). In this case, the planning actors aimed to draw a green corridor between two municipalities in the case study based on the 2050 scenario Car Decline. The transport planner showed his/her view on both the location and characteristics of the green corridor. The arguments were based on previous professional experience and deep local knowledge about the case study (individual factors). The other participants interrupted the transport planner several times, to evaluate location alternatives for the green corridor as well as potential synergies with land use and activities. The conversation mostly focused on the categories of transport and accessibility, explained by both the strong expert position of the transport planner and the low capacity of the other contributors to extend the conversation to other issues using either internal or global factors.

Table 5.3. Characterisation of conversation episodes

Ep.	Conversation topic	Duration (min)	Workshop's phase	Number of participants	Number of interventions	Number of codes	Cycle dissimilarity index (0-1)	Multi-layer dissimilarity index (0-1)
Workshop 1 (Car Decline)								
1.1	Increasing urban density in historical city centres	1	I	5	27	54	0.81	0.52
1.2	Logistics places and type of jobs generated	5	I	3	21	62	0.53	0.68
1.3	Relocating land uses to achieve multifunctional places	4	II	5	19	53	0.06	0.18
1.4	Designing a green corridor between two municipalities	5.5	II	6	31	62	0.72	0.47
1.5	Increasing multifunctional places	11	II	6	50	119	0.18	0.16
1.6	Connecting municipalities through transportation infrastructure and green corridors	12	II	5	66	138	0.67	0.33
Workshop 2 (Urban Boom)								
2.1	Discussing the content of the narrative and translating it into transformational actions in residential and industry.	7	I	5	26	41	0.88	0.52
2.2	Discussing which transport modes would predominate by 2050, and their effects on population growth and urban trends	17	I	6	66	134	0.10	0.20
2.3	Locating land uses based on environmental restrictions	5	II	6	20	27	1.00	0.85
2.4	Relocating land uses to create new green areas	9.5	II	6	42	74	0.44	0.20
2.5	Locating new urban facilities and residential according to the existing transport infrastructure	9	II	5	27	61	0.20	0.10
Workshop 3 (Urban Dystopia)								
3.1	Discussing the content of 2050 narrative and its translation into transformational actions	5	I	5	23	36	1.00	0.73
3.2	Prioritizing public or private transport	12	I	6	65	116	0.66	0.43
3.3	Discussing transformational actions in urban land uses	8.5	I	5	25	53	0.83	0.41
3.4	Specific transformations in industrial areas	7.5	II	6	63	98	0.50	0.48
3.5	Specific transformations in residential areas	6	II	5	43	63	0.78	0.50
3.6	Discussing the content of 2050 narrative to locate urban land uses	18.5	II	6	139	193	0.72	0.64
3.7	Designing a new road connecting several municipalities	13	II	6	74	133	0.12	0.09

5.5. Conclusions and discussion

The chapter sought to address the following research questions: *To foster land use and transport integration, which factors influence the effectiveness of disruptive scenarios to trigger interaction processes between planning actors?* To uncover possible answers, three academically constructed cases were tested in an experimental setting. Each academically constructed case was operationalised by a workshop, involving 6 planning actors, who analysed one of the three 2050 exploratory narratives for the Henares Corridor, Spain: (i) Car Decline, (ii) Urban Boom, and (iii) Urban Dystopia. The planning actors interacted in an open space, reconstructing and mapping land use and transport pathways to reach one of the pre-set 2050 narratives. The workshop discussions were transcribed, coded, and analysed according to conversation episodes, following a structured observation approach. For each episode, the transport–land use feedback cycle was used to estimate the level of land use and transport integration, while a multi-layer framework facilitated the characterization of the factors (internal, individual, and global) that affected the effectiveness of the 2050 narratives.

The results suggest that higher levels of land use and transport integration are obtained when 2050 scenario-building narratives provide the starting point for complex interactions between planning actors, in which factors from the internal, individual, and global environment are simultaneously used to contest and discuss the arguments of each other. A common pattern of interaction was noted in those conversation episodes with the highest integration levels (Episode 1.3, 1.5, 2.2, 2.5, and 3.7) – in all three academically constructed cases. The planning actors first grounded their views in the content of the 2050 narrative and the workshop rules (internal environment factors). Then, the other planning actors discussed these viewpoints, bringing in arguments from their personal and professional experiences (individual environment factors). As the discussion progressed, other planning actors extend the interaction using reasoning based on BAU trends, local habits, and cultural norms from the case study (global environment factors). In sum, higher complexity in deliberations based on a higher mix of factors (internal, individual, and global) provokes planning actors to deploy, in an integrated way, elements from both transport and land use to support their argument. This causality direction -starting from factors (internal, individual, and environmental) to land use and transport

integration- has been noticed during discourse analysis. The emergence of a new cycle category (transport, accessibility, land use, and activities) in each conversation episode is frequently preceded by the use of different multi-layer factors by planning actors. Nevertheless, causality could be also bidirectional, which would also reinforce one of the main messages of this research: land use and transport integration is highly associated with complex planning interactions in decision-making. Further research should gain insights into this particular point.

A different result was noted when deliberation and interaction processes were strongly linked to the 2050 narrative and internal factors dominated: the complexity of conversation episodes was lower and meaningful land use and transport integration was not achieved. The same outcome was observed when factors from individual and global environment dominated the discussion. During the experiments, these conditions were mostly found in conversation episodes located at the very beginning of the workshops and in initial stages of the second workshops phase.

Based on the results, a set of themes, limitations, and questions emerged, providing additional insights into the research question of this chapter. Three specific issues have been identified and are discussed below:

- *Research design validity.* The methodological choice was to involve planning actors in three parallel, academically constructed cases, operationalized via face-to-face workshops. This set-up provided the research team with a more controlled environment to explore causality associated with the research question (te Brömmelstroet, 2015). In this case, the specific observation rules (including the involvement of two independent observers with high values of Kappa coefficient for interobserver reliability) and the calculation of both cycle and multi-layer dissimilarity indexes increased the internal validity of this experimental approach. The benefit of this approach is the higher capacity to detect how land use and transport integration varied according to the type of factors (internal, individual, and global) used by the planning actors. The external validity of the research (generalizability of results for different experiments) was taken into consideration by implementing the three workshops in parallel rather than in a sequence. This allowed us to identify common patterns of factors for land use and transport integration irrespective of the specific 2050 scenario-

building narratives or the participating individuals. The ecological validity of experiments is low (Bryman, 2008), as the scientific findings obtained are not applicable to real planning practice in its present form. Further research is needed to distil “prescriptions” for real-life practice and increase the effectiveness of scenario-building narratives in triggering land use and transport integration in practice. In this respect, real-life experiments should be implemented and the presented research provides a useful starting point. The establishment of formal collaborations with regional and local government is crucial for advancing in this direction, ensuring the use of scenario-building narratives in the context of specific plans on transport and land use.

- *Simplicity.* This chapter uses two different “artifacts” or “models” to address its research question: the transport–land use feedback cycle is used to estimate integration, and a multi-layer framework is processed to distinguish groups of factors that shape the use of the narratives. The simplicity of those “artifacts” is both a strength and a weakness (Bertolini, 2012). It is really easy to understand and operationalize them in research; however, real-life planning practice is shaped by many other aspects. Looking at the transport–land use feedback cycle, the location of land uses is not only affected by accessibility issues and transport provision but also by the availability of land, the existing official planning documents and dynamics of the local and regional context. The three groups of factors (internal, individual, and global) in the multi-layer framework are not easily delineated in real life while using specific planning tools. Despite these limitations, the value of the transport–land use feedback cycle has been widely acknowledged, and it has been applied in multiple studies, given its capacity to explore relationships between developments in cities and mobility patterns. The multi-layer framework, however, is a novel approach created ad hoc for this research, with strong vocation for being used in other contexts in which planning tools (e.g. Planning Support System) are used under collaborative planning schemes.
- *Land use and transport integration at strategic levels.* As indicated, planning actors are increasingly tasked with interacting, deliberating, and achieving consensus on land use and transport integration in longer-term planning. That is particularly relevant in the communicative planning stage, a period in which interaction

processes between planning actors should prevail and deep uncertainty must be addressed (Innes and Booher, 2018; Lyons and Marsden, 2019; Navarro-Ligero et al., 2019). The obtained results affirm the promise of scenario-building narratives as a useful tool to fulfil the mentioned requirements. Moreover, they are particularly valuable at strategic planning levels, when planning goals must be prioritized, facilitating integration strategies. However, our results suggest that the effectiveness of the 2050 narratives for triggering land use and transport integration is highly related to the activation of complex deliberation and interaction process, with actors bringing in factors from internal, individual, and global environments.

Overall, this chapter has presented a novel approach based on testing the usability of scenario-building narratives rather than developing new applications. The aim was to generate knowledge that is “field tested” with the intended users. The obtained results can be seen as preliminary in some way due to the experimental set-up, a highly controlled environment by the research team; however, they do show promising results to stimulate further research that explores the role of scenarios in fostering land use and transport integration in real-life settings.

6

6 MAPPING DISRUPTIVE SCENARIO NARRATIVES

This *Sixth Chapter* is a reprint of the article “*Participatory mapping in exploratory scenario planning: Necessity or luxury?*”, published in *Futures* (2024), 160, 103398. <https://doi.org/10.1016/j.futures.2024.103398>

Abstract

Exploratory scenarios based on participatory approaches proved helpful in dealing with uncertainty and complexity in urban and transport systems. Such scenarios usually create coherent and manageable narratives that capture broad patterns and trends at global scales. However, significant difficulties exist in bridging disruptive scenario narratives with spatial and local realities, which is crucial for guiding policymaking in urban, regional, and mobility planning. This chapter explores whether and how deliberative mapping processes among experts and local stakeholders can impact the formulation of disruptive, exploratory scenario narratives by linking them to local particularities. It uses an experimental approach involving three participatory workshops specifically tailored to the mapping of land use and transportation-related scenario narratives for the year 2050 in the Henares Corridor (Madrid, Spain). The spatial transformations mapped during workshops have indicated that participatory mapping has an impact on scenario narratives in different ways, enabling the identification of three categories of mapping episodes with different meanings: (i) complementing narratives, (ii) expanding narratives, and (iii) modifying narratives. The chapter closes by examining the implications of the obtained findings for policymaking, including a reflection on the research’s limitations and potential for application in real-world planning processes.

Key words: Uncertainty, Transport, Land Use, Visioning, Foresight.

6.1. Introduction

Uncertainty grows around cities and regions driven by disruptive factors such as climate change, technological innovations, demographic shifts, and public health crises (United Nations Development Programme, 2022). This situation poses significant challenges for scholars, planners, and policymakers, encouraging them to embrace strategic approaches (Marchau et al., 2019). During the last decades, scenario-planning methods have been gaining prominence as valuable and effective tools for addressing the described challenges orientated towards uncertainty management (Chermack, 2004; Hickman & Banister, 2014; Bøjerson et al., 2006; Lyons and Davidson, 2016; Melander, 2018; Chakraborty & McMillan, 2015; Navarro-Ligero et al., 2019). Implementing scenario planning facilitates strategic decisions in the long term via an enhanced understanding of the potential risks and opportunities of future scenarios (ESPON, 2015; European Commission, 2023; European Environmental Agency, 2021; OECD, 2021; IPCC, 2022).

The research interest in scenario planning has progressively moved beyond normative and predictive scenarios towards exploratory scenarios (Avin & Goodspeed, 2020; Milestad et al., 2014). Instead of creating either a single preferred vision or a forecast, exploratory scenarios consider multiple possible futures, including those that may be unexpected or outside the limits of conventional thinking (Banister & Hickman, 2013; Soria-Lara & Banister, 2018; Tuominen et al., 2014). Disruptive, exploratory scenarios offer scholars and practitioners a framework to manage situations of deep uncertainty, facilitating the process of making adaptable choices over time (Marchau et al., 2019). The use of collaborative and participatory approaches has also become prevalent in designing such scenarios (Oteros-Rozas et al., 2015; Mallampalli et al., 2016; Soria-Lara & Banister, 2017; González-González et al., 2019; Tuominen et al., 2014), in which diverse groups of actors with different backgrounds, expertise, and perspectives play an active role as co-analysts of future dynamics and co-designers of future scenarios (Chakraborty, 2011; Tori et al., 2023).

Traditionally, the main outcomes resulting from exploratory scenarios take the form of scenario narratives (González-González et al., 2019; Banister & Hickman, 2013; Tuominen et al., 2014; Soria-Lara et al., 2021). These narratives often involve simplification and generalization to create a coherent and manageable storyline, capturing broad patterns and trends at global scales (Danielis et al., 2022; Dammers,

2010). As a result, they often lack detailed spatial information and fail to consider the specificities of regional and local dynamics. This is a crucial weakness when scenarios are used in the field of land use and transport, where decisions usually have significant spatial impacts, and part of decision-making is based on spatial considerations (e.g., infrastructure location, street use allocation, new urban developments, protection of green areas, etc.).

Based on the abovementioned issues, the suitability of disruptive scenario narratives for decision-making processes at regional or local scales is increasingly being contested (Bartholomew, 2007; Avin et al., 2022; Chakraborty et al., 2011; Chakraborty & McMillan, 2015; Avin & Goodspeed, 2020). To address this critique, exploratory scenario applications seek to translate scenario narratives into maps using diverse techniques. Participatory mapping approaches offer promising solutions to enhance the spatial and local specificity of scenarios by incorporating both expert and local knowledge into the mapping process (Molinero-Parejo et al., 2021; Rivas-Tabares et al., 2022; Lamarque et al., 2013; Castella et al., 2005). However, the process of mapping scenarios is usually implemented as a final step in scenario-building after narratives have been finalized rather than being integrated as an ongoing process. Consequently, the reflections and views exhibited during mapping processes are usually not incorporated into scenario narratives, thereby ignoring the opportunity to better align disruptive scenario narratives with spatial and local realities.

Based on these important issues, this chapter aims to address the following research question: *To which extent and how can participatory mapping processes contribute to spatially shaping future scenario narratives?* The Henares Corridor in the Madrid Metropolitan Area, Spain provides the empirical focus (see Section 3.2 in Chapter 3). First, the research briefly presents three disruptive scenario narratives that were previously developed through a participatory process (See Section 4.4 in Chapter 4) to explore different futures for the evolution of land uses and transport systems. Second, three participatory mapping workshops were conducted, engaging both experts and local stakeholders in mapping land use and transport changes related to the three scenario narratives (See Section 5.3.2 in Chapter 5). The deliberative processes were thoroughly analysed using structured observation techniques, delivering valuable insights into the interaction dynamics between participants, the

relevant mapping inputs, and the constraints and conflicts experienced by participants. Finally, this approach allows the research team to reflect on how the mapping process impacts the scenario narrative configuration and whether any adjustments, modifications, or redefinition of the scenario narratives are needed to align their content to local and spatial realities.

The chapter is structured as follows. Section 6.2 provides an overview of relevant literature on the visual representation challenges of exploratory and participatory scenarios in land use and transport. Section 6.3 presents the details behind the research design, while Section 6.4 summarizes the main results. Finally, Section 6.5 outlines closing remarks and recommendations for further inquiries.

6.2. Theoretical background and working hypothesis

6.2.1. Mapping scenario narratives: findings and evidence

Scenario-planning processes simplify complex systems and dynamics into coherent, manageable, and concise scenario narratives (González-González et al., 2019; Banister & Hickman, 2013; Tuominen et al., 2014; Kok et al., 2006). They primarily focus on capturing global patterns and trends (e.g., economy, demography, energy, technology) with major social implications (Danielis et al., 2022; Dammers, 2010; Kok et al., 2006) rather than providing detailed, localized, and spatial information. These macro-level scenarios are useful for summarizing and processing complex views and providing a holistic understanding of possible future trends.

However, the level of abstraction tends to overlook specific regional or local dynamics (Carter et al., 2017), omitting fine-grained intricacies and context-specific aspects. To address these limitations, many authors have downscaled scenario approaches (Fernández-Güell & Redondo, 2012; Biggs et al., 2007; Grübler et al., 2007; Zurek & Henrichs, 2007; Han et al., 2015; Capitani et al., 2015), where information on global, European, or national scenarios is frequently translated into regional and local scenarios (Frame et al., 2018; Stratigea & Giaoutzi, 2012; Shaw et al., 2009). However, such efforts tend to resemble the higher-level scenarios closely and do not offer meaningful spatial insights for smaller geographical or contextual levels (Duguma et al., 2022).

Visualization techniques offer promising solutions for enhancing spatial and local specificity in scenario-planning applications. A diverse array of techniques has been explored for visually representing scenarios, including visual harvesters (Tori et al., 2023), photo montages (Van Berkel et al., 2011), 3D views (Shaw et al., 2009; Lovett et al., 2015), and virtual reality (An & Powe, 2015). The visual representation of scenarios through maps is one of the most common (Carter et al., 2017; Duguma et al., 2022). Accordingly, the literature is full of examples of scenario-mapping applications. For example, Swetnam et al. (2011) formalized narrative-based socio-economic scenarios, converting them into spatially explicit rules to generate future land cover maps through GIS methods.

Likewise, Houet et al. (2016) applied modelling techniques to simulate fine-scale urban maps, representing elements such as urban expansion and population density. Larondelle et al. (2016) converted scenario narratives outlining potential futures for Rotterdam into rules and codes for generating land use change maps using GIS technology. In Carter et al. (2017), four scenario narratives were transformed into spatial rules suitable for integration into a GIS platform, enabling the creation of maps illustrating the primary land use consequences for each scenario. Fuglsang et al. (2013) detailed spatial parameters derived from three future transportation storylines in an Eastern Danish region, covering aspects like transportation accessibility, urban density, and distribution of jobs and population. More recently, Duguma et al. (2022) translated four alternative scenario narratives of socio-ecological change in Ethiopia into quantifiable spatial variables, facilitating subsequent spatial projections of land cover changes.

Many consulted studies used quantitative modelling approaches for mapping future scenarios, such as agent-based models (Valbuena et al., 2010) and cellular automata models (Fuglsang et al., 2013), requiring complex and intensive data gathering. As a result, only a limited set of parameters from scenario narratives is considered during the mapping process. Furthermore, the lack of transparency limits the potential for expert and stakeholder engagement in discussing and deliberating the scenarios' spatial implications. Consequently, the resulting maps from these modelling processes often lack the fine-grained intricacies and context-specific elements that can be crucial for understanding local dynamics. In contrast, some scenario-planning processes follow qualitative mapping approaches based on participatory techniques

(Castella et al., 2005; Tolvanen et al., 2019; Rivas-Tavares et al., 2022). For example, Lamarque et al. (2013) utilized a role-playing game with regional experts to map small-scale changes in land management based on detailed qualitative and participatory scenario narratives. Similarly, Hérivaux et al. (2021) engaged expert groups and local to establish rules for translating narrative scenarios into detailed maps that simulate the evolution of land uses in the Mediterranean context. These studies share the approach to include experts, who possess domain-specific knowledge, and local stakeholders, who have a deep understanding of the local context, as a powerful way to increase the accuracy and relevance of the scenario-mapping outcomes (Lamarque et al., 2013; Hérivaux et al., 2021).

6.2.2. Working hypothesis: participatory mapping for shaping scenario narratives

Section 6.2.1 details previous evidence supporting the effectiveness of scenario mapping approaches, with specific emphasis on applications rooted in participatory and qualitative methodologies (Lamarque et al., 2013; Hérivaux et al., 2021). These approaches have demonstrated their ability to effectively address the limitations associated with spatial and local specificity of traditional scenario-planning exercises. However, remarkable research gaps remain. Prior studies have primarily treated the mapping stage as a concluding aspect in their research processes (Carter et al., 2017; Duguma et al., 2022; Larondelle et al., 2016), rather than an ongoing process of visualizing future narratives. The resulting cartographic outputs are seen as supplementary material with null or limited influence on the overall configuration of the scenario narratives. Consequently, any insights and feedback that could be obtained, especially from participatory mapping exercises, tend to be undervalued, thereby neglecting their potential to enrich the alignment of exploratory scenario narratives with real-life spatial realities.

The core idea showed in this chapter is based on the notion that scenario narratives and participatory mapping are intricately interconnected, creating a mutually reinforcing relationship. Initially, scenario narratives play a crucial role as the initial catalysts for the participatory mapping processes. As individuals engage in mapping activities, the outcomes generated from these processes (i.e., narrative-based maps), in turn, (re) shape the original scenario narratives.

Accordingly, the basic hypothesis underlying this chapter is that the abovementioned reciprocal relationship could be manifested in the following forms:

- (i) *Complementing future narratives.* Participatory mapping may complement scenario narratives by providing spatial context and visual representation to the explored futures. The geographic insights gained through mapping may offer a richer understanding of the scenarios, enhancing the narrative with tangible and location-specific details.
- (ii) *Expanding future narratives.* Participatory mapping has the potential to expand the horizons of future narratives by incorporating additional layers of complexity and detail. As individuals collaboratively contribute to mapping, new dimensions, perspectives, or potential developments may emerge, enriching and broadening the scope of the original narratives.
- (iii) *Modifying future narratives.* Participatory mapping may act as a dynamic feedback loop, allowing for the modification and refinement of scenario narratives. Insights gained from the mapping process, whether through participants' input or spatial data, may lead to adjustments in the scenario narratives, reflecting a more accurate and refined description of the complexities inherent in the future scenarios.

6.3. Research design

This research follows an experimental approach with various planning actors in three academically constructed cases, with researchers tightly controlling these co-creation environments to explore causality (See Section 5.3.2 in Chapter 5). The approach is inspired by the “experiential research design” developed by Straatemeier et al. (2010) and is widely applied in transport research (Beukers et al., 2012; Soria-Lara et al., 2016; Te Brömmelstroet & Bertolini, 2010). The methodological design covers three phases: (i) input: three disruptive future narratives for the Henares Corridor; (ii) experimentation: three academically constructed cases; (iii) evidence: recording, processing, and analysing information.

6.3.1. Input: Three future narratives for the Henares Corridor

As showed in Chapter 4, participatory scenario-building methods were deployed by the research team to create a set of disruptive scenario narratives for the Henares Corridor for 2050 on potential land use and transport futures. Seven 2050 scenario narratives with different levels of disruption and remarkable differences in their contents were developed (see Section 4.4 in Chapter 4). Three of them have been used as inputs for this research: (i) “Car Decline”, (ii) “Urban Boom”, and (iii) “Urban Dystopia”. A more concise version of these three scenario narratives is provided below:

Car Decline:

In an ambitious move towards sustainable urban developments, cities within the Henares Corridor have implemented a groundbreaking initiative to create vibrant, pedestrian-friendly city centres by strictly restricting private vehicle access. This bold step encourages and prioritizes walking and cycling as the primary transportation modes to all daily destinations. The driving force behind this transformation is the desire to foster healthier, greener, and more interconnected communities. Cities have focused on integrating various aspects of daily life within accessible distances. By ensuring a rich mix of residential, commercial, leisure, and working sites, residents can enjoy the convenience of satisfying their essential needs within walking or cycling distance. Industrial and business areas are undergoing a profound metamorphosis, transiting into vibrant mixed-use zones. This transformation not only reduces the dependence on private vehicles but also promotes a diverse and inclusive urban environment where work and leisure can harmoniously coexist. In addition, green corridors are established throughout the case study, providing residents with a dense network of walking and cycling paths.

Urban Boom:

The Henares Corridor has experienced a significant surge in population growth, leading to transformative changes in urban living and transportation patterns. The main city centres have become vibrant and diverse, characterized by a mix of multi-family dwellings, urban services, and facilities. The rising number of multi-family dwellings accommodates the growing population. Meanwhile, high-income households

prefer low-density residential neighbourhoods on the city's periphery. These areas offer a blend of suburban tranquillity and a high land-use mix, providing residents with a balanced lifestyle. The transformation of the city's periphery also involves converting current work areas into multi-functional places, creating lively and dynamic hubs that cater to various needs and activities. Collective modes of transport, such as buses and trains, are increasingly used for work commutes while walking and cycling for shopping and leisure. To ensure the seamless connectivity of the region, a network of green corridors has been strategically designed to integrate active mobility with public transport systems.

Urban Dystopia:

The Henares Corridor is shaped by a distressing increase in insecurity in urban areas. High crime and robbery rates have led to a drastic shift in the modal split, with private cars becoming the prevailing choice for daily trips, including commuting, shopping, and leisure activities. The insecurity has rendered walking and cycling inadvisable, and public transport is stigmatized and predominantly used by the low-income population with limited alternatives. This grim reality has left the region devoid of green zones and safe public spaces, depriving residents of public spaces for recreation and relaxation. The urban landscape has become highly segregated, with homogeneous areas connected primarily by motorized infrastructures. City centres have been transformed into work destinations, with most employees commuting from the city's periphery, where high-income families reside in private communities. Low-income families are left with limited options, often forced to reside in insecure neighbourhoods in the city centres, exacerbating social inequalities.

6.3.2. Experimentation: Three academically constructed cases

The experimentation phase centred on three participatory mapping workshops (see Section 5.3.2 in Chapter 5) with experts and local stakeholders, designed to address the three exploratory scenario narratives: “Car Decline” (Workshop 1, Figure 6.1), “Urban Boom” (Workshop 2, Figure 6.2), and “Urban Dystopia” (Workshop 3, Figure 6.3). In total, 18 participants were involved, six per workshop, and no one took part in more than one workshop.



Figure 6.1. Participants mapping the scenario narrative “Car Decline” in Workshop 1

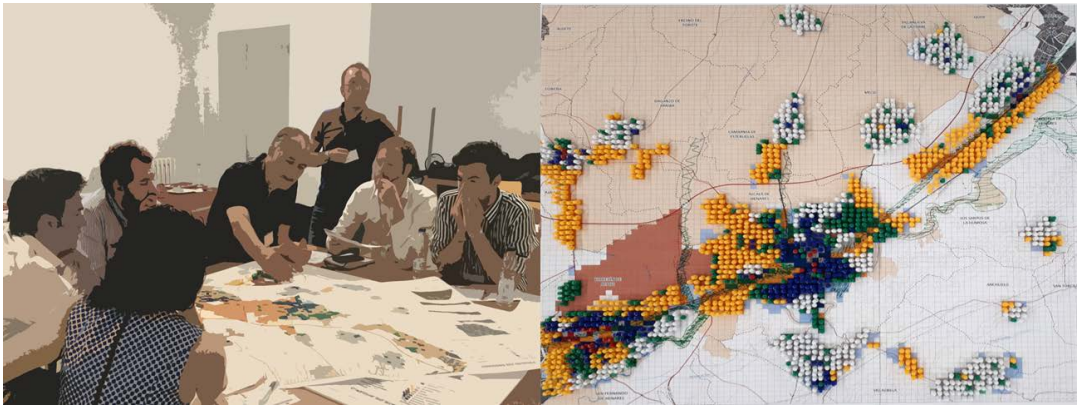


Figure 6.2. Participants mapping the scenario narrative “Urban Boom” in Workshop 2

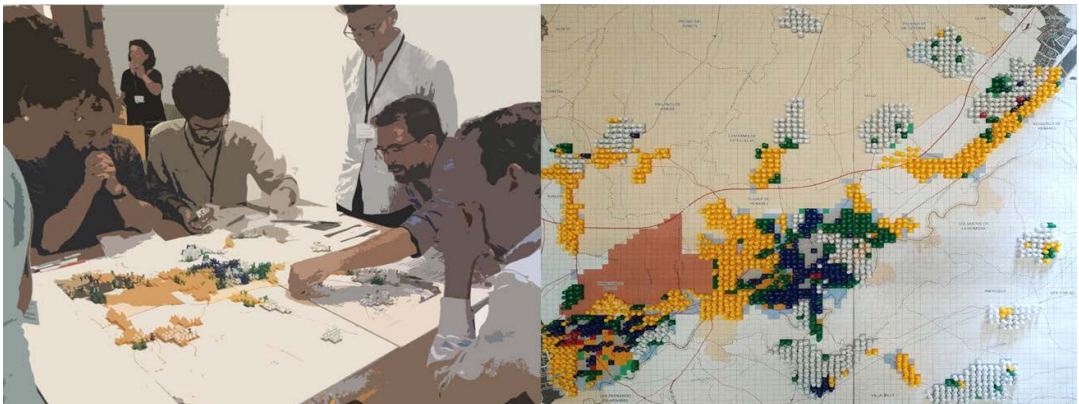


Figure 6.3. Participants mapping the scenario narrative “Urban Dystopia” in Workshop 3

Participants were strategically assigned to ensure coverage of the following profiles: (i) policymakers from local municipalities; (ii) property developers with a track record of project implementation within the study area; (iii) urban and transport planners possessing in-depth expertise in land-use and transport developments; and (iv) environmental consultants employed by regional and environmental agencies.

The three participatory mapping workshops were conducted concurrently. This methodological approach was chosen to facilitate the comparison of the obtained results between workshops. However, it is important to acknowledge certain limitations stemming from this approach. For instance, the outcomes of one workshop could not be leveraged to enhance the others. Throughout all workshops, the same team member assumed the role of mediator, while the other team members acted as external observers. The workshop duration was flexible, approximately 2 hours, divided into two distinct phases, separated by a break.

Phase 1 focused on the spatial characterization of the scenario narratives. The moderator initiated the process by describing the Henares Corridor baseline situation and subsequently presented one of the scenario narratives: “Car Decline”, “Urban Boom”, and “Urban Dystopia”. Participants had access to a portfolio containing baseline information from the case study and a description of the scenario narrative. In each workshop, participants discussed how to identify the spatial impacts of scenario narratives on transport and land use. Following these discussions, the moderator distributed individual questionnaires to each participant to capture the specificities of each workshop’s discussions into specific spatial variables.

The questionnaire included two types of questions. The first type assessed the degree of change in specific land uses (e.g., residential, industrial, and commercial) and dominant urban form patterns (e.g., levels of compactness and multifunctionality) on a Likert scale. The second type contained multi-option questions focused on prioritizing potential changes in the transport systems (e.g., an increase in public transport infrastructure). The questionnaires were processed anonymously during the workshop’s break, and the aggregated results (see Table 6.1) provided input for the next workshop phase.

Table 6.1. Spatial characterization of scenario narratives

Spatial variables	Mapping Workshop		
	1 <i>Car Decline</i>	2 <i>Urban Boom</i>	3 <i>Urban Dystopia</i>
<i>Degree of land use changes</i>			
Multi-family residential	Small growth	Small growth	Stability
Single-family residential	Loss	Moderate growth	High growth
Industrial	Stability	Stability	Loss
Commerce and services	Moderate growth	Moderate growth	Stability
<i>Dominant urban form pattern</i>			
Degree of land use mix	High	High	Low
Degree of urban compactness	High	Medium	Low
<i>Prioritized changes in the transport network</i>	Developing green corridors for walking and cycling	Increasing the public transport network	Increasing the road network
Note: loss (-25% of trend*), stability (unchanged), small growth (+25% of trend*), moderate growth (+50% of trend*), high growth (+75% of trend*).			
* Period 1988 to 2018			

During phase 2, participants collectively mapped land use and transport changes originating from scenario narratives, following the aggregated results for the spatial variables obtained from the previous questionnaire (Table 6.1). They were provided with cartography of the 2019 baseline and used different coloured pushpins to represent urban land uses (Figure 6.4). To facilitate the placement of these pushpins, a 250x250 vector grid was designed, where each grid element was assigned a representative urban land use based on cadastral information. During the mapping process, the level of growth or decline in each urban land use ultimately dictated the number of pushpins in different colours to be added or removed from the map. It was crucial that the location of land use changes on the map accurately reflects the dominant urban form pattern outlined in the questionnaire filled out during phase 1. This entails placing the pushpins adjacent to either identical or contrasting colours, as well as determining whether they should be dispersed or clustered together.

To collaboratively map the changes in the transport networks, participants utilized markers of various colours (Figure 6.5). These markers were used to signify transformations in the road network, public transport lines and stations, as well as walking and cycling infrastructure. The land use and transport changes derived from the three workshops were digitized with GIS software to deliver the final maps used in this research.



Figure 6.4. Pushpins representing urban land uses during workshops



Figure 6.5. Participants mapping spatial changes in transport systems

6.3.3. Evidence: Recording, processing, and analysing information

The workshops' insights were captured via video to facilitate a thorough examination and interpretation of the mapping process. The research team carefully identified the main spatial transformations conducted in each workshop, comparing the resulting maps with the baseline. These significant transformations could involve localized change in specific areas of the maps (e.g., the addition of a new transportation infrastructure) and/or general alterations that replicate a common pattern throughout the case study (e.g., a widespread loss of single-family residences). The recordings were segmented into mapping episodes, representing distinct parts of the workshops where participants discussed each spatial transformation.

The mapping episodes were analysed and characterized using structured observation techniques (Bryman et al., 2016). The overarching aim of this structured observation was twofold. First, it investigated how each mapping episode contributed to the scenario mapping. Second, it captured insights into the intricacies of the deliberation and interaction processes within each episode. The research team developed an observation schedule (detailed in the remainder of this section) that includes explicit rules for observing, categorizing, and documenting the information of interest within each mapping episode. To mitigate potential biases during the structured observation and ensure the reliability of the obtained results, two distinct researchers acted as independent observers. Multiple training rounds were carried out to familiarize them with the observation schedule and ensure consistency. Any relevant disparities or conflicting interpretations between the observers were addressed through discussion and consensus building, involving a third researcher, if necessary.

The observation schedule consisted of two sequential rounds. The first round aimed to explore how each mapping episode contributed to spatially shaping the exploratory scenario narratives. According to the research hypothesis (Section 6.2.2), during this first round, the observers categorized the mapping episodes into three types:

- *Mapping episodes complementing future narratives.* These episodes contribute to complementing existing and recognizable aspects of the narrative. For example, a future narrative could centre around a city's efforts to improve public transportation. Participants could decide to complement the existing narrative by adding more bus stops along existing routes. These modifications are aligned with

the original narrative's goal of improving public transportation but also focus on making incremental changes to the existing network.

- *Mapping episodes expanding future narratives.* These episodes incorporate new aspects and perspectives that are not explicitly part of the narrative. Using the previous narrative's example, mapping participants might choose to expand the narrative by unveiling an ambitious plan to build an underground metro system. This spatial representation, while also aligned with the overarching goal of improving public transportation, traces a more transformative direction, significantly broadening the scope of the story.
- *Mapping episodes modifying future narratives.* These are episodes that involve altering the existing narrative. For example, modifying the narrative could entail expanding roads instead of investing in public transit. This modification leads to an alternative interpretation of the scenario, where the focus shifts from promoting sustainable transportation options to accommodating more cars.

During the second observation round, researchers aimed to better understand how the participants' discussions and interactions during the different mapping episodes influenced the proposed spatial transformations. For this second round, the team was provided with the following observation rules:

- *Engagement and interaction.* The observers documented the participants' level of engagement by identifying those active in the mapping process as well as those assuming a more passive role. Moreover, they documented the group interaction dynamics, focusing on instances of collaboration, cooperation, dominance, and interdependence.
- *Mapping inputs.* The observers identified whether participants contributed additional inputs beyond the narrative's content during the mapping episode, stemming from their local experience with the study area or their expert knowledge of spatial transformation. They also assessed whether these individual contributions influenced the final mapping solution.
- *Mapping constraints.* The observers reported whether participants recognized any barriers or restrictions within the physical, legal, or environmental landscape (geographical boundaries, space availability, or zoning regulations). The

observers also documented the extent to which these constraints shaped the final mapping solution.

- *Mapping conflicts.* The observers documented whether discrepancies had arisen among participants during the mapping episodes. This encompassed disagreements in the interpretation of the scenario narrative or divergences in the proposed land use and transport changes. The observers also detailed how participants addressed and resolved these conflicts to reach the final solution.

6.4. Results

6.4.1. Overview of the three academically constructed cases

Workshop 1, themed “Car Decline,” lasted 1 hour and 20 minutes. It engaged six participants: two policymakers, one transport planner, one urban planner, one environmental consultant, and one property developer. Interactions were dynamic, with significant bilateral exchanges mainly involving the urban planner, the transport planner, and one of the policymakers. The research team identified six mapping episodes related to spatial transformations (Figure 6.6). Five episodes complemented the future narrative, and one extended it, without modifying the narrative.

Workshop 2, titled “Urban Boom,” ran for 1 hour and 28 minutes and involved six participants: two transport planners, one urban planner, one policymaker, one environmental consultant, and one property developer. About 80% of participant interventions were evenly distributed among the transport planners, the policymaker, and the environmental consultant. Discussions were largely collective, with limited direct replies between pairs of participants. The research team identified six mapping episodes related to spatial transformations (Figure 6.7). Three episodes complemented the future narrative, one extended it and two modified it.

Workshop 3, themed “Urban Dystopia,” lasted 1 hour and 33 minutes and featured six participants: two transport planners, one urban planner, one policymaker, one environmental consultant, and one property developer. The urban planner was the most active participant, followed by one of the transport planners, the policymaker, and the property developer, with the remaining participants being less involved. The research team identified four mapping episodes (Figure 6.8). One episode complemented the future narrative, one extended it, and two modified it.

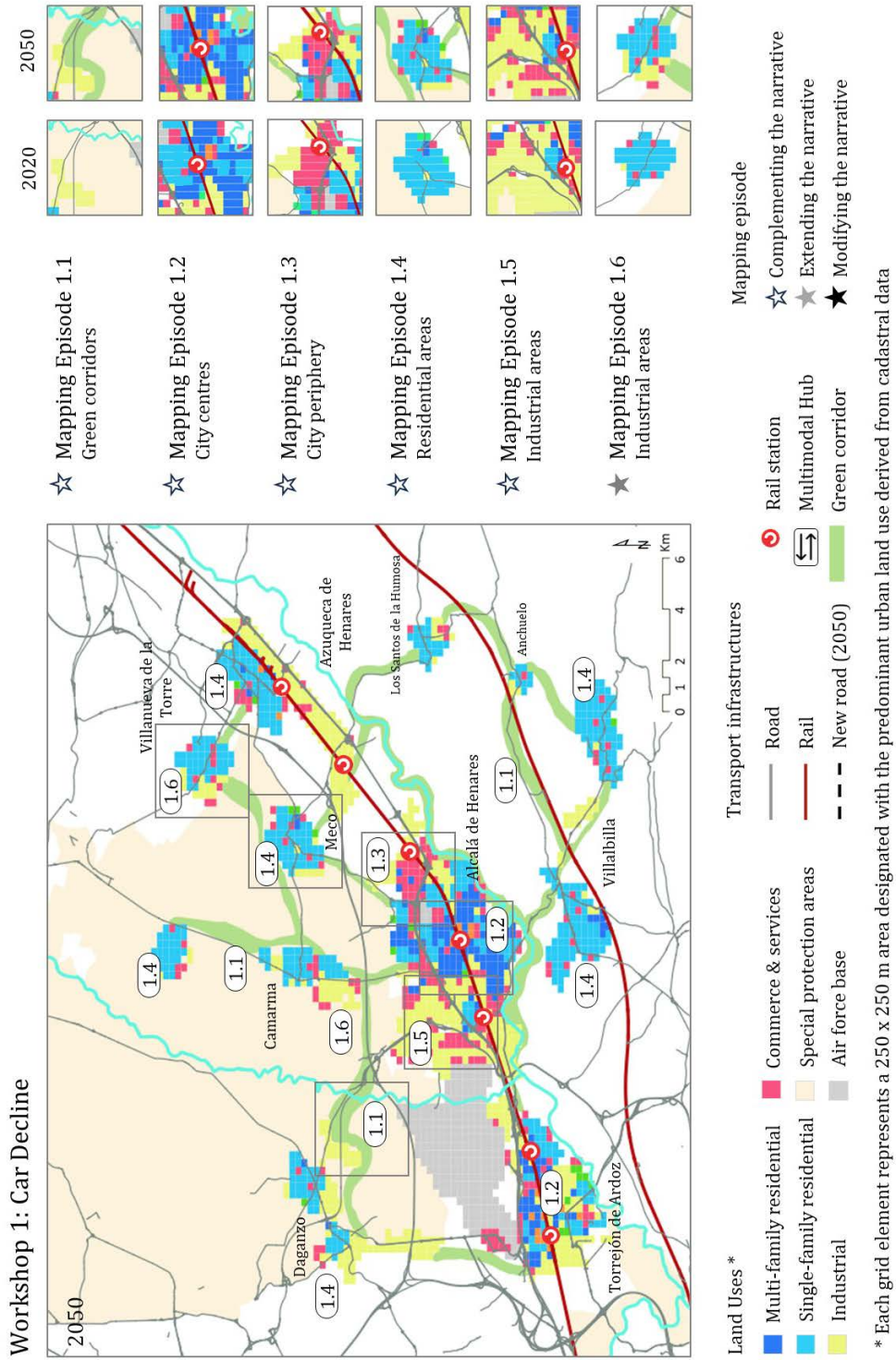


Figure 6.6. Mapping the scenario narrative Car Decline

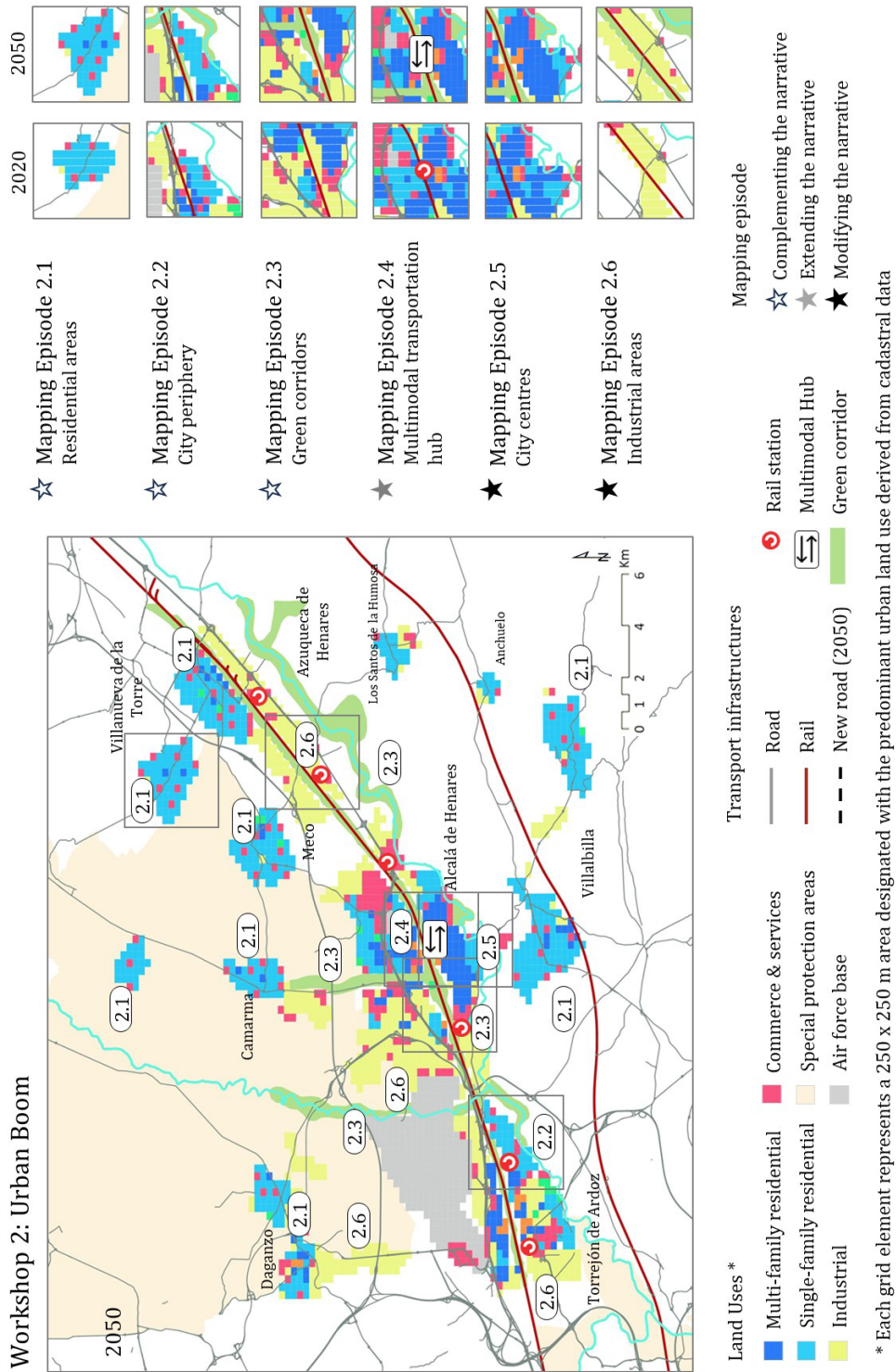
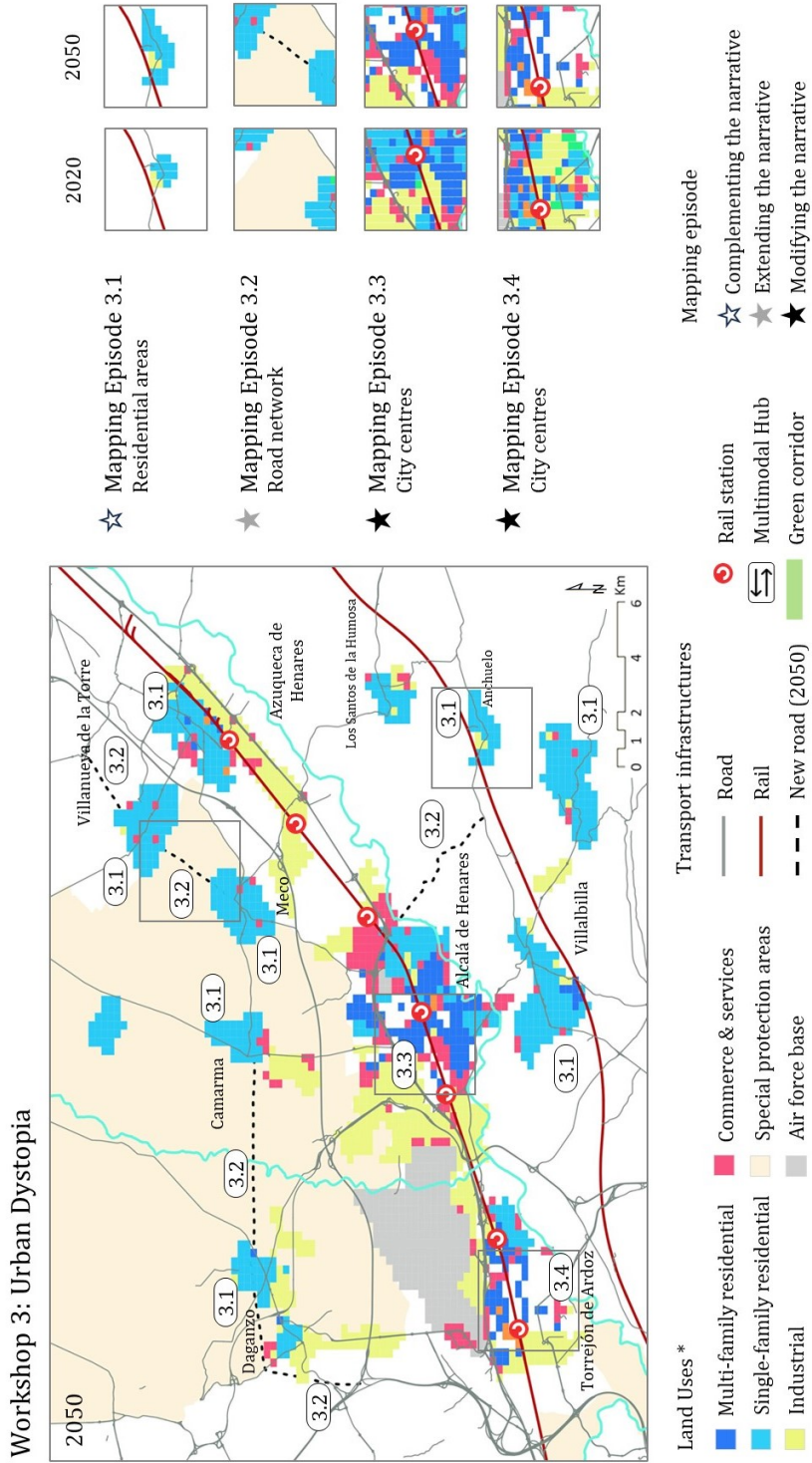


Figure 6.7. Mapping the scenario narrative Urban Boom



* Each grid element represents a 250 x 250 m area designated with the predominant urban land use derived from cadastral data

Figure 6.8. Mapping the scenario narrative Urban Dystopia

6.4.2. Mapping episodes complementing future narratives

In total, nine mapping episodes complemented future narratives: five episodes from Workshop 1 (Episodes 1.1, 1.2, 1.3, 1.4 and 1.5 in Figure 6.6); three episodes from Workshop 2 (Episodes 2.1, 2.2 and 2.3 In Figure 6.7); and one episode from Workshop 3 (Episode 3.1 in Figure 6.8). Across these mapping episodes, participants visualised and spatially interpreted a distinguishable segment of the future narratives. In all of them, the resulting spatial transformations were closely aligned with the original narrative.

In Workshop 1, most future aspirations outlined in the “Car Decline” scenario were materialized through spatial transformations that complemented the narrative. In Episode 1.1 (Figure 6.6), participants mapped several green corridors that aligned with the envisioned “dense network of pedestrian and cycling routes seamlessly connecting different municipalities” described in the future narrative. The city centre of Alcalá de Henares experienced a transformation during Episode 1.2 (Figure 6.6). In this process, new multi-family residential units replaced a single-family residential area, aligning with the narrative’s objective of “increasing the building density of historic city centres”. Similarly, in Episode 1.3 (Figure 6.6), participants incorporated multi-family housing into a mono-functional area dominated by commercial and services in the periphery of Alcalá de Henares. In this case, they were fulfilling the narrative’s expectations that “medium-high density neighbourhoods would prevail in the outskirts of the municipalities”. Ensuring a “rich mix of urban land uses” was the driving force that guided the participants during the spatial transformation of Episode 1.4 (Figure 6.6). Throughout this episode, they increased commerce and service uses across the study area, with a particular emphasis on small residential municipalities (e.g., Meco, Villalbilla). They dedicated a specific episode (Episode 1.5 in Figure 6.6) to intercalating commerce and services into the largest industrial area in Alcalá de Henares, fulfilling the narrative’s vision of “industrial and business areas transitioning into mixed-use zones”.

During Workshop 2, three mapping episodes complemented the “Urban Boom” future narrative. In the described overpopulation scenario, the narrative highlights that “the medium- to high-income population would prefer low-density peripheral neighbourhoods, [...] offering them a diverse land use mix”. In line with this concept, in Episode 2.1 (Figure 6.7), participants focused on expanding residential

municipalities on the northern edge of the Henares Corridors, integrating new single-family residential areas with commercial and service spaces. Similarly, in Episode 2.2 (Figure 6.7), participants developed new low-density residential zones in the outskirts of Alcalá de Henares and Torrejón de Ardoz. At a different moment during Workshop 2, in Episode 2.3 (Figure 6.7), participants mapped different greenways to fulfil the narrative's goal of "ensuring the seamless connectivity of the region through a network of green corridors". In the design of this network, special attention was given to the greenway running alongside the railway tracks, spanning longitudinally across the entire study area. Participants strategically conceived this design to smoothly "integrate active mobility with public transport", aligning the spatial transformations with the future narrative.

In Workshop 3, only one mapping episode complemented the "Urban Dystopia" scenario narrative. This is Episode 3.1 (Figure 6.8), in which participants notably increased the surface dedicated to single-family residential land use in small municipalities distant from large cities. This process was guided by the insecurity depicted in the narrative, particularly the notion that "a significant portion of the region's population would relocate from city centres to the outskirts, seeking a heightened sense of security and privacy".

All these mapping episodes complemented and enhanced the narratives by illustrating the scale and locations of the outlined land use and transport changes. Furthermore, the deliberation and interaction processes underpinning each spatial transformation provide valuable insights. For instance, there were episodes in which participants contributed their personal knowledge as input for mapping. For instance, in Episode 1.2 of Workshop 1 (Figure 6.6), the scope of the transformation process in the Municipality of Alcalá de Henares was influenced by the policymaker's local knowledge about preservation regulations in the historic city centre. This led to a more localized change around the train station area. There were other episodes in which participants dealt with mapping constraints. In Episode 1.1 of Workshop 1 (Figure 6.6), participants expressed concerns about mapping green corridors in the southern part of the study area due to the slope of the terrain. They recognized the limited walking or cycling potential of these corridors. Similarly, in Workshop 2, participants strictly adhered to the spatial constraints posed by natural protection areas when mapping new residential developments in Episode 2.1 (Figure 6.7).

Lastly, some episodes featured mapping conflicts among participants. For example, during Workshop 1, participants struggled to reach a consensus on which types of land uses were compatible with the industrial area they were transforming in Episode 1.5 (Figure 6.6).

6.4.3. Mapping episodes expanding future narratives

In total, three mapping episodes expanded future narratives: one episode from Workshop 1 (Episode 1.6 in Figure 6.6); one from Workshop 2 (Episode 2.4 in Figure 6.7); and one from Workshop 3 (Episode 3.2 in Figure 6.8). Throughout these mapping episodes, participants introduced novel elements or viewpoints not explicitly outlined in the initial narratives, thereby extending the narratives' dimensions while maintaining their coherence.

During Workshop 1, Episode 1.6 (Figure 6.6) emerged as a pivotal moment that significantly expanded the scope of the "Car Decline" narrative. Within this episode, participants conducted a series of transformative changes within the Corridor's industrial landscape. The origin of this episode traces the preceding events of Episode 1.5 (as delineated in Section 6.4.2), where the removal of some industries from a prominent industrial area catalysed a dynamic discussion, compelling participants to contemplate their redistribution. The ensuing dialogue revealed distinct viewpoints among the participants. One faction advocated for their dispersion across the southern peripheral municipalities – a strategy aimed at minimizing motorized commutes in this area. Conversely, transport and urban planning experts underscored the northern sector as the most suitable destination for these industrial nodes. Ultimately, this latter viewpoint prevailed, shaping the eventual course of action. As a result, new clusters of small-scale industrial activities were located next to the existing transportation infrastructure in the northern sector. While this spatial transformation was not initially envisioned within the framework of the "Car Decline" scenario, its incorporation was a significant enrichment aligned with the narrative's aspiration to foster a higher mix of urban land uses. Moreover, the strategic siting of these industrial zones introduces a fresh layer to the narrative, underscoring a harmonious alignment of both industrial functionality and transport efficiency.

During Workshop 2, in Episode 2.4 (Figure 6.7), participants orchestrated modifications within the public transportation network. These changes were

recognized as potential extensions to the overarching “Urban Boom” narrative. The key action of this episode was the establishment of a versatile multimodal transportation hub for both buses and trains. The participants did not adhere to any specific narrative guidance, and there was no evidence suggesting that this episode was a product of prior discussions or transformations conducted during the workshop. Instead, the episode emerged as a spontaneous mapping decision initiated by the transport planning expert. Although not anticipated, the other participants accepted this inventive decision, unanimously acknowledging that fostering multimodality was coherent with the future narrative. The astute integration of the new multimodal hub within the network of green spaces further amplified this collective recognition. This strategic fusion represents more than a spatial solution – it is a conceptual expansion of the narrative by depicting the future integration of active mobility with public transportation.

During Workshop 3, within the context of Episode 3.2 (Figure 6.8), participants made substantial and purposeful contributions that propelled the evolution of the “Urban Dystopia” narrative. Their active engagement involved a strategic expansion of the road network within the Henares Corridor. This enhancement, although not explicitly prescribed by the narrative, seamlessly integrates with the narrative’s central emphasis on the prevalence of motorized transportation. During deliberation, participants thoughtfully considered the prospect of enhancing the capacity of existing roads, entertaining concepts such as additional lanes to accommodate increased traffic. However, their perceptive analysis led them to conclude that these incremental improvements would not address the narrative’s transport demand. Instead, they chose to chart an innovative course by introducing entirely new roads. The selection of road locations was informed by the events of Episode 3.1 (as detailed in Section 6.4.2), wherein certain municipalities experienced a noteworthy surge in single-family residential developments. This surge proved instrumental in guiding the placement of three new roads. Two roads intentionally connected the northern expansions, while an additional road linked the municipality of Alcalá de Henares with the burgeoning southern developments.

6.4.4. Mapping episodes modifying future narratives

Four mapping episodes modified future narratives: two episodes from Workshop 2 (Episodes 2.5 and 2.6 in Figure 6.7), and two from Workshop 3 (Episodes 3.3 and 3.4 in Figure 6.8). Across these mapping episodes, the participants enacted spatial changes that diverged from the original trajectories outlined in the future narratives, yielding not only alternative interpretations but also meaningful modifications.

In Workshop 2, Episode 2.5 (Figure 6.7) marked a critical moment where participants embarked on spatial transformations within the municipalities of Alcalá de Henares and Torrejón de Ardoz. They were initially guided by the principles of the “Urban Boom” narrative, which depicted a scenario of “overpopulation in historical city centres leading to increased building density”. After a short discussion, they increased the density of the city centres by adding multi-family residential buildings. In this process, they replaced other land uses, including commercial, industrial, and single-family residential. Consequently, the outcome was the transformation of these city centres into mono-functional residential zones. This outcome overlooked that the “Urban Boom” narrative is also characterized by its emphasis on “the coexistence and integration of diverse land uses into multi-functional areas”. Therefore, the outcomes resulting from these mapping episodes, although unintentionally, represent a significant deviation from the narrative’s initial trajectory.

During Episode 2.6 (Figure 6.7), participants’ actions once again demonstrated a deviation from the “Urban Boom” narrative. In contrast to the previous episode, the participants were fully aware that their decisions did not align with the narrative’s intended direction. This was evident in their collective disagreement with the narrative element stating that “industrial areas would undergo substantial shifts towards multifunctionality”. During the deliberation and interaction process, participants signalled a lack of prior evidence suggesting that an overpopulation scenario would naturally lead to the kind of spatial transformation envisioned in the narrative. They also manifested their desire to influence the evolution of the urban landscape in directions that diverged from the narrative’s guidelines. Based on this perception, participants opted to preserve the mono-functional character of industrial areas while simultaneously increasing their total surface area. This intentional deviation underscores the participants’ active role in shaping the future narrative.

Participants of Workshop 3 made deliberate choices to deviate from the predetermined trajectory of the “Urban Dystopia” narrative, resulting in profound spatial transformations that significantly modified the established narrative framework. During Episode 3.3 (Figure 6.8), participants removed a substantial portion of single-family residential land use from the city centre of Alcalá de Henares. While the narrative explicitly states that “insecure central areas would be relegated to low-income populations, as well as commercial and service uses”, they opted to challenge this narrative element. The outcome was the creation of vacant spaces, which remained unoccupied, thereby generating an empty urban core that contradicted the narrative’s original vision. In Episode 3.4 (Figure 6.8) participants continued to challenge the “Urban Dystopia” narrative via similar spatial transformation. In this episode, they relocated nearly all industrial activities from the city centre of Torrejón de Ardoz to the peripheral industrial sites. The ensuing result mirrored the previous episode, with vacant spaces left unoccupied, leading to the emergence of an empty city centre in Torrejón de Ardoz. Through these two mapping episodes, the participants demonstrated their capacity to redefine the narrative’s outcomes and introduce spatial configurations that had not been previously envisioned.

6.5. Discussion and conclusions

The chapter sought to address the following research question: *To what extent and how can participatory mapping processes contribute to spatially shaping disruptive scenario narratives?* Three academically constructed cases were tested in an experimental setting. Each case was operationalized in a workshop with six participants who analysed one of the three 2050 exploratory narratives for the Henares Corridor, Spain: (i) Car Decline in Workshop 1, (ii) Urban Boom in Workshop 2, and iii) Urban Dystopia in Workshop 3.

The participants engaged in collaborative mapping activities, focusing on changes in land use and transportation in line with the scenario narratives. The examination of the dialogue and interaction dynamics during the mapping episodes (i.e., distinct segments of the workshops leading to relevant spatial transformations) underwent a comprehensive analysis through a structured observation approach. This approach provided the research team with insights into the influence of participatory mapping

on shaping the spatial and local dimensions within scenario narratives. It aimed to discern whether such mapping practices have an impact on complementing, expanding, and/or modifying the original future narratives.

The results reveal a primary group of mapping episodes that complemented future narratives by skilfully representing recognizable elements. In these episodes, it became evident that the discussion and interaction processes among participants neither introduced new elements nor deviated from the original narratives. These complementing episodes were predominantly observed in Workshop 1, based on the Car Decline scenario. In addition, a second typology of mapping episodes emerged across the three workshops, characterized by their capacity to expand upon future narratives. Participants introduced elements and perspectives not explicitly outlined in the future narratives. Remarkably, even with this expansion, the narratives maintained their overall coherence. Finally, a third group of mapping episodes was identified, demonstrating the transformative potential of participatory mapping. In these instances, participants conducted spatial transformations that diverged from the original trajectories outlined in the future narratives, introducing meaningful modifications. These transforming episodes were observed in Workshop 2 (Urban Boom) and Workshop 3 (Urban Dystopia).

Based on the results, a collection of themes, constraints, and queries emerged, offering additional perspectives on the research question. Three key issues are discussed below.

Scenario narratives and participatory mapping: a reciprocal relationship

The working hypothesis of this study is based on an intricate interconnection between scenario narratives and participatory mapping, establishing a mutually reinforcing relationship. This hypothesis, grounded in the acknowledgment that scenario narratives act as pivotal catalysts for the initiation of the participatory mapping process, aligns with previous literature in the field (Carter et al., 2017; Duguma et al., 2022; Larondelle et al., 2016). What distinguishes this study is the recognition that participatory mapping functions as an active instrument, exerting influence on the trajectory of scenario narratives beyond a concluding phase. This hypothesis is substantiated by the empirical evidence derived from the experiments conducted in this study, i.e., mapping workshops with experts and local stakeholders.

These workshops have affirmed that narratives can be complemented, expanded, and modified through the participatory mapping process.

The ramifications for scenario planning are profound. Firstly, this study substantiates the conceptualization of participatory scenario mapping as an indispensable requirement, overcoming any scepticism regarding its perceived utility as merely a useful yet dispensable visualization process. Secondly, the conventional scenario planning approach in which narratives are formulated and presented as immutable endpoints is scrutinized (Carter et al., 2017; Molinero-Parejo et al., 2021; Rivas-Tabares et al., 2022; Lamarque et al., 2013). The findings advocate for a more iterative and adaptive methodology for scenario-building. In this framework, scenario narratives are regarded as dynamic entities capable of evolution and adaptation through continuous engagement with various experts and local stakeholders. The active role of participatory mapping incorporates an innovative feedback loop, enabling ongoing adjustments and refinements to scenario narratives grounded in local and expert insights.

Local and expert knowledge: challenges and opportunities

A key methodologically choice in this study entailed the implementation of a participatory mapping process, involving both domain experts and local stakeholders. It was documented participants contributing additional insights during the mapping process, extending beyond the narratives' content. Local stakeholders drew upon their experiential knowledge within the study area (e.g., policymakers' understanding of local regulations or residential preferences), while experts contributed their specialized knowledge in spatial transformations (e.g., transport planners' expertise in road design). Participants identified various mapping constraints, recognizing barriers and restrictions, particularly linked to geographical conditions (e.g., adverse topography, accessibility requirements). As emphasized in prior literature (Lamarque et al., 2013; Hérivaux et al., 2021), all narrative elements, including those intangible elements that might scape unnoticed in a more quantitative approach, influenced the mapping process. These findings underscore the aforementioned central idea that scenario narratives should not be treated as generic, one-size-fits-all concepts; rather, they should be perceived as customizable and adaptable frameworks capable of assimilating new knowledge and adjusting to spatial constraints.

Through the structured observation process, there were also documented instances of conflicts and discrepancies among participants, encompassing disagreements in the interpretation of scenario narratives or divergences in proposed changes to land use and transportation. In most cases, the mapping process functioned as a structured platform for consensus-building—a observation consistent with existing literature (Lamarque et al., 2013; Hérivaux et al., 2021). Additionally, observers noted differences in participants' levels of engagement, at times leading to the identification of situations involving dominance or a lack of dialogue. This manifested in an overemphasis on one type of spatial change over others, such as prioritizing land use developments over transportation initiatives. It is noteworthy that, when dealing with small workshops (six participants), concerns may arise regarding the impact of participants' personality.

In the context of scenario mapping experiments, the local scale assumes paramount significance. This research highlights the indispensable role played by local stakeholders, facilitating a more profound examination of nuanced aspects within the region and illuminating localized factors and micro-level dynamics that might otherwise escape notice (Duguma et al., 2022; Carter et al., 2017). This emphasis on the local scale holds broader implications for scenario planning, suggesting that scenario narratives should intricately consider the unique characteristics and challenges at the local level, in addition to overarching global or national trends. The participatory mapping process, in this regard, offers a promising solution for the development of more contextually rich and nuanced scenarios.

Validity and reliability

Validity, a crucial aspect in qualitative research, encompasses factors like trustworthiness, authenticity, and quality (Maxwell, 2013; Creswell, 2014; Bryman, 2016; Larsen, 2020). It denotes the accuracy and credibility of study results and conclusions, rendering them useful and believable (Maxwell, 2013). Observational approaches in qualitative research often grapple with "researcher bias" as a validity concern, addressing how researchers' values and expectations may influence observations and conclusions (Maxwell, 2013; Creswell, 2014). In this study, specific strategies were employed to mitigate validity concerns. First, a prolonged observation process allowed observers to repeat and verify observations. Second, the dataset was meticulously curated to be comprehensive and diverse, ensuring a

nuanced portrayal of the workshops. Observers, equipped with both video footage and full transcripts, were presented with a rich dataset, minimizing the risk of bias by preventing narrow interpretations aligned with preconceptions. Furthermore, a multi-setting approach involving three distinct workshops aimed to identify common interactions and overarching patterns beyond scenario specifics or individual participants. Despite these efforts, certain validity strategies were not implemented in this study, which could have helped in detecting bias. These other strategies may have included soliciting feedback from workshop participants on the results obtained, engaging an external auditor for process review, or incorporating specific statistics to elucidate the basis of conclusions.

Ensuring the reliability of research also holds significant importance in qualitative studies (Bryman, 2016; Creswell, 2014). This research has implemented various strategies to uphold the reliability of the obtained findings. Initially, a meticulous observation schedule was established, outlining a comprehensive protocol and database. Two independent observers adhered to this schedule, documenting procedural steps exhaustively. Cross-checks were performed by comparing their observations, with a third researcher intervening to resolve discrepancies when necessary. To prevent misinterpretation of established categories during the observation process, observers underwent multiple training rounds. The research team facilitated regular communication between the two observers, ensuring consistent documentation and shared analysis. Additionally, thorough checks were conducted on workshops' transcripts to mitigate transcription errors.

Finally, it is essential to note the experiment's limited ecological validity (Bryman et al., 2016; Larsen et al., 2020). The methodology involved the active engagement of experts and local stakeholders in three academically constructed cases, implemented through a series of three in-person mapping workshops. This selection aimed to create a controlled setting for an in-depth exploration of causality concerning the research question (Te Brömmelstroet, 2015). The experiment was deliberately kept separate from the formal planning processes of the case study, allowing the research team the flexibility to explore and experiment without being constrained by governmental interests. Therefore, the outcomes derived from this study do not directly translate into practical applications for current planning practices in the case

study. Future studies should test real-world experiments, establishing formal collaboration with regional and local governments.

In summary, this chapter has introduced an innovative method that centres on investigating the usefulness and effectiveness of participatory mapping within the scenario-building processes rather than introducing entirely new applications. The primary objective was to produce knowledge that has been “field tested” with the intended users. The findings suggest that participatory mapping processes go beyond the creation of narrative-based maps, showcasing their potential influence on shaping the spatial and local dimensions of scenario narratives. This impact is evident in their ability to complement, expand, and modify the content of these narratives. While acknowledging that the obtained results can be seen as preliminary due to the controlled experimental set-up, they present encouraging outcomes that can catalyse additional research into the role of participatory mapping within scenario-building processes in real-world contexts.

7

7 RE-THINKING THE ROLE OF DISRUPTIVE SCENARIOS FOR ADAPTIVE POLICYMAKING

This *Seventh Chapter* is a reprint of the article “*Re-thinking the role of exploratory scenarios for adaptive policymaking: An application for land use and transport planning*”, published in *Futures* (2023), 149, 103139.

<https://doi.org/10.1016/j.futures.2023.103139>

Abstract

While scenario-building has proven useful in situations marked by considerable uncertainty in the context of land use and transport policymaking, additional research is needed to develop adaptive and dynamic scenario-building schemes. To address this gap, the present chapter conceptualises an adaptive scenario-building approach that would facilitate adaptive policy responses by using disruptive exploratory scenarios as intermediate tipping points. An empirical research design is also conducted following a participatory approach, with a case study of the Henares Corridor in the Metropolitan Area of Madrid, Spain. Three exploratory scenarios are assessed as experimental tipping points for the basic policy pathways initially adopted by regional and local governments. The use of such tipping points suggested different adaptive policy responses: (i) preserving policy responses when scenarios are strongly aligned with the basic pathways; and (ii) transforming policy responses when significant deviations are perceived between the scenarios and the basic pathways. The chapter also discusses the real-life application potential of this adaptive scenario-building approach, further research steps, and future horizons for scenario-building.

Key words: uncertainty; adaptation; foresight; visioning; participation

7.1. Introduction

The future of cities and transport systems is now – more than ever – shaped by disruptive events with low predictability, which trigger dynamic responses and social change (Marchau et al., 2019; Lyons & Marsden, 2019). For example, the ongoing COVID-19 outbreak shapes urban planners' perceptions of the future as deeply uncertain, where any predictions are strongly contested (Batty, 2020). In this highly dynamic context, supporting policymaking processes that effectively address land use and transport integration is crucial for achieving sustainable outcomes (Banister, 2005; Bertolini, 2017). However, achieving this goal demands high flexibility and adaptability among policymakers, to be able to cope with unexpected futures marked by turbulences (Van Drosser et al., 2018, 2020; Walker et al., 2010; Soria-Lara et al., 2021; Van Drunen et al., 2011). Such approaches may result in alternative policymaking schemes based on interaction and learning processes between stakeholders and institutions, just-in-time mechanisms for monitoring planning outcomes, and, most innovatively, adaptive policy pathways.

The field of future studies provides planning actors with a set of social science methods to consider future outlooks under situations of high complexity and uncertainty (Akerman & Höjer, 2006; Banister et al., 2000; Lyons & Davidson, 2016; Vergragt & Quist, 2011; Hickman & Banister, 2014). It can be identified three main types of scenario-building studies that illustrate alternative ways of thinking about the future (Amara, 1891; Björson et al., 2006; Dreborg et al., 2006; Vergragt & Quist, 2011): (i) predictive scenarios, based on foreseeing the most probable futures; (ii) normative scenarios, orientated towards searching and achieving a desired future; (iii) exploratory scenarios, which examine plausible futures to cover a wide scope of possible future situations. In the view of this research, the nature of exploratory scenarios is particularly of interest for the development of robust policies that survive to various external future developments, becoming a promising basis for transforming traditional policymaking into an adaptive scheme.

To cope with the complexity and dynamism of cities and transport systems, previous studies have constructed multiple and simultaneous exploratory scenarios for a limited set of possible or plausible long-term contexts (Tuominen et al., 2014; Liimatainen et al., 2014; Varho & Tapio, 2013; Soria-Lara et al., 2021). The predominant approach sees such futures as long-term endpoints, which are

ultimately connected to the present situation through separated policy pathways following a static and just-in-case policymaking scheme (Höjer et al., 2011; Olsson et al., 2015; Soria-Lara & Banister, 2018; Hickman et al., 2011; Zimmermann et al., 2013). These pathways are only activated if there is a clear intention to achieve the expected outcomes from a specific future state, usually seen as the most appropriate one (Keseru et al., 2021; Soria-Lara & Banister, 2018; Hickman et al., 2012). This approach strongly limits the ability of scenario-building methods to adapt the established policy pathways to changing situations and unexpected futures (Walker et al., 2001, 2011, 2013; Kwakkel et al., 2010). A research gap exists to examine how disruptive scenarios could be used for activating adaptive policymaking processes (Zapata & Kaza, 2015; Chakraborty et al., 2011; Hallegatte, 2009). Moreover, the present research seeks to address this gap by re-thinking the role of disruptive scenarios for considering an alternative paradigm that can trigger adaptive policy responses.

Specifically, this chapter aims to explore the following research question: *To what extent it is possible to obtain different adaptive policy responses using disruptive exploratory scenarios as intermediate tipping point, rather than using them as independent long-term future endpoints?* First, a theoretical framework for an adaptive scenario-building approach has been conceptualised, transferring traditional concepts from adaptive policymaking to scenario-building methods (Walker et al., 2010; Marchau et al., 2010). Under this framework, exploratory scenarios are proposed as intermediate tipping points, identifying situations in which the adopted policy pathways might fail in achieving strategic goals and suggesting different potential policy responses. Second, a total of 25 experts were used to assess the capacity of such intermediate tipping points for resulting in a variety of adaptive policy responses for land use and transport planning. The context of the Henares Corridor in the Metropolitan area of Madrid, Spain provides the empirical focus.

The chapter continues by discussing the theoretical framework for an adaptive scenario approach in the next section. Further, Section 7.3 shows the empirical research design, while Section 7.4 details the main results. Finally, Section 7.5 closes with concluding remarks on the proposed framework, its implementability, research design validity, and further research developments.

7.2. Moving from static to adaptive scenario-building

7.2.1. The static approach: scenarios as long-term endpoints

Despite the bounded rationality inherent in planning (Checkmarn, 2004; Van Drunen et al., 2011), future studies have made significant progress in creating multiple scenarios combining desired and plausible long-term endpoints that cover the widest range of future outlooks (Liimatainen et al., 2014; Von der Gracht & Darkow, 2016; Soria-Lara et al., 2021). Following a static scheme, such endpoints will be reached through separate and specific policy pathways (Höjer et al., 2011; Olsson et al., 2015; Soria-Lara & Banister, 2017b; Hickman et al., 2011) (Figure 7.1). The designed policy pathways are only activated if there is a clear objective to reach the outcomes of a specific desired future after appraisal processes (Keseru et al., 2021). The selected future and pathway would be eventually adopted, while the remaining possible futures and policy pathways are no longer used. This static approach strongly limits the ability of scenario-building methods to change or adapt policy pathways over time, reducing the chances to implement a robust policymaking process for complex, dynamic, and highly uncertain future contexts.

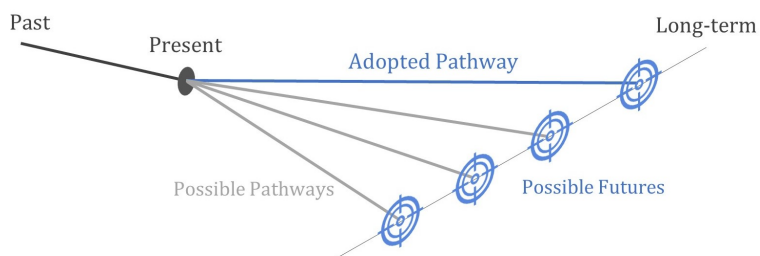


Figure 7.1. Traditional scenario-building schemes: a static approach

Multiple examples following the static scenario approach can be found in academic literature (Liimatainen et al., 2014; Varho & Tapio, 2013; Höjer et al. 2011). For example, Tuominen et al., (2014) create eight radically different 2050 scenarios to address CO₂ transport emissions in Finland. For each scenario, a separate policy pathway is designed, without a comprehensive consideration of all possible futures and their respective pathways. Similarly, Hickman et al., (2011) and Banister and Hickman & Banister (2013) develop a business-as-usual baseline and alternative scenarios for the UK and India. For each scenario, single policies are listed and

grouped into packages and separate paths without considering potential options for adaptive schemes.

Another example comes from Shifan et al., (2003), who design two separate policy pathways, respectively based on likely and desired policies to reach two different futures in Tel Aviv Metropolitan Area, Israel. Olsson et al., (2015) also construct two future scenarios for a post-fossil fuels road transport system in Stockholm, and then, two different just-in-case policy pathways linking the present with each scenario. Soria-Lara & Banister (2017) develop three policy pathways to reach a desired transport future for Andalusia, Spain. Although the three individual pathways are integrated in a single pathway, the system cannot evolve and be adaptive to future uncertainties. González-González et al., (2020) propose single policies grouped into large packages to reach a driverless transport scenario as future endpoint. Again, a static framework prevails against other possible adaptive approaches. Although the focus of this research is mainly on land use and transport sectors, static scenario approaches are also found in adjacent fields: energy efficiency (Kishita et al., 2017; Svenfelt et al., 2011), economic development (Nikolakis, 2020), sustainable lifestyles (Neuvonen et al., 2014), and water management (Kok et al., 2011).

7.2.2. The adaptive approach: exploratory scenarios as intermediate tipping points

Previous research on adaptive policymaking and dynamic adaptive planning is seen as useful for overcoming the static scenario approach (Walker et al., 2001; 2011; Kwakkel et al., 2010; Swanson et al., 2010). Adaptive policymaking has been used in several fields, including transport (Marchau et al., 2008, 2010; Agusdinata et al., 2007; Rahman et al., 2008; Wall et al., 2015). It ideally establishes that policy pathways should incorporate the ability to adapt dynamically to a rapidly changing world, in which static policymaking approaches are likely to fail (Kwakkel et al., 2010; Walker et al., 2013).

The basis of adaptive policymaking is the adoption of a basic policy pathway, together with the identification of both the vulnerabilities and opportunities of that path. A monitoring system is activated and tipping points are defined, determining the conditions under which the basic policy pathway no longer meets its specified goals. When one tipping point reaches predetermined critical levels, a series of adaptive

pathways are implemented, ensuring that the basic pathway stays on track to reach the desired planning goals. Both tipping points and adaptive pathways consider the timing of actions explicitly in their approach (Walker et al., 2013).

This research proposes to transfer the concept of tipping points and adaptive pathways to scenario-building methods, providing a new theoretical framework that would offer more robustness and adaptability to policymaking in highly uncertain futures. This adaptive scenario approach proposes to simultaneously use exploratory scenarios as intermediate tipping points, activating possibilities to adopt alternative policy responses when necessary. The process would follow several steps (Figure 7.2):

- Step 1: strategic goal(s) and basic policy pathway(s). One or several strategic goals would be established for the long-term. These goals would illustrate “universal values” in pursuit of e.g., social, economic, and environmental sustainability (e.g., reduction of car dependency, abolition of social inequality). For reaching each strategic goal, a basic policy pathway would be designed. Such basic pathways would be initially conceived with no consideration of potential disruptive events that can alter the system(s) significantly.
- Step 2: exploratory scenarios as intermediate tipping point(s). In a second step, mid-term exploratory scenarios would be elaborated. These scenarios would explore plausible intermediate situations, developments or turning points that may originate an impact in the system(s) (e.g., overpopulation, social conflicts). In particular, exploratory scenarios would conform one or several tipping points that inform policymaking by identifying potential situations in which a basic pathway would fail or succeed.
- Step 3: adaptive policy response(s). In a third step, the use of exploratory scenarios as tipping point(s) would result in determining the policy response needed to ensure that a specific strategic goal can be finally reached. This policy response would adjust or significantly modify the basic pathway to adapt the system(s) against deviations.

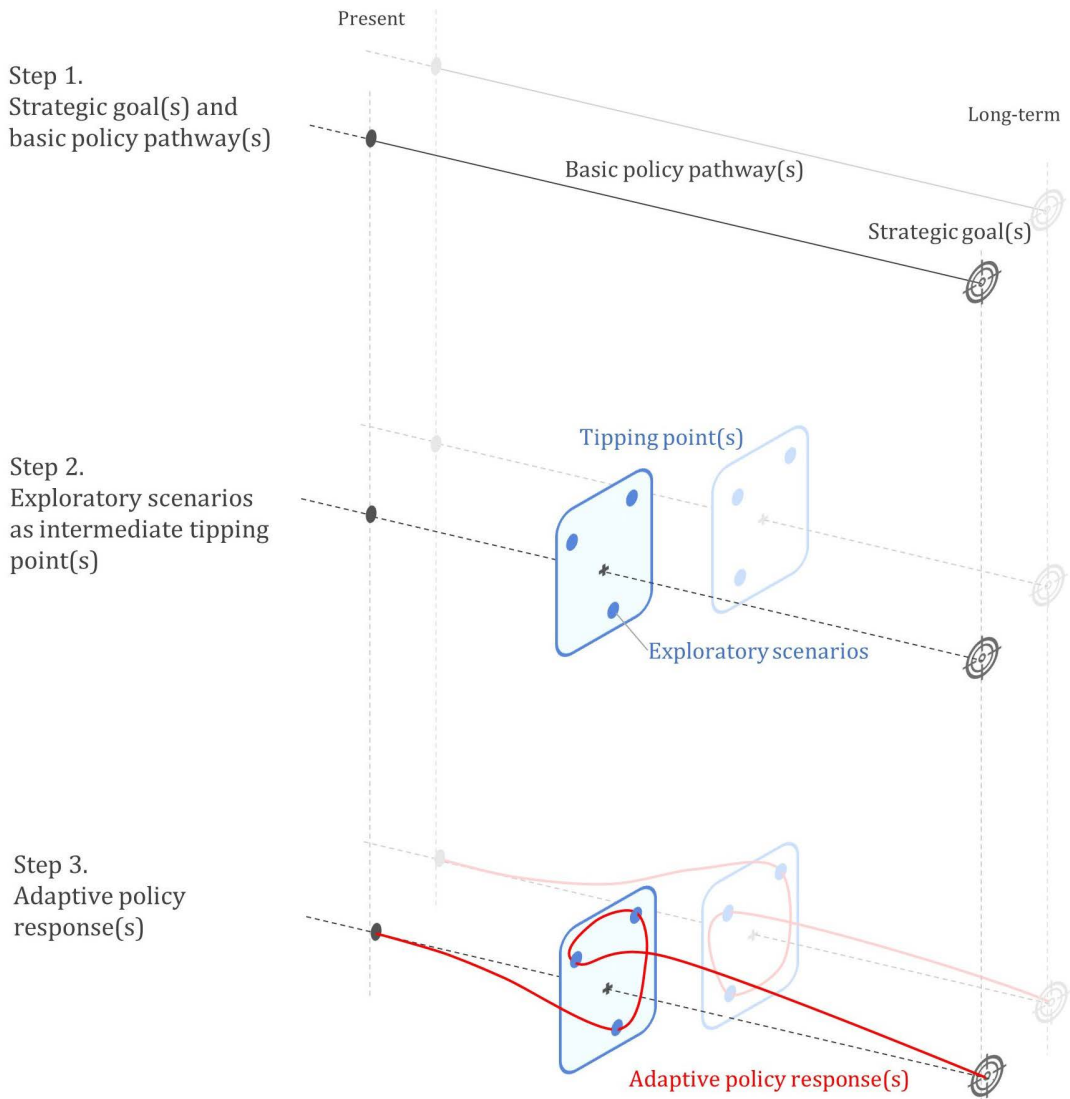


Figure 7.2. The process for an adaptive scenario-building approach

Two main types of policy responses could be activated by intermediate tipping points: preserving and transforming (Figure 7.3). Preserving policy responses would result from tipping points in which non-significant deviations are seen between the basic pathway(s) and the content of exploratory scenarios. Only minor readjustments to the basic pathway would be necessary over time. Such readjustments rely on smooth and incremental actions, as radical changes would not be necessary to finally achieve a specific strategic goal. On the contrary, transforming policy responses would result from tipping points in which significant deviations between the basic pathway(s) and exploratory scenarios are identified. Major modifications to the basic pathway are necessary over time, including changes in planning assumptions and models.

Different types of actions can be distinguished within the context of transforming policy responses. On the one hand, such transforming responses could be outcomes-oriented when deviations are perceived between the expected outcomes from the basic policy pathway and the content of exploratory scenarios. Then, mitigating actions to avoid possible vulnerabilities are necessary and/or seizing actions that take advantage of possible opportunities (Figure 7.3). On the other hand, transforming responses could be priority-oriented when deviations are perceived between the basic policy pathway and the exploratory scenarios for prioritizing the achievement of certain strategic goals. Then, recovery actions to guard against the possibility of underprioritizing the achievement of a strategic goal can be necessary and/or boosting actions to harness overprioritizing situations. It must be considered that both outcomes and priority-oriented policies are not exclusive, but they can simultaneously coexist.

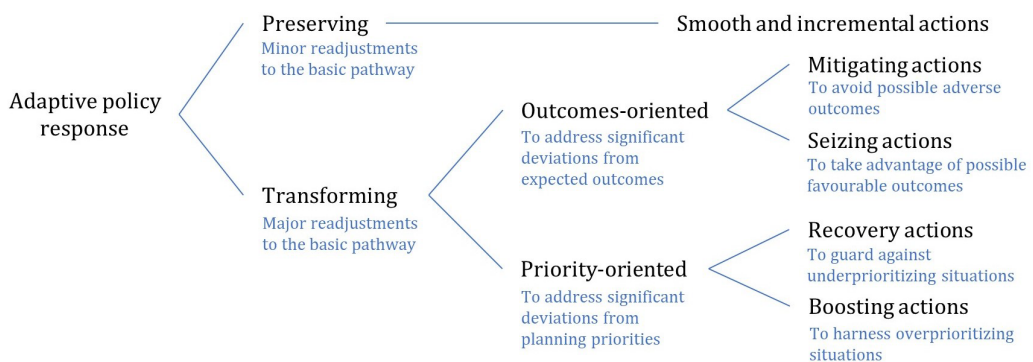


Figure 7.3. Types of adaptive policy responses

7.3. Research design

An empirical research design has been used to explore potential answers to the main objective of this chapter, namely the analysis of the possibilities of obtaining different adaptive policy responses through the use of disruptive scenarios as intermediate tipping points. The Henares Corridor, located in the eastern part of the Metropolitan Area of Madrid, Spain serves as case study (see Section 3.2 in Chapter 3). The complexity and dynamism of the region makes its future highly uncertain, being an appropriate location for evaluating the possibilities of an adaptive scenario approach. Achieving high levels of land use and transport integration – supportive interconnections between land use development and transport systems – is also seen as crucial for both local and regional authorities. In this respect, most of policy actions adopted pursuit the mentioned integration as a priority aspect (e.g. reduction of car transit in city centres).

The methodological design implemented in this research follows the three steps previously detailed for implementing an adaptive scenario-building approach (Section 7.2.2): (i) strategic goal(s) and basic policy pathway(s); (ii) disruptive scenarios as intermediate tipping points; (iii) adaptive policy responses. The reminder of this Section details each step.

7.3.1. Step 1: Strategic goal(s) and basic policy pathway(s)

A review of local and regional strategies, aimed at addressing the main land use and transport planning challenges (e.g., GHG emissions, urban sprawl, social inequalities, or degradation of natural ecosystems), has been conducted. In particular, a total of five long-term strategic goals for land use and transport integration have been identified in the Henares Corridor: (i) spatial equity; (ii) urban compactness; (iii) transport multimodality; (iv) biodiversity and ecosystem integration; (v) urban environmental quality. To achieve these strategic goals, local and regional authorities have adopted a set of five basic policy pathways:

- Basic pathway 1. This pathway aims to achieve the strategic goal of spatial equity, which consists of an equitable location/distribution of urban land uses and transport systems for everyone. The basic policy pathway is based on regional and local strategies, focused on promoting physical, economic, and social

- regeneration of urban areas (e.g., achieving affordable housing prices and encouraging commercial revitalization) (Comunidad de Madrid, 2016; Ayuntamiento de Alcalá de Henares, 2014). Additionally, the regional mobility plan (Consortio Regional de Transportes de Madrid, 2013) promotes equitable and easier access for the general population and vulnerable groups to major destinations (e.g., decreasing distances to collective transport stations and providing aids for low-income populations).
- Basic pathway 2. This pathway seeks to achieve the strategic goal of urban compactness, fostering compact urban development, as a contribution to decreasing car dependency. The basic policy pathway is mainly based on regulatory and local policies seeking to prevent urban sprawl. In addition, municipalities are also implementing urban renewal policies (e.g., new public facilities in suburban areas) (Ayuntamiento de Alcalá de Henares, 2018; Ayuntamiento de Torrejón de Ardoz, 2013).
 - Basic Pathway 3. This pathway aims to address the strategic goal of transport multimodality, through enhancing the connectivity and complementarity of transport systems and networks. The basic policy pathway focuses on the regional transportation strategy (Consortio Regional de Transportes de Madrid, 2013), including a wide range of land use and transport policies (e.g., new public transport services connecting recent urban developments, multi-modal transport hubs, and bus corridors). Improvements to the pedestrian and cycling network are also planned.
 - Basic Pathway 4. This pathway aims to reach the strategic goal of biodiversity and ecosystems integration. It shows the intention to achieve an effective integration of urban areas into the surrounding ecosystems, protecting and enhancing local biodiversity. The regional government has adopted a set of actions based on nature-based solutions for urban and peri-urban areas, providing relevant ecosystem services across the case study (Comunidad de Madrid, 2011, 2020a). The key policy is the implementation of a green infrastructure system (Comunidad de Madrid, 2020b).
 - Basic Pathway 5. This pathway is intended to achieve the strategic goal of urban environmental quality, ensuring high-quality environmental and health standards in urban areas (e.g., air and noise pollution). It is being implemented via both the

regional mobility plan (Consortio Regional de Transportes de Madrid, 2013) and the regional strategy for air quality and climate change (Comunidad de Madrid, 2013). This basic pathway mainly covers traffic control policies (e.g., pedestrianisation of city centres) and energy efficiency actions (e.g., tax benefits for electric vehicles).

7.3.2. Step 2: Disruptive scenarios as intermediate tipping points

The research team used a set of disruptive scenarios on transport and land use to construct intermediate tipping points for the five basic pathways previously described (Section 7.3.1). These scenarios were developed by the research team following a participatory process that included a total of 129 semi-structured interviews in the Henares Corridor (see Section 4.4 in Chapter 4). Seven 2050 scenario narratives with different levels of disruption and remarkable differences in their contents were developed (see Section 4.4 in Chapter 4). Three of them have been used as inputs for this research: “Car Decline”, “Urban Boom”, and “Urban Dystopia”. A more concise version of these three scenario narratives is provided below:

Car Decline: *In an ambitious move towards sustainable urban developments, cities within the Henares Corridor have implemented a groundbreaking initiative to create vibrant, pedestrian-friendly city centres by strictly restricting private vehicle access. This bold step encourages and prioritizes walking and cycling as the primary transportation modes to all daily destinations. The driving force behind this transformation is the desire to foster healthier, greener, and more interconnected communities. Cities have focused on integrating various aspects of daily life within accessible distances. By ensuring a rich mix of residential, commercial, leisure, and working sites, residents can enjoy the convenience of satisfying their essential needs within walking or cycling distance. Industrial and business areas are undergoing a profound metamorphosis, transiting into vibrant mixed-use zones. This transformation not only reduces the dependence on private vehicles but also promotes a diverse and inclusive urban environment where work and leisure can harmoniously coexist. In addition, green corridors are established throughout the case study, providing residents with a dense network of walking and cycling paths.*

Urban Boom: *The Henares Corridor has experienced a significant surge in population growth, leading to transformative changes in urban living and transportation patterns. The main city centres have become vibrant and diverse, characterized by a mix of multi-family dwellings, urban services, and facilities. The rising number of multi-family dwellings accommodates the growing population. Meanwhile, high-income households prefer low-density residential neighbourhoods on the city's periphery. These areas offer a blend of suburban tranquillity and a high land-use mix, providing residents with a balanced lifestyle. The transformation of the city's periphery also involves converting current work areas into multi-functional places, creating lively and dynamic hubs that cater to various needs and activities. Collective modes of transport, such as buses and trains, are increasingly used for work commutes while walking and cycling for shopping and leisure. To ensure the seamless connectivity of the region, a network of green corridors has been strategically designed to integrate active mobility with public transport systems.*

Urban Dystopia: *The Henares Corridor is shaped by a distressing increase in insecurity in urban areas. High crime and robbery rates have led to a drastic shift in the modal split, with private cars becoming the prevailing choice for daily trips, including commuting, shopping, and leisure activities. The insecurity has rendered walking and cycling inadvisable, and public transport is stigmatized and predominantly used by the low-income population with limited alternatives. This grim reality has left the region devoid of green zones and safe public spaces, depriving residents of public spaces for recreation and relaxation. The urban landscape has become highly segregated, with homogeneous areas connected primarily by motorized infrastructures. City centres have been transformed into work destinations, with most employees commuting from the city's periphery, where high-income families reside in private communities. Low-income families are left with limited options, often forced to reside in insecure neighbourhoods in the city centres, exacerbating social inequalities.*

These three disruptive scenarios have been used as intermediate tipping points, depicting potential deviations from the basic pathways to achieve each strategic goal. In total, such exploratory scenarios were used for five specific tipping points, one per strategic goal and its associated basic pathway.

7.3.3. Step 3: Adaptive policy responses

The five tipping points shaped by exploratory scenarios (one per strategic goal; see Section 7.3.1) have ultimately been used for proposing adaptive policy responses that adjust or modify each basic pathway. According to the theoretical framework described in Section 7.2.2, the type of policy response would depend on the level of alignment between the three exploratory scenarios and the basic pathways adopted. In this particular context, a total of four alignment measures have been used to identify the type of policy response for each tipping point (Figure 7.4):

- Favourable outcomes: it measures the alignment between favourable outcomes from exploratory scenarios – if any – and the expected outcomes from the basic pathway.
- Adverse outcomes: it measures the alignment between adverse outcomes from exploratory scenarios – if any – and the outcomes expected from the basic pathway.
- Overprioritized goal: it measures the alignment between the level of priority for achieving a specific strategic goal and the possible overprioritization of such goal by the exploratory scenarios.
- Underprioritized goal: it measures the alignment between the level of priority for achieving a strategic goal and the possible underprioritization of such goal by the exploratory scenarios.

To translate the four alignment measures into adaptive policy responses for each strategic goal, such alignment measures were showed in two cross axes (Figure 7.4). The horizontal axis illustrates the two outcomes alignment measures (favourable outcomes and adverse outcomes), while the vertical axis shows the two priority alignment measures (overprioritized goal and underprioritized goal). Figure 7.4 illustrates a theoretical example of a tipping point with 3 exploratory scenarios and the 4 alignment measures.

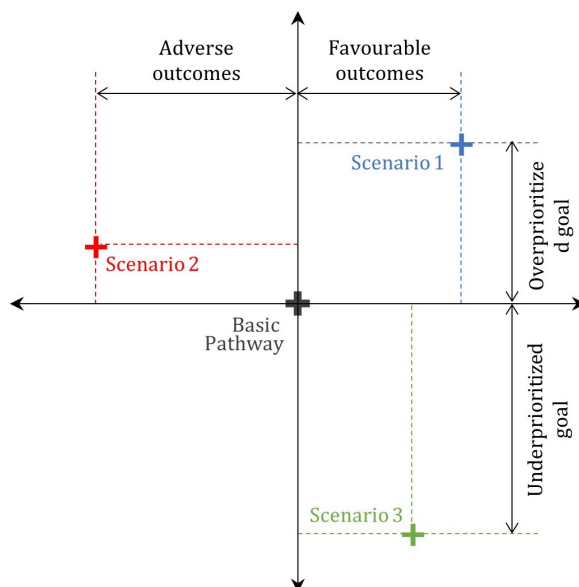


Figure 7.4. Theoretical example of tipping point

To obtain the four alignment measures for each tipping point, an online questionnaire⁴ was used. The questionnaire was answered by 25 experts previously selected, living in the Henares Corridor. The expert profiles included: five transport planners, four urban/regional planners, five environmental planners, four real-estate developers, three entrepreneurs, and four representatives from non-governmental organizations and citizen's associations.

In the first part of the questionnaire, participants were individually asked by the level of alignment between the three exploratory scenarios (Car Decline, Urban Boom, and Urban Dystopia) and each basic pathway for both favourable and adverse outcomes. For this purpose, participants indicated whether each exploratory scenario would trigger favourable or adverse outcomes to achieve each strategic goal, namely: spatial equity, urban compactness, transport multimodality, biodiversity and ecosystem integration, urban environmental quality. They also had to indicate the level of alignment between such favourable/adverse outcomes and the basic pathway. A 10-point scale was used for this purpose, with 0 indicating very high level of alignment and 10 very low.

⁴ The original content of the questionnaire (in Spanish) can be found in Annex 3.

In the second part of the questionnaire, participants were individually asked by the level of alignment between the three exploratory scenarios and each basic pathway for both overprioritizing and underprioritizing the achievement of strategic goals. For this purpose, participants were asked to indicate whether each exploratory scenario would overprioritize or underprioritize the achievement of the strategic goals under evaluation. They also had to indicate the level of alignment between the initial priority given to a strategic goal and its possible over/underprioritization by each exploratory scenario. Again, a 10-point scale was used, with 0 indicating very high level of alignment and 10 very low.

In each tipping point, individual responses for the three exploratory scenarios were processed to obtain a final set of alignment values that cover the range of individual responses provided by participants (Figure 7.5). These alignment values would be used to define the type of adaptive policy responses to be adopted. Outliers (i.e., extreme values that differ from most other values in a data set) were carefully identified and eliminated, so that they do not produce an impact in the results. To determine the type of policy response that corresponds in each tipping point, the four alignment values were classified according to 10-points scales, where 0-3 values indicate strong, 4-6 moderate, and 7-10 poor alignment.

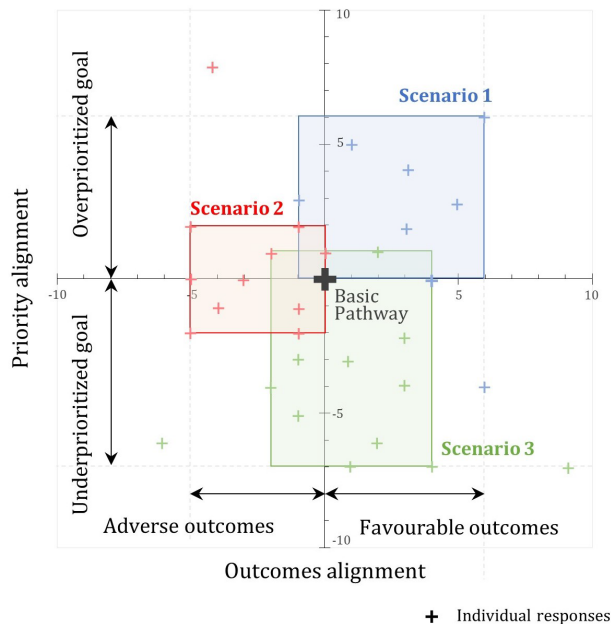


Figure 7.5. Example of data processing results for each tipping point

Accordingly, a tipping point would indicate the need for a preserving policy response when the four alignment measures indicate strong alignment (0-3 points). On the contrary, transforming policy responses would be recommended for moderate (4-6 points) and poor alignment values (7-10 points). Moreover, transforming policy responses could be outcomes- and/or priority-oriented, depending on whether moderate or poor alignment values between exploratory scenarios and a basic pathway are mainly found for outcomes and/or planning priorities, respectively.

7.4. Results

The obtained scores for the four alignment measures are summarized in Table 7.1, together with the type of policy response that corresponds in each case.

Table 7.1. Alignment values obtained for each tipping point and suggested policy response

Tipping point	Alignment measures between exploratory scenarios and the basic pathway				Adaptive policy response
	Adverse outcomes	Favourable outcomes	Underprioritized goal	Overprioritized goal	
1	Strong (3)	Strong (2)	Strong (2)	Strong (2)	Preserving
2	Moderate (6)	Strong (2)	Strong (1)	Moderate (5)	Transforming (Outcomes- and priority-oriented)
3	Moderate (5)	Strong (3)	Strong (2)	Strong (2)	Transforming (Outcomes-oriented)
4	Moderate (5)	Strong (3)	Strong (3)	Strong (2)	Transforming (Outcomes- and priority-oriented)
5	Moderate (6)	Strong (3)	Strong (2)	Strong (2)	Transforming (Outcomes-oriented)

Note: values of 0-3 indicate strong alignment, 4-6 moderate alignment, and 7-10 poor alignment

Tipping point for the basic pathway 1

The basic pathway 1 aims to achieve the strategic goal of spatial equity (Section 7.3.1). The obtained tipping point for this basic pathway shows the need for a preserving policy response (Table 7.1; Figure 7.6). In particular, the four alignment measures show a strong alignment (0-3) between the three exploratory scenarios and the basic pathway for both outcomes and planning priorities. Only scenario 3 (Urban Dystopia) might lead to slightly adverse outcomes, differing from the basic pathway in terms of spatial equity.

The results of this tipping point suggest that only minor readjustments to the established basic pathway might be necessary over time to achieve the strategic goal of spatial equity. Such readjustments would rely on smooth and incremental actions. Regional and current local policies for achieving an equitable distribution of urban land uses and transport systems would remain valid. Given its robustness, current strategies for commercial revitalisation and affordable housing prices could be extended to other disadvantaged areas within the case study. Proximity to public transport networks would remain a priority to reduce the risk of social exclusion.

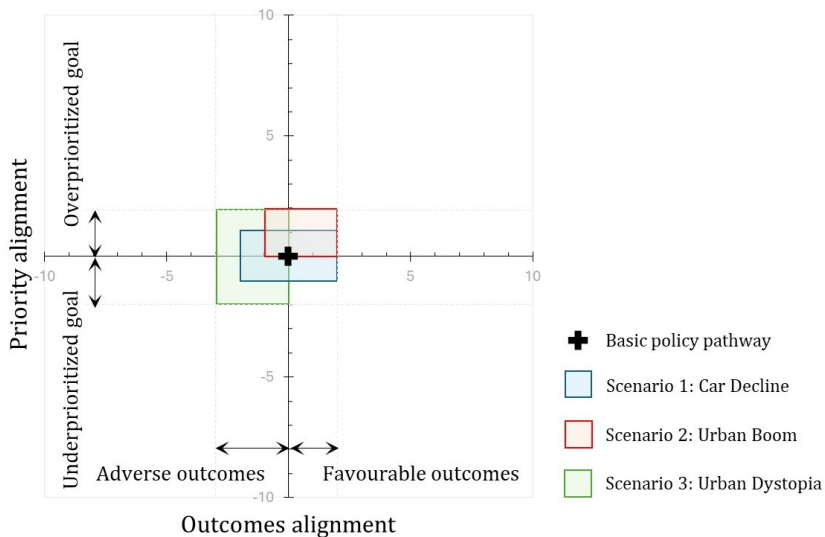


Figure 7.6. Tipping point for the basic pathway 1 (spatial equity)

Tipping point for the basic pathway 2

The basic pathway 2 aims to achieve the strategic goal of urban compactness (Section 7.3.1). The tipping point for this basic pathway indicates a need for a transforming policy response (Table 7.1, Figure 7.7). Participants in the questionnaire revealed strong alignment values (0-3) between exploratory scenarios and the basic pathway for the measures of favourable outcomes and underprioritized goal. However, they only found moderate alignment values (4-6) between the three exploratory scenarios and the basic pathway for the other two alignment measures: adverse outcomes and overprioritized goal. Exploratory scenarios would trigger adverse outcomes that can be different in a significant way from those expected outcomes from the basic pathway. Only outcomes from scenario 1 (Car Decline) would be aligned with the basic pathway initially adopted. Exploratory scenarios would also lead to overprioritizing the achievement of urban compactness as strategic goal in comparison with the basic pathway. This is particularly relevant for the context of scenario 3 (Urban Dystopia). Therefore, this transforming policy response should be both outcomes- and priority-oriented.

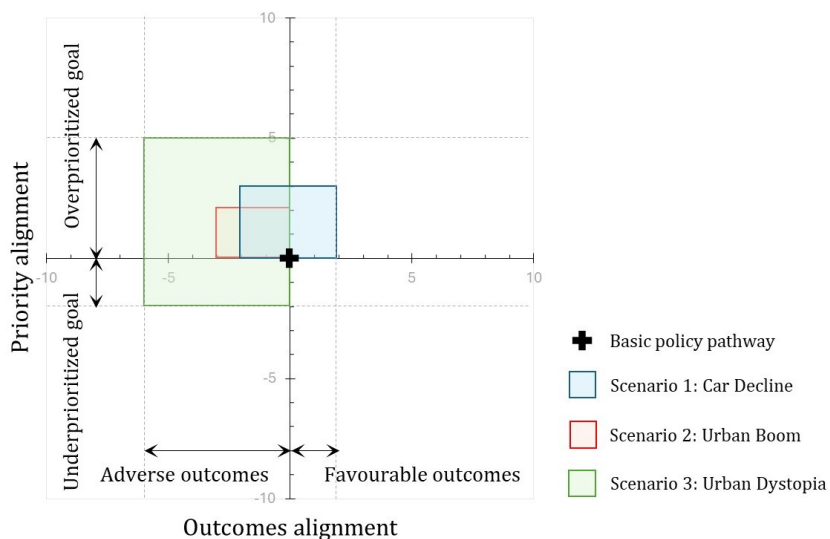


Figure 7.7. Tipping point for the basic pathway 2 (urban compactness)

Based on the abovementioned aspects, the basic pathway might easily fail or become obsolete. This tipping point emphasizes the need for radical changes to the basic pathway, involving mitigating actions to drastically curtail adverse outcomes. At the same time, boosting actions would be highly needed to take advantage of overprioritized situations. Some actions could be aimed at reinvesting in existing neighbourhoods to move people from suburban neighbourhoods to city centres, including local government tax incentives. Preserving natural resources (e.g., farmlands, parks, open spaces, unused land) could also limit the construction of large, single-family dwellings. Providing residents with a sense of place and creating a better sense of community should be prioritised on the institutional and professional agendas (e.g., siting schools, offices, sports stadiums, shopping centres, and parks close to existing neighbourhoods, instead in isolated areas away from cities and suburbs). A higher level of coordination between local and regional governments could be required to prioritize these dense real estate developments.

Tipping point for the basic pathway 3

The basic pathway 3 aims to achieve the strategic goal of transport multimodality (Section 7.3.1). The tipping point for this basic pathway would trigger a transforming policy response (Table 7.1, Figure 7.8). The analysis of this tipping point indicates that the three exploratory scenarios are strongly aligned with the basic pathway in the priority of achieving the strategic goal of transport multimodality. In fact, strong alignment values (0-3) were obtained between exploratory scenarios and this basic pathway for the measures of overprioritized and underprioritized goal. A strong alignment value was also obtained for the favourable outcomes measure. Scenario 1 (Car Decline) and scenario 2 (Urban Boom) would have minor favourable outcomes. However, a moderate alignment value (5) was obtained for the adverse outcomes measure. In this tipping point, scenario 3 (Urban Dystopia) would trigger significant adverse effects for reaching the strategic goal of transport multimodality. Therefore, this transforming policy response should be outcomes-oriented.

This tipping point shows that significant changes to the basic policy pathway might be necessary, mainly including mitigating actions to take advantage of adverse outcomes. Investment in hard infrastructure would be needed. For example, multimodal hubs would ensure easy access and interchanges between different modes. Soft infrastructure aspects could be also included, such as aligning timetables,

ticketing measures, and providing information on transfer opportunities. Finally, coordination between different transport authorities and private transport providers should be also promoted.

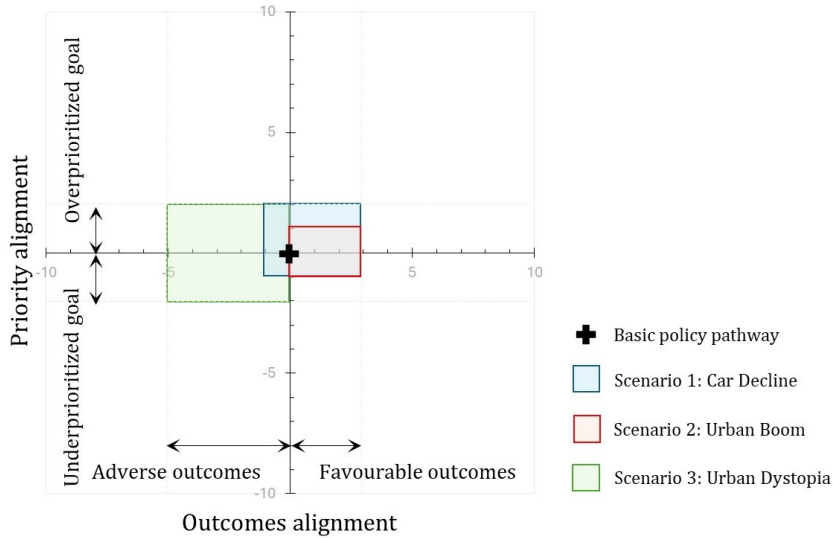


Figure 7.8. Tipping point for the basic pathway 3 (transport multimodality)

Tipping point for the basic pathway 4

The basic pathway 4 aims to achieve the strategic goal of biodiversity and ecosystem integration (Section 7.3.1). The tipping point for this basic pathway shows the convenience of activating a transforming policy response (Table 7.1, Figure 7.9). Participants indicated strong alignment values (0-3) between the three exploratory scenarios and the basic pathway for the measures of favourable outcomes and overprioritized goal. However, moderate alignment values are obtained for the measures of adverse outcomes and underprioritized goal. While scenario 1 (Car Decline) and scenario 2 (Urban Boom) are aligned with the basic pathway, scenario 3 (Urban Dystopia) entail major adverse outcomes and significantly underprioritize the achievement of this strategic goal. Therefore, this transforming policy response should be both outcomes- and priority-oriented.

Significant modifications to the basic pathway may be needed over time, including both mitigating actions to take advantage of possible adverse outcomes and recovery actions to guard against underprioritizing situations. In this respect, the green

infrastructure projects included in the basic pathway could be extended to other urban and peri-urban areas, such as grazing grounds and rivers. Local authorities could support minimum standards in construction and rehabilitation projects (e.g., planting green roofs and facades). Authorities could also prioritize nature-based solutions (e.g., protection and management of natural ecosystems, incorporation of blue-green infrastructures in urban areas, application of ecosystem-based principles to agriculture systems) and take biodiversity into account in all impact studies.

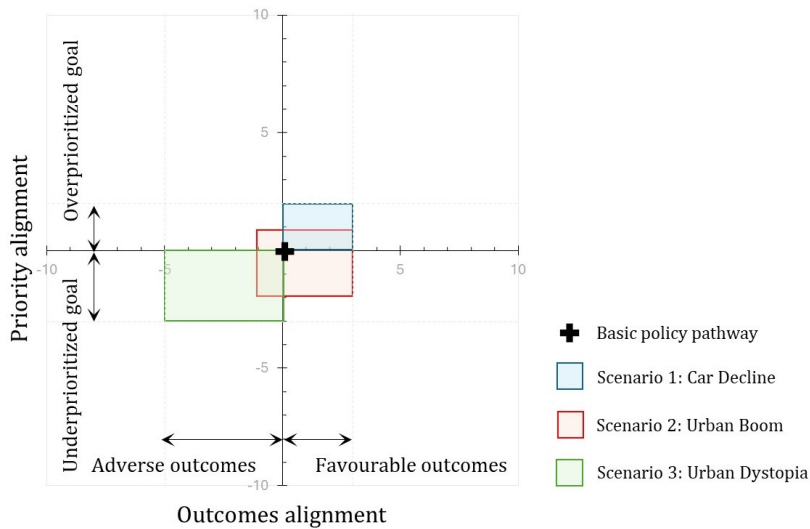


Figure 7.9. Tipping point for the basic pathway 4 (biodiversity & ecosystem integration)

Tipping point for the basic pathway 5

The basic pathway 5 aims to achieve the strategic goal of urban environmental quality (Section 5.3.1). The tipping point for this basic pathway would trigger the need for a transforming policy response (Table 7.1, Figure 7.10). Strong alignment values (0-3) are obtained for the alignment measures of favourable outcomes, underprioritized goal, and overprioritized goal. However, the alignment value for the adverse outcomes measure is moderate (6). In this tipping point, scenario 2 (Urban Boom) and scenario 3 (Urban Dystopia) would originate significant adverse outcomes for achieving this strategic goal. Only outcomes from scenario 1 (Car Decline) would be closely aligned with the basic pathway on urban environmental quality issues. Therefore, this transforming policy response should be outcomes-oriented.

According to this tipping point, significant changes to the basic pathway might be necessary to achieve the strategic goal on urban environmental quality. These changes would mainly rely on mitigating actions to reduce adverse future outcomes. According to the future outlooks analysed, current pedestrianization policies and energy efficiency measures may be insufficient. Local authorities could implement severe restrictions on the access of ICE vehicles into city centres when high CO₂ peaks are reached as well as prioritizing freight and logistics with low-emission vehicles. Other actions in the public space would focus on creating a more favourable environment for pedestrians and cyclists.

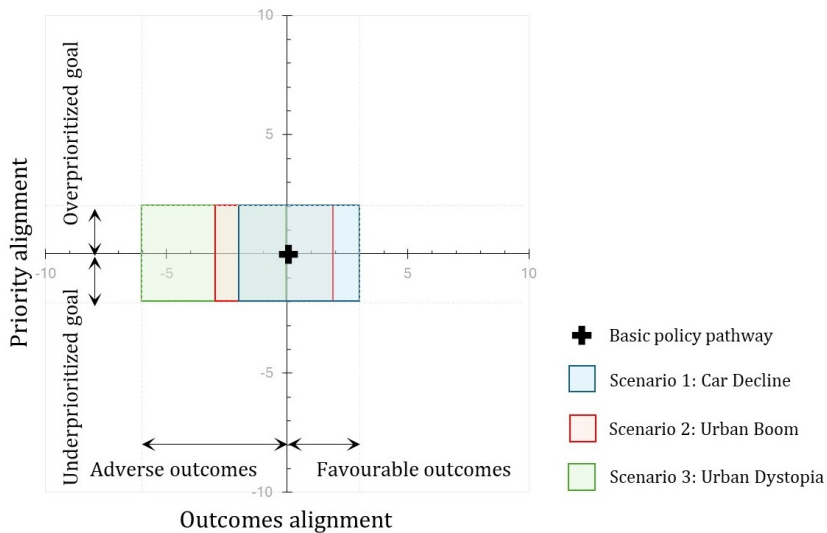


Figure 7.10. Tipping point for the basic pathway 5 (Urban environmental quality)

7.5. Conclusion and discussion

This chapter explored potential answers to the following research question: *To what extent it is possible to obtain different adaptive policy responses using disruptive scenarios as intermediate checkpoints, rather than using them as independent long-term future endpoints?* First, a theoretical framework for an adaptive scenario-building approach was conceptualised and discussed (Section 7.2). Then, the research question was addressed empirically in the case of the Henares Corridor in the Metropolitan Area of Madrid, Spain with the participation of 25 respondents via an online questionnaire (Sections 7.3 and 7.4).

A set of concluding issues to be discussed emerged during the research. They provide additional insights into the robustness of the proposed framework, the validity of the empirical exploration, the main limitations, and further research developments.

- *The role of disruptive scenarios for adaptive policymaking.* The adaptive approach conceptualized in Section 7.2.2 discusses the traditional role of future scenarios as desired/plausible endpoints (Hickman et al., 2011; Tuominen et al., 2014; Liimatainen et al., 2014). Innovatively, this approach reconsiders the role of disruptive scenarios in two main aspects: (i) checkpoints to assess potential readjustments to the basic policy pathway initially adopted; and (ii) catalysts for specific policy responses to adapt the basic policy pathway to new realities. The new role of scenarios opens challenging scientific horizons for scenario-building. On the one hand, scenarios should not be seen as producing an ultimate goal to be achieved in the long-term, but as an active part of policymaking, marked by regular reflection and adjustment. On the other hand, methodological changes are also necessary, as multiple disruptive scenarios for the short-, mid-, and long term could be needed to generate sufficient tipping points. However, the design of multiply scenarios for different moments could also result in linear processes, which may impede the development of disruptive scenarios between those time horizons.
- *Tipping points and adaptive policy responses.* Inspired by previous research focused on adaptive policymaking and dynamic adaptive planning (Walker et al., 2001; 2011; Kwakkel et al., 2010; Swanson et al., 2010), the chapter's main theoretical contribution is the use of disruptive scenarios as tipping points for developing adaptive policy responses. Tipping points essentially assess the level of alignment between a set of disruptive scenarios and the basic policy pathway initially adopted to achieve a strategic goal(s). The assessment is based on alignment along two aspects: planning outcomes and planning priorities. In this framework, a tipping point can lead to a potential policy response that can be preserving or transforming. While the first -preserving responses- consists of only minor readjustments to the basic pathway, the second -transforming responses- entail major changes. Depending on whether such major changes address deviations in planning outcomes (outcomes-oriented policy responses) and/or planning priorities (priority-oriented policy response), specific actions

should be proposed. The definition of these actions has been also part of this research. The obtained results show a variety of policy responses, ranging from preserving to transforming, and including both outcomes- and priority-oriented. In this respect, the chapter's empirical contribution should be seen as a kind of proof-of-concept, rather than as validated truths. Nevertheless, the obtained results can be seen as a promising finding for further examination, development, and application in the field of scenario-building and policymaking.

- *Research design validity.* The main methodological choices included the use of (i) three disruptive scenarios as tipping points and (ii) a participatory research design based on a questionnaire. Having only three scenarios can be seen as a potential limitation, as real-life application may require more. However, limiting the number of scenarios to a maximum of three provided the research team with a more controlled environment, to examine how disruptive scenarios interacted with each other as well as the relevance of that process for tipping points' evaluations. The use of a participatory scheme via online questionnaires to assess the two tipping points dimensions (planning outcomes and planning priorities) can be also seen as a limitation. Lockdown policies during the COVID-19 pandemic impeded the use of other participatory formats, such as workshops, experiential research design (simulating close-to-real-life conditions), and others. In this respect, new multi-method approaches are needed to provide a richer evaluation of the potential of exploratory scenarios and tipping points to inform practice.

In sum, this research has introduced a novel approach based on using multiple disruptive scenarios as tipping points to glimpse different policy responses that adapt basic pathways to potential future deviations. Although part of the obtained results can be seen as preliminary due to the limitations during application, they provide promising directions for re-examining the role of scenarios in coping with uncertainty and highly dynamic contexts. Controlled experiments in which tipping points and adaptive policy responses can be developed under close-to-real-life conditions are a particularly promising research avenue. Nevertheless, both the theoretical framework and its empirical validation open new scientific horizons and move scenario-building towards more dynamic and adaptive schemes.

8

8 CONCLUSIONS

In this *Eight Chapter*, the insights gained from the research are synthesised and discussed in detail. The remainder of the chapter is structured as follows. Section 8.1 provides the concluding summary of the PhD research process and findings. Section 8.2 outlines methodological reflections, including a discussion on research design validity, reliability, replicability, and limitations. Finally, Section 6.3 offers recommendations for future research directions

8.1. Concluding summary

This PhD dissertation aimed to provide methodological solutions and theoretical frameworks that can support participatory scenario-building to face dynamic and unpredictable nature of transport and land use systems. Specifically, the generation, communication, and applicability for policymaking of disruptive future scenarios is addressed. The Henares Corridor, in the metropolitan area of Madrid, Spain, served as case study. Based on the central objective, this PhD dissertation sought to answer the four following research questions (RQs):

RQ1 *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory scenario-building?*

In Chapter 4, RQ1 was addressed through the introduction of an innovative participatory scenario-building method. This approach integrates wild cards as catalysts to stimulate unconventional thinking during semi-structured interviews. The procedural framework entails the development of an initially envisioned scenario, followed by its gradual distortion through the introduction of wild cards as "what-if" conditions. The empirical validation of this method took place in the Henares Corridor, involving a participatory process with 129 local participants aged between 18 and 32, engaged in semi-structured interviews. A total of six wild cards were used, encompassing both imaginable and unimaginable processes. A meticulous process of transcription and coding was implemented to derive the final set of

collective 2050 scenarios narratives. These future narratives are designed to emphasize the interplay between land use and transport systems in the case study.

Seven distinct 2050 scenario narratives were formulated, with one representing the desired scenario and the remaining six exploring scenarios influenced by wild cards. Subsequently, a panel of 21 experts evaluated the degree of disruption introduced by each scenario narrative. The findings suggest that the incorporation of wild cards proved effective in fostering disruptive thinking among participants, particularly when dealing with unimaginable processes. Conversely, scenarios based on imaginable processes exhibited a level of disruption similar to the common desired scenario. This observation underscores the importance of incorporating highly surprising elements to generate disruptions and challenge linear thinking.

RQ2 *Which factors influence the effectiveness of disruptive scenario narratives to trigger interaction processes between planning actors, with the aim of fostering land use and transport integration, and why?*

In Chapter 5, RQ2 was tackled through the development of a multi-layer framework. This framework explores three group of factors that influence planning actors while using scenario-building narratives: (i) the global environment, (ii) the individual environment; and (iii) the internal environment. To uncover possible answers to RQ2, the research adopted an experimental approach with three participatory mapping workshops involving experts and local stakeholders. During workshops, participants were tasked with mapping land use and transport changes in the Henares Corridor, using three of the disruptive scenario narratives derived from Chapter 4. The workshop discussions were transcribed, coded, and analysed according to conversation episodes, following a structured observational approach.

For each episode, the multi-layer framework facilitated the characterization of the factors (internal, individual, and global) that influence the achievement or non-achievement of land use and transport integration. The results suggest that higher integration levels are obtained when 2050 scenario narratives provide the starting point for complex interactions between planning actors, in which factors from the internal, individual, and global environment are simultaneously used during discussions. Conversely, a different result was noted when one or two layers of

factors dominated the discussion. In these cases, the complexity of conversation episodes is lower and meaningful land use and transport integration is not achieved.

RQ3 *To which extent could participatory mapping processes contribute to shaping disruptive scenario narratives?*

In chapter 6, the exploration of RQ3 unfolds through the establishment of a theoretical framework that delineates various situations arising as diverse planning actors engage in the process of mapping scenario narratives. This framework categorizes three types of mapping processes: (i) those that complement future narratives; (ii) those that expand future narratives; (iii) and those that modify future narratives. To assess the effectiveness of this framework in answering RQ3, the three participatory workshops developed for Chapter 5 are leveraged. The workshops are segmented into mapping episodes to be analysed using structured observation techniques.

The research emphasizes the vital role of participatory mapping, positioning it as an essential and integral component within the scenario-building process. The results highlight a primary set of mapping episodes that effectively complemented disruptive future narratives by skilfully depicting recognizable elements. In these instances, it was evident that the interactive process among participants neither introduced new elements nor strayed from the original narratives. Moreover, a second category of mapping episodes surfaced during the three workshops, distinguished by their ability to expand future narratives. Participants introduced elements and perspectives not explicitly outlined in the initial narratives, yet remarkably, the narratives maintained overall coherence despite this expansion. Additionally, a third category of mapping episodes was identified, showcasing the transformative potential of participatory mapping. In these cases, participants executed spatial transformations diverging from the original trajectories outlined in the future narratives, introducing meaningful modifications.

RQ4 *To what extent it is possible to obtain different adaptive policy responses using disruptive scenarios as intermediate tipping points, rather than using them as independent long-term endpoints?*

In Chapter 7, RQ4 is addressed through conceptualising an adaptive scenario-building approach. Under this innovative framework, disruptive scenarios are proposed as intermediate tipping points, identifying situations in which the adopted policy pathways might fail in achieving strategic goals and suggesting different potential policy responses. It mainly distinguishes between *preserving* and *transforming* policy responses, depending on whether deviations between policy pathways and disruptive scenarios are non-significant or significant, respectively. An empirical validation was conducted following a participatory method and using the Henares Corridor as case study. Some of the scenarios developed in Chapter 4 are assessed as experimental tipping points for the policy pathways adopted by regional and local governments. A total of 25 experts were involved in this assessment through a questionnaire.

The obtained results underscore the promising capabilities of the proposed framework in discerning diverse policy responses. Firstly, the framework demonstrates its efficacy in situations where exploratory scenarios closely align with the established policy pathways. In such instances, it excels in identifying and advocating for the preservation of existing policies. Conversely, the framework also exhibits its value when significant deviations arise between the exploratory scenarios and the established pathways. In these cases, it proves instrumental in recommending transforming policy response. Rather than adhering to the status quo, the framework recognizes the need for adaptive measures to address the substantial disparities detected. If the deviations primarily impact planning outcomes, the framework suggests specific actions geared towards aligning policies with the altered landscape. On the other hand, if the deviations influence planning priorities, the framework recommends targeted actions to realign policies with the revised strategic objectives. These results highlight the relevance of the adaptive approach in situations where flexibility in policy formulation is crucial.

8.2. Concluding research reflections

8.2.1. *Internal validity and reliability*

In the context of this PhD dissertation, the proposed artifacts have proven their effectiveness in addressing identified research gaps and providing comprehensive responses to the research questions (RQs), as evidenced in the concluding summary of Section 8.1. The commitment to internal validity is evident throughout the research process, ensuring that the obtained results faithfully and accurately represent the phenomena under investigation.

Reliability is a pivotal aspect that guarantees the consistency and stability of measurements and observations. It serves to affirm that the proposed artifacts and methods consistently produce intended outcomes. This is crucial not only for the current study but also for the potential replication of the research by other scholars, instilling confidence in the validity of the findings. The subsequent paragraphs delve into the conscientious considerations of reliability that have been incorporated throughout the course of this doctoral dissertation.

In Chapter 4, the emphasis on reliability is evident in the use of semi-structured interviews. This methodological choice played a critical role in establishing a standardized approach across all participants. By prompting interviewees to reflect on identical future aspects under uniform conditions, the research ensured consistency in exploring diverse future perspectives. This standardized approach facilitated a meaningful and comparative analysis of responses, allowing for a coherent interpretation of the nuanced views presented. The meticulous and systematic treatment of semi-structured interviews, encompassing transcribing, coding, and processing, further contributed to the reliability of the study. This approach ensured that subtleties and insights from interview data were accurately captured, enriching the depth and richness of the final 2050 scenario narratives.

The experimental methodology detailed in Chapters 5 and 6 also underscores the commitment to reliability. The active involvement of planning actors in meticulously crafted academic cases through in-person scenario mapping workshops aimed to create a controlled environment for investigating causality related to research questions (RQ2 and RQ3). The implementation of specific observation schedules, overseen by independent observers and guided by measures such as kappa

coefficients and dissimilarity indexes, emphasized the commitment to consistency in the experimental approach. The use of three distinct workshops served the purpose of identifying common interaction and mapping patterns that transcended the specifics of the 2050 scenario narrative or individual participants. Additionally, the segmentation of workshops into distinct types of episodes, each constituting individual units of analysis, added another layer of methodological rigor. This segmentation facilitated a nuanced exploration of spatial transformations in land uses and transport systems, contributing to the overall reliability and depth of the research findings.

In Chapter 7, reliability takes central stage as a critical aspect of the study's methodology. The chapter delves into the intricacies of identifying policy responses to tipping points, employing a robust approach through the use of four alignment measures. These measures serve as the foundation for determining the type of policy responses at each tipping point, offering a comprehensive understanding of the adaptive strategies proposed. The reliability of the findings is underscored by the meticulous use of 10-point Likert scales during the questionnaire process, ensuring a nuanced and granular assessment. To further enhance the interpretability of the alignment measures, the chapter employs a visual representation with two cross axes. These axes showcase outcomes alignment measures and priority alignment measures, offering a clear and structured framework for translating the alignment measures into adaptive policy responses.

8.2.2. Recommendations for replicability

Replicability refers to the ability of a study or experiment to be consistently reproduced by different researchers using the same methods, ensuring its external validity. The paragraphs below outline the recommendations regarding the replicability of this research.

From Chapter 4 outlines several methodological choices that proved to be crucial in achieving the objective of obtaining disruptive scenario narratives. Notably, this chapter emphasized the importance of sample size. Larger samples proved instrumental in fostering disruptive thinking, and divergent views emerged, particularly among smaller sub-groups. These smaller groups, characterised by homogeneity in certain socio-economic aspects, contribute to unique perspectives in

the scenario-building exercise. The research diverged from the common practice of homogenising responses into a single scenario, instead employing a multi-phase, semi-structured interview approach that incorporated diverse wild cards. This method facilitated capturing minority views and translating them into distinct scenario narratives, challenging the probability of obtaining disruptive future scenarios. The strategic choice of participants aged 18 to 32, recognized for their capacity to transcend conventional thinking, was instrumental in enhancing the innovativeness and uniqueness of the research outcomes. The inclusion of a wide range of wild cards was also identified as a pivotal factor in generating disruption. This research highlighted the significance of making participants choose between wild cards, triggering divergences and incorporating outlier views. The deliberate choice between different types of wild cards enhanced the participatory process, underscoring the importance of diversity in shaping innovative and disruptive future scenarios.

Chapters 5 and 6 provide insightful lessons for enhancing replicability in experimental set-ups, particularly focused on scenario mapping exercises. One key lesson underscores the critical importance of scale in scenario development. The research highlights that the local context profoundly influences scenario outcomes, advocating for the incorporation of fine-grained local scales. While large-scale scenarios offer a high-level view, translating them into meaningful cartographic representations poses challenges. In contrast, a focus on local scales enables a detailed examination of nuances within a region, revealing localized factors and micro-level dynamics that are often overlooked. This approach enhances the effectiveness of scenarios, especially in guiding spatial-dependent decision-making related to land uses and infrastructure locations. Another pivotal lesson centres on the integration of local and expert knowledge. The research emphasizes that exclusive reliance on data and models may overlook critical factors. Integrating local and expert knowledge ensures a more comprehensive understanding of the scenario context and facilitates the customization of scenarios to address specific community needs and goals. This inclusive approach not only prevents scenarios from being generic but also navigates potential conflicts or competing visions for the future through constructive dialogue and consensus-building. Involving local stakeholders and experts provides a structured platform for resolving disputes and aligning scenarios with the concerns and aspirations of the community.

Chapter 7 also places a significant emphasis on lessons learned for replicability, particularly regarding the selection of participants for the alignment measurement between exploratory scenarios and the established policy pathways. Recognizing the critical role of participant profiles, the study prioritizes individuals who possess a deep understanding of the case study under investigation. This deliberate selection ensures that respondents are well-versed in the intricacies of the subject matter, enhancing the quality and relevance of the data collected. The meticulous consideration given to participant profiles contributes to the study's replicability by establishing a foundation of informed responses, rooted in a contextual understanding of the issues at hand. Moreover, the visualization of tipping points through the two cross axes with alignment measures adds another layer of clarity and accessibility to the findings. This visual representation not only aids in comprehending the nuances of policy responses but also serves as a valuable tool for other researchers aiming to replicate the study, providing a transparent and structured framework for analysis.

8.2.3. Research limitations

This section aims to transparently present the research limitations encountered in this PhD dissertation, offering a nuanced understanding of the study's constraints and implications for the interpretation and generalization of its findings.

The first notable limitation of this research revolves around practical validity or applicability. It is a crucial consideration in design science research, where the final objective is to develop practical solutions applicable to real-world issues. In this study, the ecological validity is deemed low, implying that the scientific findings may not directly translate into applicable solutions for real planning practices in their current form. The 2050 scenario narratives obtained in Chapter 4, while providing valuable insights, face challenges in practical implementation. The use of a convenience sample comprising individuals between 18 and 32 years old, although contributing to a controlled environment for hypothesis testing, raises concerns about the generalizability of the findings to the broader population. This limitation becomes particularly evident in the uncertainty surrounding the representativeness of the sample in real decision-making processes. Chapters 5 and 6 introduce novel approaches based on scenario-building within controlled environments. While aiming

to field-test knowledge with intended users, the highly controlled experimental setup by the research team may compromise the ecological validity of the results. The outcomes, though valuable, are acknowledged as preliminary due to the constrained nature of the experimental design. Similarly, Chapter 7 presents empirical contributions with certain limitations, emphasizing the need to view the obtained results as a proof-of-concept rather than validated truths. These limitations introduce a degree of uncertainty, suggesting that further validation and refinement may be necessary for broader, real-world applicability.

Connected with the practical validity is the simplicity of the designed artifacts, which, in certain aspects, can be viewed as a weakness. Real-life planning practice is inherently complex and influenced by numerous factors not fully captured by the artifacts developed in this study. The participatory scenario-building process introduced in Chapter 4 focuses on a limited set of variables related to urban land uses and transportation systems. While providing valuable insights, this narrowed scope may not fully encompass the multifaceted considerations involved in real-world planning decisions. The oversimplification of the scenario-building process could limit its effectiveness in addressing the intricacies of urban planning and transportation dynamics. In Chapter 5, the multi-layer framework introduces groups of factors that may not easily delineate in real-life planning processes when utilizing specific planning tools. The complexity of real-world situations may surpass the structured layers outlined in the framework, potentially limiting its practical utility in addressing the nuanced challenges of planning practices. Similarly, the typologies of mapping situations presented in Chapter 6 and the different types of policy responses outlined in Chapter 7 are subject to the challenge of oversimplification that may compromise the ability of these artifacts to adequately capture the diverse and complex nature of planning issues.

Methodological limitations associated with the participatory methods employed in this research are crucial to understanding the potential constraints in the data collection process. In Chapter 4, the use of semi-structured interviews is acknowledged with a specific focus on its limitations. One primary drawback is the absence of participant interaction, inhibiting the potential for collaborative learning processes. The inability of participants to engage with each other hinders the dynamic modulation of discourses through shared insights and perspectives.

Additionally, the identification of wild cards by the research team to deviate from business-as-usual (BAU) projections may limit the creativity of the process. While this approach breaks from official planning documents, it may overlook the potential richness derived from open participatory processes that stimulate creative thinking among participants. In Chapter 7, the use of online questionnaires as a participatory scheme to assess tipping points dimensions is recognized as a limitation. The reliance on online platforms might restrict the depth of engagement compared to more interactive formats such as workshops or experiential research designs. The imposition of lockdown policies during the COVID-19 pandemic is noted as a contextual limitation, impeding the utilization of alternative participatory methods. Workshops and experiential research designs, which simulate close-to-real-life conditions, could offer more comprehensive insights but were hindered by the constraints imposed by the pandemic.

A final limitation in this PhD project pertains to the number of scenarios used throughout the research. Initially, a total of seven scenarios were designed, each representing varying levels of disruption. However, the practicality of incorporating all seven scenarios into the subsequent chapters of the thesis was deemed unmanageable. Consequently, from Chapter 5 onwards, only three scenarios were utilized. Limiting the number of scenarios to a maximum of three offered the research team a more controlled environment, enabling focused exploration and analysis. This approach allowed for a more in-depth examination of the selected scenarios, facilitating a nuanced understanding of their implications. However, the decision to restrict the scenarios to three may be viewed as a potential limitation, especially in the context of real-life applications that often necessitate a broader range of scenarios to capture the complexity and variability of possible futures.

8.3. Future research avenues

This section delves into the potential future research directions, exploring the horizons that lie ahead in the field of participatory scenario-building. Among the compelling avenues for inquiry, the themes of disruption, visualization, adaptation, and real-life application emerge as focal points, holding the promise of transforming the scenario-building landscape.

Disruption. The first compelling avenue for future research is the nuanced exploration of disruption, with a specific emphasis on wild cards as potential agents of transformative change in urban landscapes. Acknowledging the inherent unpredictability and multifaceted nature of disruptions, researchers must delve into methodologies that enhance the anticipation and preparedness for a broad spectrum of unforeseen shifts. This necessitates an exploration of innovative approaches and tools designed to identify and assess potential wild cards, forming the bedrock of more disruptive participatory scenario-building processes. The development of a systematic framework for categorizing wild cards becomes essential, contributing significantly to the refinement of wild card selection methodologies and allowing for a more nuanced understanding of disruptions' diverse nature. Moreover, the optimization of the deployment of wild cards within participatory scenario-building processes emerges as a crucial research endeavour. This involves the development of efficient methods for generating and identifying wild cards, ensuring seamless integration into scenario narratives. Such optimization is vital for authentically mirroring the complexity of real-world disruptions and enhancing the relevance and impact of the scenarios constructed. In parallel, the exploration of effective mechanisms for assessing the level of disruption introduced through the wild cards becomes imperative. This evaluation provides a metric for gauging the authenticity and significance of wild cards in shaping plausible future scenarios, contributing to a deeper understanding of their potential impact on urban landscapes.

Scenario visualization. Chapters 5 and 6 have provided insightful revelations, emphasizing that participatory processes in scenario visualization as not to be viewed as mere adjuncts or supplementary steps to the broader scenario-building framework. Instead, they underscore the pivotal role of such participatory visualization methods as a fundamental step, prompting the need for deeper exploration. In this context, it becomes imperative to delve into the potential transformative effects of adopting more immersive visualization methods, with a specific focus on the burgeoning realm of Virtual Reality (VR). Chapters 5 and 6 have laid the groundwork by highlighting the importance of engaging experts and local stakeholders in the scenario visualization process. Now, a natural progression of this exploration involves probing into the nuanced impacts and advantages that immersive technologies like VR might bring to the participatory aspect of scenario development. VR, with its ability to create simulated environments that closely mimic

real-world scenarios, represents an intriguing avenue for further investigation. Understanding how stakeholders interact with scenarios in a virtual realm can shed light on the depth of engagement, the quality of insight gained, and the overall efficacy of participatory scenario-building processes. This potential shift towards more immersive visualization methods could reshape not only how scenarios are constructed but also how they are perceived and internalized by those actively involved in the decision-making process. Subsequent investigations could delve into case studies or experimental setups where VR is employed as a participatory tool for scenario visualization.

Adaptation. The trajectory of future research in participatory scenario-building, outlined in Chapter 7, signifies a paradigm shift challenging conventional frameworks. This evolution redefines scenarios from determinants of long-term goals to dynamic agents within policymaking processes. Future research should delve into and formalize this perspective, emphasizing continuous reflection and adjustment, recognizing scenarios as active shapers of policymaking strategies. To maximize the impact of exploratory scenarios and tipping points on policy, future investigations must focus on innovative multi-method approaches. Recognizing the complexity of dynamic systems, research should transcend traditional frameworks, incorporating diverse participatory formats like workshops and experiential research design, offering nuanced insights crucial for guiding policymakers in uncertain futures. Moreover, exploring methodological variations is key to enhancing the effectiveness of exploratory scenarios in guiding policymaking. The use of multiple scenarios across short-, mid-, and long-term horizons emerges as an innovative approach, with future research aiming to refine and formalize these variations. This approach holds potential to amplify the identification of tipping points and provide a nuanced understanding of their temporal dynamics, requiring a flexible and adaptive policymaking approach in line with evolving tipping points. Navigating this uncharted territory necessitates a focused future research agenda refining and formalizing multi-method approaches. Developing frameworks for seamlessly integrating diverse participatory formats and establishing guidelines for employing methodological variations in scenario-building processes can significantly contribute to the evolution of participatory scenario-building, transforming it into a responsive tool for policymakers grappling with the uncertainties of a rapidly changing world.

Real-life application. Finally, a crucial trajectory for future research involves amplifying the practical impact of the participatory scenario-building methods expounded in this PhD, aiming to enhance their efficacy and real-world relevance. Shifting from theoretical abstractions to concrete outcomes demands the implementation of real-life experiments, leveraging the present PhD research as a foundational stepping stone. These experiments serve as vital proving grounds for participatory scenario-building methodologies, validating theoretical frameworks while uncovering practical nuances and challenges that may elude scrutiny in controlled research settings. A pivotal stride in advancing this agenda is the establishment of formal collaborations with regional and local governments. This strategic alliance between academia and governance institutions is instrumental in translating research insights into tangible urban and transport planning initiatives. Collaborative endeavours ensure the seamless integration of participatory scenario-building into the decision-making processes of on-the-ground projects related to transport and land use. The knowledge derived from these applications contributes substantively to the ongoing refinement of participatory methods, adapting them to the specific needs and complexities of diverse urban planning scenarios. Moreover, this collaborative approach establishes a valuable feedback loop. Real-life experiences and challenges encountered during experiments inform the continuous evolution of participatory scenario-building methods. This iterative process ensures that the methodologies not only retain relevance but also remain responsive to the dynamic nature of real-world urban development.

ANNEXES

ANNEX 1

SEMI-STRUCTURED INTERVIEW

This Annex contains the original content (in Spanish) of the semi-structured interviews conducted to obtain the scenario narratives presented in Chapter 4.

Instrucciones para el entrevistador:

El investigador informará al entrevistado del proyecto de investigación en el que se está realizando este trabajo. Indicará que la entrevista tendrá un tiempo aproximado de 20 minutos y solicitará permiso para que pueda ser grabada. Aclarará que el tratamiento de los resultados será siempre de forma agregada y nadie podrá identificar opiniones personales. Entregará una tarjeta identificativa de la investigación que servirá para participar en un sorteo. Dicha tarjeta tendrá una dirección de e-mail a la que podrá escribir el entrevistado para retirar su entrevista del estudio en caso de que lo considere necesario.

Por último, el investigador informará de que el tratamiento de la información será conforme a lo establecido en la Ley de Protección de Datos del estado español y conforme a las indicaciones del comité ético de la Universidad Politécnica de Madrid.

Bloque 1. Datos básicos del entrevistado

- Año de nacimiento
- Sexo
- Nivel de estudios: (a) primaria, (b) secundaria, (c) bachillerato, (d) grado, (e) máster, (f) estudiante secundaria o bachillerato, (g) estudiante educación superior, (h) sin estudios.
- Situación laboral: (a) estudiante, (b) trabajador por cuenta ajena, (c) trabajador por cuenta propia, (d) desempleado, (e) otro.
- Modos habituales de transporte: (a) coche propio, (b) coche no propio de familiares o amigos, (c) autobús, (d) tren de cercanías o metro, (e) bicicleta, (f) caminando, (g) otro.

- Municipio en el que reside
- Tipo de vivienda en la que reside: (a) vivo con mis padres en una vivienda de su propiedad, (b) vivo con mis padres en una vivienda alquilada, (c) vivo emancipado en una residencia en propiedad, (d) vivo emancipado en una residencia en alquiler, (e) otro.
- Composición del hogar: (a) vivo con mis padres, (b) vivo solo, (c) vivo con amigos / compañeros de trabajo, etc., (d) vivo en pareja, (e) vivo en pareja con mis hijos, (f) vivo solo con mis hijos, (g) otro
- Frecuencia con la que viaja por el corredor del Henares: (a) diariamente, (b) semanalmente, (c) ocasionalmente, (d) otro.

Concepciones:

Se le van a plantear varias afirmaciones en relación con el modelo de ciudad, la tecnología, el transporte y la sostenibilidad. Deberá responder el grado de acuerdo que manifiesta con dichas afirmaciones en una escala de 1 (nada de acuerdo) a 5 (totalmente de acuerdo)

- Me considero una persona concienciada con el medio ambiente
- Procuero informarme de los últimos avances tecnológicos que existen en campos de mi interés personal o profesional
- Considero que la tecnología es clave para abordar los grandes retos de la sociedad actual
- Me considero una persona preocupada por la desigualdad social
- Me gustaría vivir en un lugar diferente del que vivo ahora
- Soy consciente de que el tipo de viviendas que se construyen en la ciudad tiene influencia en los modos de transporte que se usan en ella.
- Cuando elijo un lugar de residencia soy consciente de las implicaciones que esa decisión tiene sobre la movilidad
- Considero que el Transporte Público es para aquellos que no pueden ir en vehículo privado.

Bloque 2. Visiones deseadas

Instrucciones para el entrevistador:

Esta parte de la entrevista se centra en la obtención de visiones deseadas sobre el transporte y los usos del suelo para el año 2050. Es importante que el investigador haga ver que se tratan de visiones en el muy largo plazo, más allá de una fecha concreta. También es clave que se haga ver que la visión sería la culminación de un proceso que empezaría ahora y que culminaría en 2050.

El principal problema que se puede encontrar el investigador es que los entrevistados se queden bloqueados y no digan nada. En ese caso habrá que dar ejemplos si es necesario, pero teniendo cuidado de que esos ejemplos no direcciones la entrevista. Es muy importante que el entrevistador tenga las preguntas memorizadas para así establecer una cierta conversación con el entrevistado más que una entrevista propiamente. La idea es siempre que el entrevistado no se aburra y le resulte ameno los minutos que estemos con él.

Contexto general

Imagina un día laborable ideal en 2050 ¿Cómo sería la manera más idónea de cubrir las necesidades de desplazamiento de ese día laborable?

Instrucciones para el entrevistador: esta es una respuesta muy amplia, de manera que puede ser que el entrevistado ya nos haya respondido alguna de las preguntas que figuran debajo. En ese caso, no volver a preguntarla y anotarlo en el cuaderno de campo para que se tenga en cuenta a la hora de la transcripción y el análisis.

Cuando el entrevistado indique que desearía ir en coche, indicar las características del mismo (combustible, autónomo o no, en propiedad o no, compartido o no).

Lo mismo con el Transporte Público (tren, metro, bus, combustible...)

Bicicletas: En propiedad, eléctricas....

Comportamiento de viaje y modos de transporte

Para que se pueda llegar a producir ese día deseable en 2050 que usted ha descrito previamente: ¿Qué cambios de hábito a la hora de viajar en el día a día tendrían que empezar a suceder en el momento actual (ej. el coche no será el modo principal de desplazamiento)?

Teniendo en mente ese día deseado que nos has descrito al principio de la entrevista ¿Qué modos de transporte desearías que fuesen los principales a nivel urbano en 2050? Razone su respuesta

¿Cómo desearías desplazarte a tu trabajo en 2050?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar la compra diaria en 2050?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar actividades de ocio en 2050?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

Situándonos en tu día deseado y suponiendo que vamos de camino de una estación de transporte público ¿qué tipo de actividades (tiendas, empleos, zonas verdes, etc.) desearías encontrarte?

Innovaciones tecnológicas con influencia en el sector del transporte

¿Qué principales innovaciones tecnológicas desearías que ocurriesen en el ámbito del transporte en 2050?

Instrucciones para el entrevistador: es posible que ya haya mencionado una innovación tecnológica relevante que desearía que sucediese. En ese caso, lo ideal sería recordárselo y solicitarle que liste algunas innovaciones más que se le ocurran que tendrían cabida en ese día deseado.

Cada vez que se diga un modo de transporte hay que preguntar de él las siguientes características: ¿qué fuente de combustible tiene? ¿lo conduce una persona o es

autónomo? En caso de que sea autónomo, preguntar que hace el viajero dentro (¿va trabajando? ¿Va estudiando? ¿Va hablando por facetime?)

¿De qué modo dichas innovaciones tecnológicas modificarán la forma en que nos desplazamos actualmente?

Instrucciones para el entrevistador: es posible que esto ya esté mencionado. En ese caso obviarlo o solicitar algún tipo de aclaración si se cree conveniente.

Modelo de ciudad y planificación urbana

Teniendo en mente ese día deseado que nos has descrito al comienzo de la entrevista ¿Cómo desearías que fuese el barrio donde vivirás en 2050? ¿Podrías describirlo? ¿visualizas un barrio basado en viviendas plurifamiliares (bloques) o unifamiliares?

Instrucciones para el entrevistador: en caso de que el participante se quede bloqueado, se puede hacer uso de la lámina con fotografías que llevamos con nosotros. Nunca empezar la pregunta mostrando directamente las fotografías ya que podemos estar condicionando la visión que él tiene.

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050: ¿Los lugares principales de trabajo estarán mezclados con lugares de residencia o estarán ubicados en lugares diferentes?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050: ¿Te ves trabajando en el centro urbano o en zonas periféricas?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050: ¿Dónde realizarás tus compras diarias en 2050? ¿en tu barrio o fuera de él? ¿en centros comerciales o en pequeños comercios?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050: ¿Cómo serán los espacios verdes en tu barrio en 2050? ¿tendrán continuidad espacial? ¿qué tipo de actividades se realizarán en ellos?

Bloque 3. Visiones basadas en “weak signals” (Eventos/procesos imaginables)

Instrucciones para el entrevistador: la idea principal es que el entrevistado “distorsione” su día deseado en función de una serie de condiciones que vamos a ponerle y que pueden afectar a algunas/muchas de los deseos futuros mostrados previamente.

En este bloque, tales condiciones que vamos utilizar para modificar su día deseado se llamarán: “weak signals”. Se refieren a elementos plausibles de la realidad futura, detectables en el horizonte futuro, pero con un impacto poco claro sobre el estilo de vida del ciudadano y la sociedad (transición o transformación). Ej. el auge de la automatización en el transporte, la crisis de los recursos y cambio hacia políticas de transporte sostenible, instauración de sistemas de restricción de acceso al vehículo privado.

En primer lugar, el entrevistado será preguntado que señale entre una lista de posibles “weak signals” aquel que le parece más disruptivo (que más puede cambiar el futuro teniendo como referencia la situación actual) en el ámbito del transporte, la movilidad y los usos del suelo. Atención: no le pedimos que señale su “weak signal” deseado, sino aquel que considera más disruptivo.

Sobre el “weak signal” escogido, el investigador preguntará las cuestiones que integran el bloque 3 de la entrevista. Puesto que las preguntas son las mismas que en el bloque 2, no hay que preguntarlas tal cual están. La idea es preguntarle la manera en que el “weak signal” que él ha escogido va a modificar su día deseable. Evitar volver a preguntarlas literalmente ya que la entrevista puede ser muy larga.

Identificación de “weak signals”

Por “weak signals” entenderemos elementos plausibles de la realidad futura, detectables en el horizonte futuro, pero con un impacto poco claro sobre el estilo de vida del ciudadano y la sociedad (transición o transformación). Ej. el auge de la automatización en el transporte, la crisis de los recursos y cambio hacia políticas de transporte sostenible, instauración de sistemas de restricción de acceso al vehículo privado.

En primer lugar, el entrevistado será preguntado que señale entre una lista de posibles “weak signals” aquel que le parece más disruptivo (que más puede cambiar el futuro teniendo como referencia la situación actual) en el ámbito del transporte, la movilidad y los usos del suelo.

Por favor, identifique de la siguiente lista el factor que considera que cambiaría más drásticamente en el largo plazo los hábitos diarios sobre la manera en que los ciudadanos se desplazan en su día a día:

- Prohibición total de la circulación de vehículos que no sean 0 emisiones
- Recuperación del espacio viario de los centros históricos para una movilidad exclusivamente basada en modos no motorizados
- Uso generalizado del “teletrabajo” en todos los trabajos que no requieren presencia física

Atención: no le pedimos que señale su “wild signal” deseado, sino aquel que considera más disruptivo.

Utilice el “weak signal” elegido por el entrevistado para formular el resto de preguntas que integran el bloque 3 del cuestionario.

Contexto general

Teniendo en mente el día deseado que nos has comentado al comienzo de la entrevista ¿Cómo desearías que transcurra ese día si [insertar “weak signal”]? ¿Qué tipo de hábitos desearía tener teniendo en cuenta que algunos de estos hábitos se han podido ver modificados por el “weak signal escogido” (ej. ir a trabajar, horarios, rutina, etc.)? Por favor, visualice en genérico cómo sería ese día deseado.

Comportamiento de viaje y modos de transporte

Para que se pueda llegar a producir ese día deseable en 2050 que usted ha descrito previamente: ¿Qué cambios de hábito a la hora de viajar en el día a día tendrían que empezar a sucederse en el momento actual (ej. el coche no será el modo principal de desplazamiento) si [insertar “weak signal”]?

Instrucciones para el entrevistador: en caso de que el “weak signal” elegido no afecte a los hábitos de viaje que el entrevistado ha mostrado en la primera parte de la entrevista, no hacer esta pregunta. Hacerla solamente para ver los cambios que el “weak signal” puede producir respecto de su día deseado.

Teniendo en mente ese día deseado que nos has descrito al principio de la entrevista ¿Qué modos de transporte desearías que fuesen los principales a nivel urbano en 2050 teniendo en cuenta que ese día deseado se ha podido ver alterado por [insertar “weak signal”]? Razone su respuesta

¿Cómo desearías desplazarte a tu trabajo en 2050 si [insertar “weak signal”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar la compra diaria en 2050 si [insertar “weak signal”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar actividades de ocio en 2050 si [insertar “weak signal”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

Situándonos en tu día deseado y suponiendo que vamos de camino de una estación de transporte público ¿qué tipo de actividades (tiendas, empleos, zonas verdes, etc.) desearías encontrarte, teniendo en cuenta que tú día deseado se ha podido ver alterado por [insertar “weak signal”]?

Innovaciones tecnológicas con influencia en el sector del transporte

¿Qué principales innovaciones tecnológicas desearías que ocurriesen en el ámbito del transporte en 2050 teniendo en cuenta que [insertar “weak signal”] ha podido alterar las posibles innovaciones tecnológicas que previamente deseabas?

Instrucciones para el entrevistador: es posible que ya haya mencionado una innovación tecnológica relevante que desearía que sucediese. En ese caso, lo ideal sería recordárselo y solicitarle que liste algunas innovaciones más que se le ocurran que tendrían cabida en ese día deseado.

¿De qué modo dichas innovaciones tecnológicas modificarán la forma en que nos desplazamos actualmente si [insertar “weak signal”]?

Instrucciones para el entrevistador: es posible que ya haya mencionado una innovación tecnológica relevante que desearía que sucediese. En ese caso, lo ideal sería recordárselo y solicitarle que liste algunas innovaciones más que se le ocurran que tendrían cabida en ese día deseado.

Modelo de ciudad y planificación urbana

Teniendo en mente ese día deseado que nos has descrito al comienzo de la entrevista ¿Cómo desearías que fuese el barrio donde vivirás en 2050 si [insertar “weak signal”]? ¿Podrías describirlo? ¿visualizas un barrio basado en viviendas plurifamiliares (bloques) o unifamiliares?

Instrucciones para el entrevistador: en caso de que el participante se quede bloqueado, se puede hacer uso de la lámina con fotografías que llevamos con nosotros. Nunca empezar la pregunta mostrando directamente las fotografías ya que podemos estar condicionando la visión que él tiene.

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar “weak signal”]: ¿Los lugares principales de trabajo estarán mezclados con lugares de residencia o estarán ubicados en lugares diferentes?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar “weak signal”]: ¿Te ves trabajando en el centro urbano o en zonas periféricas?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar “weak signal”]: ¿Dónde realizarás tus compras diarias en 2050? ¿en tu barrio o fuera de él? ¿en centros comerciales o en pequeños comercios?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar “weak signal”]: ¿Cómo serán los espacios verdes en tu barrio en 2050? ¿tendrán continuidad espacial? ¿qué tipo de actividades se realizarán en ellos?

Bloque 4. Visiones basadas en “wild cards” (Eventos/procesos no imaginables)

Instrucciones para el entrevistador: La idea principal es que el entrevistado “distorsione” su día deseado en función de una serie de condiciones que vamos a ponerle y que pueden afectar a algunas/muchas de los deseos futuros mostrados previamente.

En este bloque, tales condiciones que vamos utilizar para modificar su día deseado se llamarán: “wild cards”. Se refieren a elementos sorprendentes (menos plausibles que

“weak signals”), que incrementan la distancia entre la realidad conocida por el ciudadano y la realidad futura, buscando un impacto potencial elevado sobre su rutina, e, incluso, sobre su percepción de la realidad. Ej. un concepto de transporte urbano completamente diferente (ej. no hay coches en propiedad), una catástrofe, una realidad completamente diferente (ej. internet no es paradigma; la calle no es un espacio seguro para caminar ni socializar, etc.)

En primer lugar, el entrevistado será preguntado que señale entre una lista de posibles “wild cards” aquel que le parece más disruptivo (que más puede cambiar el futuro teniendo como referencia la situación actual) en el ámbito del transporte, la movilidad y los usos del suelo. Atención: no le pedimos que señale su “wild card” deseado, sino aquel que considera más disruptivo.

Sobre el “wild cards” escogido, el investigador preguntará las cuestiones que integran el bloque 3 de la entrevista. Puesto que las preguntas son las mismas que en el bloque 2, no hay que preguntarlas tal cual están. La idea es preguntarle la manera en que el “wild card” que él ha escogido va a modificar su día deseable. Evitar volver a preguntarlas literalmente ya que la entrevista puede ser muy larga.

Identificación de “wild cards”

Por favor, identifique de la siguiente lista el factor que considera que cambiaría más drásticamente en el largo plazo los hábitos diarios sobre la manera en que los ciudadanos se desplazan en su día a día:

- Las consecuencias del cambio climático (alta frecuencia de eventos meteorológicos extremos) han propiciado un alto nivel de conflicto internacional que se traducen en un intenso incremento de flujos demográficos hacia países de la UE
- Prohibición de vehículos en propiedad.
- El espacio público es altamente inseguro como consecuencia de problemas drásticos de desigualdad social. Está desaconsejado caminar, ir en bicicleta o moto

Utilice el “wild card” elegido por el entrevistado para formular el resto de preguntas que integran el bloque 3 del cuestionario.

Contexto general

Teniendo en mente el día deseado que nos has comentado al comienzo de la entrevista ¿Cómo desearías que transcurra ese día si [insertar “wild card”]? ¿Qué tipo de hábitos desearía tener teniendo en cuenta que algunos de estos hábitos se han podido ver modificados por el “wild card” escogido (ej. ir a trabajar, horarios, rutina, etc.)? Por favor, visualice en genérico cómo sería ese día deseado

Comportamiento de viaje y modos de transporte

Para que se pueda llegar a producir ese día deseable en 2050 que usted ha descrito previamente: ¿Qué cambios de hábito a la hora de viajar en el día a día tendrían que empezar a sucederse en el momento actual (ej. el coche no será el modo principal de desplazamiento) si [insertar “wild card”]?

Instrucciones para el entrevistador: en caso de que el “wild card” elegido no afecte a los hábitos de viaje que el entrevistado ha mostrado en la primera parte de la entrevista, no hacer esta pregunta. Hacerla solamente para ver los cambios que el “wild card” puede producir respecto de su día deseado.

Teniendo en mente ese día deseado que nos has descrito al principio de la entrevista ¿Qué modos de transporte desearías que fuesen los principales a nivel urbano en 2050 teniendo en cuenta que ese día deseado se ha podido ver alterado por [insertar “wild card”]? Razone su respuesta

¿Cómo desearías desplazarte a tu trabajo en 2050 si [insertar “wild card”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar la compra diaria en 2050 si [insertar “wild card”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

¿Cómo desearías desplazarte para realizar actividades de ocio en 2050 si [insertar “wild card”]?

Instrucciones para el entrevistador: es posible que esta pregunta ya la haya respondido cuando ha descrito su día deseado. En ese caso no volver a preguntarla. Valorar si preguntar por alguna aclaración al respecto en caso de que no esté suficientemente clara la respuesta dada.

Situándonos en tu día deseado y suponiendo que vamos de camino de una estación de transporte público ¿qué tipo de actividades (tiendas, empleos, zonas verdes, etc.) desearías encontrarte, teniendo en cuenta que tú día deseado se ha podido ver alterado por [insertar “wild card”]?

Innovaciones tecnológicas con influencia en el sector del transporte

¿Qué principales innovaciones tecnológicas desearías que ocurriesen en el ámbito del transporte en 2050 teniendo en cuenta que [insertar “wild card”] ha podido alterar las posibles innovaciones tecnológicas que previamente deseabas?

Instrucciones para el entrevistador: es posible que ya haya mencionado una innovación tecnológica relevante que desearía que sucediese. En ese caso, lo ideal sería recordárselo y solicitarle que liste algunas innovaciones más que se le ocurran que tendrían cabida en ese día deseado.

¿De qué modo dichas innovaciones tecnológicas modificarán la forma en que nos desplazamos actualmente si [insertar “wild card”]?

Instrucciones para el entrevistador: es posible que ya haya mencionado una innovación tecnológica relevante que desearía que sucediese. En ese caso, lo ideal sería recordárselo y solicitarle que liste algunas innovaciones más que se le ocurran que tendrían cabida en ese día deseado.

Modelo de ciudad y planificación urbana

Teniendo en mente ese día deseado que nos has descrito al comienzo de la entrevista ¿Cómo desearías que fuese el barrio donde vivirás en 2050 si [insertar “wild card”]?
¿Podrías describirlo? ¿visualizas un barrio basado en viviendas plurifamiliares (bloques) o unifamiliares?

Instrucciones para el entrevistador: en caso de que el participante se quede bloqueado, se puede hacer uso de la lámina con fotografías que llevamos con

nosotros. Nunca empezar la pregunta mostrando directamente las fotografías ya que podemos estar condicionando la visión que él tiene.

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar "wild card"]: ¿Los lugares principales de trabajo estarán mezclados con lugares de residencia o estarán ubicados en lugares diferentes?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar "wild card"]: ¿Te ves trabajando en el centro urbano o en zonas periféricas?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar "wild card"]: ¿Dónde realizarás tus compras diarias en 2050? ¿en tu barrio o fuera de él? ¿en centros comerciales o en pequeños comercios?

Teniendo en cuenta el tipo de ciudad en la que tú deseas vivir en 2050 si [insertar "wild card"]: ¿Cómo serán los espacios verdes en tu barrio en 2050? ¿tendrán continuidad espacial? ¿qué tipo de actividades se realizarán en ellos?

ANNEX 2

QUESTIONNAIRE ONE

This Annex contains the original content (in Spanish) of the online questionnaire conducted to obtain the disruption level of the scenario narratives presented in Chapter 4.

VISIONES FUTURAS SOBRE EL TRANSPORTE Y EL ENTORNO URBANO EN 2050

Introducción

Desde el Centro de Investigaciones del Transporte (TRANSyT) de la Universidad Politécnica de Madrid, le hacemos llegar este cuestionario que se enmarca dentro del Proyecto del Plan Nacional I+D+i “Simulación de escenarios colaborativos para integrar políticas de transporte urbano sostenible y usos del suelo (TRANS-URBAN)” en colaboración con la Universidad de Alcalá.

Dicho cuestionario pretende evaluar el grado de disrupción de una serie de visiones futuras con respecto al escenario tendencial que usted imagina respecto del transporte y el entorno urbano para 2050. En total, se le pide contestar a un total de 36 preguntas en un tiempo que oscila entre los 10-15 minutos.

Tenga en cuenta que los resultados obtenidos serán confidenciales, nadie podrá identificar en ellos ningún dato personal y serán siempre tratados de manera agregada y anónima. Los cuestionarios se almacenarán en una base de datos, siguiendo el protocolo del comité ético de la Universidad Politécnica de Madrid, conforme a la normativa nacional de protección de datos.

Si tiene alguna duda sobre el cuestionario, no dude en escribir al correo electrónico: mariaamor.ariza@upm.es

Agradeciendo de antemano su colaboración.

A continuación, se le muestra una serie de afirmaciones que ilustran cómo podría ser la movilidad y los patrones de uso del suelo en el año 2050. Por favor, marque en una escala de 1 a 5 el grado de interrupción de tales afirmaciones, siendo 1 no disruptivo, 2 algo disruptivo, 3 disruptivo, 4 muy disruptivo y 5 altamente disruptivo.

Distribución modal

- *En 2050, se reducirá notablemente el uso del transporte público en el interior de los municipios, en favor de un aumento de los desplazamientos peatonales y ciclistas*
- *En 2050, se reducirá notablemente el uso del transporte público a nivel metropolitano, en favor de un aumento de los desplazamientos en coche*
- *En 2050, el uso del transporte público a nivel metropolitano se mantendrá en niveles similares a los actuales*
- *En 2050, se reducirá notablemente el uso del coche en el interior de los municipios, en favor de un aumento de los desplazamientos peatonales y ciclistas*
- *En 2050, el uso del coche a nivel metropolitano se mantendrá en niveles similares a los actuales*
- *En 2050, los modos no motorizados (caminar e ir en bicicleta) serán muy poco usados por la población*
- *En 2050, los modos no motorizados (caminar e ir en bicicleta) serán la opción preferente para la población a nivel municipal*

Car-sharing

- *En 2050, al rededor un 25% de los desplazamientos en coche se realizarán bajo la modalidad de "car-sharing"*
- *En 2050, al rededor un 50% de los desplazamientos en coche se realizarán bajo la modalidad de "car-sharing"*
- *En 2050, los desplazamientos en coche se realizarán íntegramente bajo la modalidad de "car-sharing"*
- *En 2050, los sistemas de "car-sharing" no serán utilizados por la población*

Coche autónomo

- *En 2050, menos del 10% de los coches serán autónomos*
- *En 2050, alrededor de un 25% de los coches serán autónomos*

Fuentes de energía

- *En 2050, alrededor de un 80% de la flota de vehículos estará basada en sistemas eléctricos y en otros modos de energía alternativos (ej. hidrógeno)*
- *En 2050, la flota de vehículos estará basada exclusivamente en sistemas eléctricos o en otros modos de energía alternativos (ej. hidrógeno)*

Teletrabajo

- *En 2050, los niveles de “teletrabajo” serán muy bajos*
- *En 2050, existirá un uso generalizado del “teletrabajo”*

Compras por internet

- *En 2050, alrededor de un 10% de la población exclusivamente realizará compras online y no se desplazará al comercio en tienda*
- *En 2050, alrededor de un 25% de la población exclusivamente realizará compras online y no se desplazará al comercio en tienda*

Infraestructuras

- *En 2050, las infraestructuras de transporte por carretera y ferrocarril perderán protagonismo a nivel municipal y metropolitano, en favor de una red destinada a modos no motorizados y espacios verdes*
- *En 2050, las infraestructuras de transporte por carretera y ferrocarril ganarán protagonismo, cedido en gran parte por los actuales espacios peatonales y ciclistas*

Usos del suelo

- *En 2050, las actividades del entorno urbano estarán fuertemente mezcladas en espacios multifuncionales (alta mezcla de actividades y servicios)*
- *En 2050, las actividades del entorno urbano estarán fuertemente segregadas en espacios monofuncionales (baja o nula mezcla de actividades y servicios)*

Centros industriales y tecnológicos

- *En 2050, las principales áreas de trabajo (ej. parques industriales y tecnológicos) estarán segregadas de las áreas residenciales y del resto de actividades del entorno urbano*
- *En 2050, las principales áreas de trabajo (ej. parques industriales y tecnológicos) estarán mezcladas con las áreas residenciales y el resto de actividades del entorno urbano*
- *En 2050, se reducirán las necesidades de suelo destinado a usos industriales y tecnológicos*

Desarrollo edificatorio y dinámica urbana

- *En 2050, predominarán edificaciones en bloques de mediana altura (4-8 plantas) con amplias zonas ajardinadas y bajos comerciales*
- *En 2050, en los centros históricos de los municipios predominarán desarrollos edificatorios en altura (más de 8 plantas)*
- *En 2050, habrá un importante desarrollo de los barrios con viviendas unifamiliares en la periferia de los municipios*
- *En 2050, la población aumentará en el centro de los municipios*
- *En 2050, los centros históricos de los municipios quedarán relegados a usos de tipo comercial, servicios y viviendas ocupadas por población de baja renta*

Trama viaria

- *En 2050, parte de la trama viaria de los municipios se habrá recuperado para un uso destinado a modos no motorizados*
- *En 2050, la trama viaria de los centros históricos de los municipios se habrá recuperado íntegramente para un uso destinado a modos no motorizados*

Espacios públicos

- *En 2050, las estaciones de transporte público estarán mayoritariamente ubicadas en superficie y altamente integradas con el entorno urbano circundante y su red de espacios verdes*

- *En 2050, las estaciones de transporte público serán lugares altamente inseguros y muy poco frecuentados*
- *En 2050, los espacios verdes se convertirán en lugares privados, vallados y/o vigilados*

ANNEX 3

QUESTIONNAIRE TWO

This Annex contains the original content (in Spanish) of the online questionnaire conducted to obtain the adaptation tipping points and adaptive policy responses presented in Chapter 7.

ESCENARIOS FUTUROS DOBRE EL ENTORNO URBANO Y EL TRANSPORTE

Introducción

Desde el Centro de Investigación del Transporte – TRANSyT – de la Universidad Politécnica de Madrid y en colaboración con la Universidad de Alcalá, le hacemos llegar este cuestionario que se enmarca en el Proyecto del Plan Nacional I+D+i TRANS-URBAN (<https://geogra.uah.es/transurban/>).

TRANS-URBAN se centra en aportar soluciones sostenibles en la planificación de la ciudad y el territorio, a través de la simulación de escenarios colaborativos para diseñar y evaluar políticas integradas de transporte urbano sostenible y usos del suelo. El ámbito territorial del Proyecto es el Corredor del Henares (Área Metropolitana de Madrid), situado entre las ciudades de Madrid y Guadalajara.

En este cuestionario se presentan un total de cuatro escenarios que representan situaciones futuras hipotéticas para el Corredor del Henares para el año 2050, centrados en aspectos relacionados con el transporte y la estructura urbanístico-territorial. El tiempo estimado para finalizarlo oscila entre 15 y 20 minutos.

Tenga en cuenta que los resultados obtenidos serán siempre confidenciales y tratados de manera agregada y anónima, siguiendo el protocolo ético de la Universidad Politécnica de Madrid y conforme a la normativa nacional de protección de datos.

Si tiene alguna duda sobre el cuestionario, no dude en escribir al siguiente correo electrónico: mariaamor.ariza@upm.es

Agradecemos de antemano su colaboración

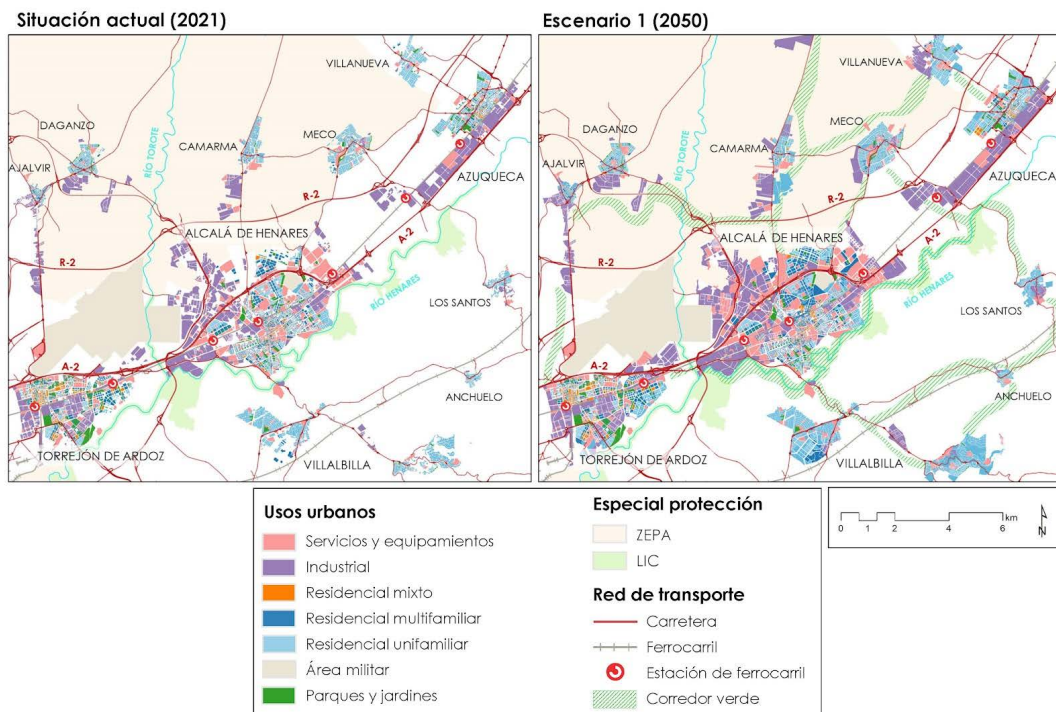
Información general

- *Indique el sector profesional al que pertenece:* (a) planificación urbana y/o regional en la administración pública, (b) planificación urbana y/o regional fuera de la administración pública, (c) planificación, gestión y/o operación del transporte en la administración pública, (d) planificación, gestión y/o operación del transporte fuera de la administración pública, (e) constructor y/o promotor inmobiliario, (f) medio ambiente y/o salud pública, (g) investigación y desarrollo, (h) otro.
- *Indique sus años de experiencia en el sector:* (a) menos de dos años, (b) entre 2 y 5 años, (c) entre 5 y 10 años, (d) más de 10 años.
- *Indique su titulación de origen.*

Instrucciones

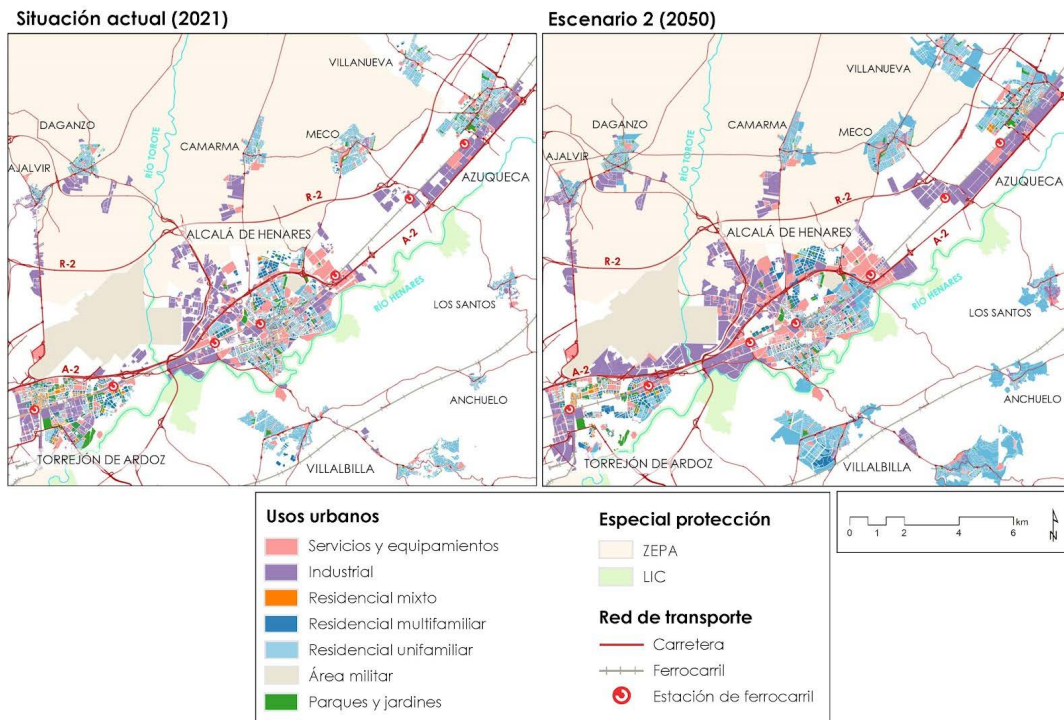
A continuación, se presentan tres escenarios futuros para 2050 que muestran distintos aspectos relacionados con el transporte y la estructura urbanístico-territorial del Corredor del Henares. Por favor, examine con atención la descripción y la representación espacial de dichos escenarios y conteste a las preguntas que se le formulan en cada caso.

ESCENARIO 1



Descripción Escenario 1 (Car Decline): Los municipios del eje central del Corredor tienen una alta mezcla de usos y actividades urbanas. En las áreas industriales periféricas de los núcleos centrales se han localizado nuevos servicios y equipamientos urbanos. Los municipios localizados en el margen norte han ganado ligeramente en mezcla de usos con la aparición de usos industriales, de servicios y equipamientos. Los municipios del margen sur continúan siendo eminentemente residenciales, de baja densidad y altamente dependientes de los municipios del eje central. Se han implantado restricciones totales de acceso de vehículos privados a los centros históricos de los núcleos urbanos. Los desplazamientos peatonales han aumentado exponencialmente, sobre todo en los municipios del eje central, y los desplazamientos en vehículo privado suponen un porcentaje pequeño de la movilidad interior del Corredor. Una densa red de espacios verdes articula un elevado número de desplazamientos peatonales y ciclistas entre municipios próximos. Las estaciones de transporte público han sido renovadas e integradas en la red de espacios verdes, favoreciendo la combinación de la movilidad activa con el uso del transporte público.

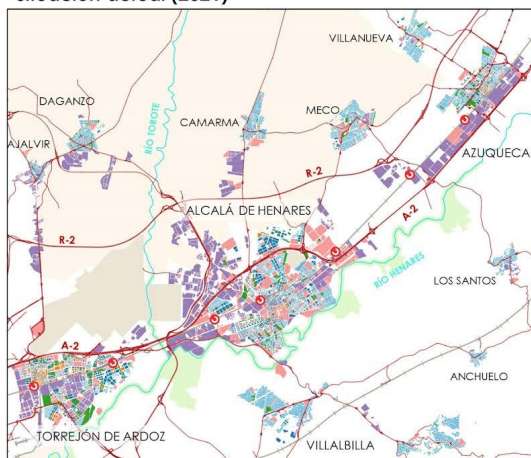
ESCENARIO 2



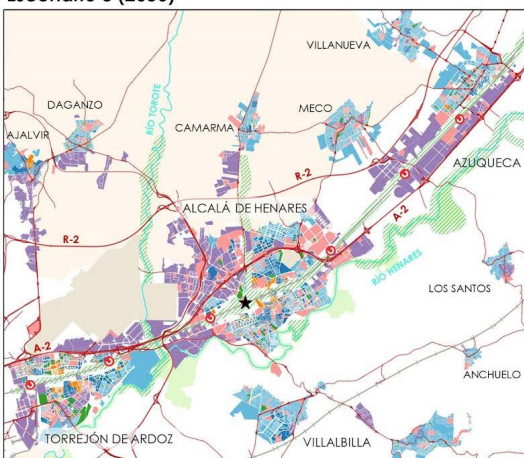
Descripción Escenario 2 (Urban Dystopia): Existen altos niveles de inseguridad ciudadana en los municipios del Corredor, consecuencia de una creciente desigualdad social y un aumento en los índices de criminalidad. Se han originado nuevos núcleos residenciales de baja densidad en municipios alejados del eje central del Corredor con una escasa dotación de servicios y equipamientos urbanos. En los municipios del eje central del Corredor se ha reducido notablemente el número de viviendas plurifamiliares y establecimientos comerciales, dando lugar a un gran vacío edificatorio en sus centros históricos. Se ha perdido parte del tejido industrial, que ha quedado concentrado en la periferia de los principales municipios y segregado del resto de usos urbanos. Existe una escasa presencia de espacios verdes y zonas peatonales seguras, que hacen que caminar o ir en bicicleta sea altamente desaconsejable. Para canalizar un elevado número de desplazamientos en vehículo privado, se han construido nuevas carreteras entre municipios y se han desdoblado otras ya existentes. La red de transporte público es considerada como altamente insegura y sólo es utilizada por la población con menos recursos económicos.

ESCENARIO 3

Situación actual (2021)



Escenario 3 (2050)



Descripción Escenario 3 (Urban Boom): Existe un importante problema de superpoblación en el Corredor. Los centros de los municipios del eje central del Corredor han ganado en mezcla de usos gracias a un crecimiento en el número de viviendas plurifamiliares, acompañado de nuevos servicios y equipamientos urbanos. Algunos de los principales polígonos industriales se han transformado ligeramente en áreas de uso mixto en las que se localizan nuevos servicios y equipamientos urbanos. Ha aumentado considerablemente el número de viviendas unifamiliares en la periferia de los municipios del eje central y en algunos municipios de los márgenes del corredor, para acoger a los sectores de la población con mayor poder adquisitivo. El uso del transporte público es notable, sobre todo para los desplazamientos laborales, tras la creación de varios carriles BUS VAO, uno de ellos en la autovía A-2 y la construcción de un intercambiador de transporte público en el centro de Alcalá. Los márgenes de las vías del ferrocarril a su paso por los municipios del eje central, así como los márgenes de los principales ríos, se han convertido en grandes corredores verdes. Ha aumentado la movilidad peatonal y ciclista y se han reducido los desplazamientos en vehículo privado en el interior del Corredor.

Objetivos Estratégicos:

A continuación se presentan un conjunto de objetivos estratégicos a alcanzar para el año 2050.

- *EQUIDAD Y JUSTICIA ESPACIAL. Garantizar una accesibilidad equitativa de toda la ciudadanía a los servicios, actividades, equipamientos urbanos y a la red de transporte público.*
- *MULTIFUNCIONALIDAD Y COMPACIDAD URBANA. Promover un desarrollo urbano compacto con una alta mezcla de usos del suelo y distancias cortas a los principales destinos (empleos, servicios, equipamientos, red de transporte público, parques, etc.)*
- *INTERMODALIDAD. Lograr una adecuada integración física y temporal entre los distintos sistemas de transporte, garantizando la máxima fiabilidad de acceso a los principales destinos urbanos.*
- *INTEGRACIÓN DE BIODIVERSIDAD Y ECOSISTEMAS. Conseguir una adecuada integración de las áreas urbanas y sus espacios verdes en los ecosistemas circundantes, incorporando los servicios ecosistémicos en los entornos urbanos a la vez que se garantice su protección y la de la biodiversidad existente*
- *CALIDAD AMBIENTAL URBANA. Garantizar una adecuada calidad y salud ambiental de las áreas urbanas, con especial atención a la contaminación atmosférica y acústica y al diseño y cuidado del paisaje urbano*

PREGUNTAS:

Bloque 1. En el contexto del escenario descrito, indique si para usted representa una desviación favorable o desfavorable para alcanzar cada uno de los objetivos estratégicos presentados. Utilice la siguiente escala, siendo 10/-10 muy favorable/desfavorable, 1/-1 ligeramente favorable/desfavorable.

Bloque 2. En el contexto del escenario descrito, indique si para usted representa una situación en la que aumentaría o disminuiría la prioridad de alcanzar cada uno de los objetivos estratégicos presentados. Utilice la siguiente escala, siendo 10/-10 aumentaría/disminuiría mucho, 1/-1 aumentaría/disminuiría ligeramente.

Nota: las preguntas se respondieron de forma independiente para cada escenario y cada objetivo estratégico.

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