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Rethinking strategic resilience through urban mobility: A conceptual model of Homo Urbanus Mobilitatis Sustinens (HUMS) and the geo-economic autonomy of the European Union

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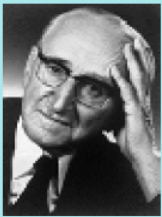
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# Ordnungspolitische Diskurse

## Discourses in Social Market Economy



**Monika Paradowska**

**Rethinking Strategic Resilience through Urban Mobility: A Conceptual Model of Homo Urbanus Mobilitatis Sustinens (HUMS) and the Geo-Economic Autonomy of the European Union**

**Diskurs 2026 - 3**

# Rethinking Strategic Resilience through Urban Mobility:

**A Conceptual Model of Homo Urbanus Mobilitatis Sustinens (HUMS) and the Geo-Economic Autonomy of the European Union**

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## **Abstract:**

In light of growing geopolitical volatility, the energy transition, and rapid digitalization, urban mobility emerges as a critical vector of the European Union's strategic resilience. This article presents the Homo Urbanus Mobilitatis Sustinens (HUMS) model as a novel conceptual framework that integrates behavioural and geo-economic dimensions of resilience. Grounded in systems thinking and behavioural public policy, HUMS redefines mobility practices as forms of behavioural capital – a systemic resource that underpins Europe's open strategic autonomy. By extending resilience theory beyond technological infrastructures, the model positions mobility as a cognitive, social, and institutional process of adaptive learning within complex socio-technical systems. Developed through conceptual synthesis and informed by empirical insights from the NCN MINIATURA 6 project (2022–2023), HUMS links micro-, meso-, and macro-levels of analysis. As a normative and diagnostic tool, it offers a foundation for designing urban mobility policies where behavioural, infrastructural, and governance components coalesce to advance behavioural sovereignty and long-term adaptive capacity in the EU.

## **Key Words:**

HUMS, Strategic Resilience, Behavioural Capital, Urban Mobility, Open Strategic Autonomy, Systems Thinking, Behavioural Public Policy, Geo-Economics, European Union

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## 1. INTRODUCTION

In the context of escalating geopolitical tensions, the energy transition, and accelerated digitalization, urban mobility has become a strategic domain for shaping the European Union's future resilience. According to the European Environment Agency (EEA, 2021, 2024a), cities account for over 70% of final energy consumption and 75% of carbon dioxide emissions. Urban transport systems represent a critical intersection of ecological, technological, and social transformations. However, while the reduction of emissions in the mobility sector is essential, it introduces new forms of dependency, including reliance on critical raw materials, the concentration of digital technologies in non-EU entities, and structural pressures on the automotive sector (European Commission, 2023a, 2023b; Maisonneuve, 2023; Pardi, 2024). As a result, mobility policy is increasingly shaped by geostrategic dynamics and may give rise to new economic asymmetries.

Emerging systemic risks highlight the continued vulnerability of Europe's transport transformation to external shocks, both in terms of material resources and digital infrastructures. Dependence on imported lithium, cobalt, and rare earth elements, as well as on data infrastructures and algorithms developed outside Europe, has triggered what scholars have described as a "dependency shift": a transition from one form of reliance to another (e.g., Hache & Normand, 2024; Righetti & Rizos, 2024; Blot, 2024). In parallel, rising global competition in the e-mobility sector, including the expansion of Chinese manufacturers, raises concerns about the sustainability of Europe's industrial advantage (Borrell, 2020). These challenges necessitate a reframing of mobility as a component of systemic resilience – integrating technologies, institutions, and citizen behaviours.

To date, EU transport policy has largely focused on infrastructural and technological dimensions, such as *Fit for 55*, the *European Green Deal*, and the *New EU Urban Mobility Framework*, while marginalizing the cognitive and behavioural aspects that increasingly shape the efficacy of public interventions. As noted by John and Stoker (2019) and Banerjee and John (2021), the capacity of societies to engage, reflect, and think critically is now a key pillar of democratic resilience. This article addresses a specific research gap: the lack of models that integrate behavioural and geoeconomic perspectives in the study of urban mobility transformation, despite growing awareness

that social adaptation is a precondition for both emissions reduction and digitalization (Hertwig & Grüne-Yanoff, 2017; Lehto, 2025).

The article introduces the *Homo Urbanus Mobilitatis Sustinens* (HUMS) model as a conceptual tool for analysing the EU's strategic resilience through the lens of urban mobility. It conceptualizes mobility-related behaviours as *behavioural capital* – a systemic asset that strengthens Europe's energy, technological, and social autonomy. HUMS aligns with the notion of open strategic autonomy (European Commission, 2023c; Fiott, 2018), understood not as isolation, but as the capacity for self-regulation and cooperation under conditions of complex interdependence (Held & McGrew, 2007).

This work is a conceptual–theoretical framework paper. Its purpose is to establish the theoretical and methodological foundations of the HUMS model rather than to present empirical results. The study builds on a systemic analysis and synthesis of literature in behavioural economics, geoeconomics, resilience theory, and public policy, incorporating findings from the NCN MINIATURA 6 research project (2022–2023), which examined the extent to which nudge+ interventions can reduce the attitude–behaviour gap in everyday transport choices related to sustainable urban mobility. It represents the conceptual phase of a broader research agenda, with subsequent stages planned to include empirical validation and applied development of the model in the context of urban and energy policy.

The article's research aim is to explore how the HUMS model can serve as both an interpretative and design-oriented framework for public policies that integrate infrastructural, cognitive, and civic dimensions of mobility transformation.

The guiding research questions are as follows:

1. How can sustainable urban mobility policies support the EU's strategic autonomy and systemic resilience in light of growing resource and technological dependencies?
2. In what ways does the HUMS model reconceptualize mobility behaviours from an ecological to a geoeconomic perspective?
3. To what extent can HUMS serve as a foundation for designing *behavioural resilience* policies that complement the technological transformations driven by *Fit for 55* and the *European Green Deal*?

The article is structured into five sections. Following this introduction (1), Section 2 outlines the theoretical background and research context. Section 3 presents the structure and assumptions of the HUMS model and its relevance for public policy. Section 4 analyses implementation challenges and geoeconomic implications. Finally, Section 5 concludes with reflections on the role of HUMS in advancing behavioural sovereignty and enhancing the EU's strategic autonomy.

## **2. LITERATURE REVIEW AND THEORETICAL CONTEXT**

### **2.1. Cities in the Geoeconomic and Climate Context**

Cities are a core component of the European Union's socio-economic system, reflecting complex interdependencies between economic activity, environmental pressures, and social behaviours. As noted, urban areas account for approximately 70% of final energy consumption and 75% of total CO<sub>2</sub> emissions in the EU, positioning them as both a primary source of environmental pressure and a potential site for resilience-oriented interventions (EEA, 2021, 2024a). Cities can be described as "epicentres of transformation" – spaces where decarbonization, digitalization, and social change converge, producing new challenges and opportunities (EEA, 2024b; Maisonneuve, 2023). From a geoeconomic perspective, this means that urban policy has become a strategic tool not only for emissions reduction but also for enhancing systemic resilience and mitigating external dependencies on critical resources and technologies.

Urban mobility is one of the leading sectors of energy consumption and emissions in European cities. According to Tzavaras et al. (2025), transport accounts for 30–35% of urban energy use, with private vehicles as the dominant mode. Despite growing electrification and fleet modernization, emissions from urban transport remain relatively stable (EEA, 2024a). This is largely due to the fact that low-emission technologies do not fully offset the rising volume of mobility. As Szpilko et al. (2024) observe, technology alone is insufficient without behavioural change, since the energy efficiency of transport systems is shaped by social patterns of infrastructure use. Similarly, research from the Öko-Institut shows that urban policy could reduce energy consumption by up to 40% by 2040 if it incorporates not only technological investments but also educational, participatory, and behavioural elements (Seibert et al., 2024).

Lin et al. (2025) deepen this perspective by analysing how everyday mobility affects climate risk exposure. A study of 80 European cities demonstrated that higher daily mobility increases residents' heat exposure by 7.8% during summer months, while slightly lowering risk in winter. These findings confirm that mobility behaviour influences not only energy balances but also communities' climate and health resilience. In this sense, transport policy should be treated as an adaptive instrument that combines infrastructure, culture, and behaviour, consistent with the assumptions of the *Homo Urbanus Mobilitatis Sustinens* (HUMS) model developed in this study.

From a broader geoeconomic standpoint, Europe's energy and mobility transitions are driving a dependency shift – from fossil fuels to strategic raw materials and digital components. As Maisonneuve (2023) notes, the rise of e-mobility and digital transport platforms increases the EU's reliance on rare earths and cobalt – materials largely processed in China and mined in the Democratic Republic of Congo – as well as on semiconductors predominantly manufactured in Taiwan and South Korea (Haramboure et al., 2023). Gavrikov et al. (2025) further show that geopolitical risk (measured using the Geopolitical Risk Index (GPR)) directly affects investment decisions and the stability of energy mixes across 31 European countries. These findings reveal that Europe's energy resilience depends on the adaptive capacity and diversification of local systems, both technologically and behaviourally. In this context, the HUMS model functions as a micro-social adaptation mechanism, reinforcing soft systemic resilience.

As Bluszcz et al. (2025) argue, the EU's decarbonization process is territorially uneven and may exacerbate regional disparities. While urban regions possess greater innovation potential, they are also more exposed to rising energy costs and regulatory burdens. This calls for an integrated approach that links climate policy with regional development and citizen participation. Suproń (2025) and Paradowska (2020) complement this view by showing that willingness to adopt sustainable mobility behaviours is strongly shaped by socio-economic factors, such as income, education, age, and gender, as well as the perceived availability of alternative transport options. This highlights the need for socially embedded transitions and urban policies that cultivate both motivation and capabilities – central dimensions of the HUMS framework.

At the institutional and infrastructural levels, Bâra et al. (2025) emphasize the role of energy communities in building local resilience. Decentralized energy production through urban communities not only reduces dependence on external providers but

also strengthens social capital and civic participation. In practice, such initiatives exemplify the integration of physical, digital, cultural, and behavioural infrastructures that are one of core dimensions of the HUMS model. Di Salvo (2025) and Tedeschi (2024) further show that the successful development and implementation of sustainable urban mobility and energy plans depends on coordination across institutional, technological, and social levels, enhancing cities' adaptability to energy crises. Similarly, Kochskämper and Monstadt (2025) argue that urban decarbonization and reduction of emissions require collaboration among actors from multiple governance levels and public policy spheres.

As a result, European cities can be seen as systemic microstructures playing a pivotal, even strategic, role in geoeconomic resilience. The mobility and energy behaviours of urban residents are not only ecological factors but also strategic economic assets (Maisonneuve, 2023). Cities are where patterns of cooperation, responsibility, and energy efficiency are forged – patterns that shape the long-term adaptability of the European system. These observations are consistent with earlier findings by Paradowska (2017), who emphasized that the availability and quality of transport services are not merely technical categories but also social indicators of citizen inclusion and agency in the co-creation of public goods (cf. Brandsen et al., 2018; Nevens et al., 2018).

## **2.2. Objectives and Instruments of the EU Common Transport Policy**

The Common Transport Policy (CTP) of the European Union is one of the foundational pillars of European integration, established in Articles 90–100 of the Treaty on the Functioning of the European Union (TFEU). Originally aimed at liberalizing the transport market, eliminating cross-border barriers, and ensuring economic competitiveness, the CTP has since evolved into a strategic instrument for the EU's climate and geoeconomic transformation. It now operates within the broader frameworks of the European Green Deal (COM(2019) 640 final), the Fit for 55 package (COM(2021) 550 final), and the New EU Urban Mobility Framework (COM(2021) 811 final) (European Commission, 2019, 2021a, 2021b).

As Butnaru-Troncotă (2020) notes, EU transport policy has shifted from a liberal market-oriented approach toward a “triple objective” paradigm encompassing efficiency,

social cohesion, and environmental sustainability. Strategically, the CTP is now considered one of the key delivery mechanisms for the European Green Deal, which targets climate neutrality by 2050 and a minimum 55% reduction in greenhouse gas emissions by 2030. Given that transport accounts for approximately 25% of the EU's total emissions, achieving a 90% reduction in transport-related emissions by 2050, compared to 1990 levels, is a central goal (European Commission, 2019; Finger, 2020).

Within this framework, the CTP has taken on a systemic role, extending beyond the transport sector to encompass energy, industrial, and social policy dimensions. It delivers a legal and financial toolkit aimed at building systemic resilience. Through transport policy, the EU tests its capacity to translate climate targets into socio-economic transformation, while upholding the principle of a “just transition” that integrates emissions reduction with social justice (European Commission, 2019; Korolova-Nozharova, 2021).

The Fit for 55 package (European Commission, 2021a) operationalizes the CTP through thirteen legislative proposals, including reforms to the Emissions Trading System (ETS2), CO<sub>2</sub> emission standards for vehicles (Regulation (EU) 2019/631), the development of alternative fuels infrastructure (Regulation (EU) 2023/1804), and the establishment of the Social Climate Fund to protect vulnerable groups during the transition. As such, transport policy becomes a mechanism not only for emission reduction but also for mitigating geoeconomic dependencies, for example, by fostering local mobility systems, energy sources, and technology production capacities (Pardi, 2024).

This reconceptualization of transport positions it not merely as an economic sector but as a space where adaptive behaviours, cooperation patterns, and resilience strategies are developed. It implies that a successful mobility transition in the EU depends on the simultaneous development of three complementary pillars: modal shift, electrification, and digitalization, that together define the emerging paradigm of European transport policy.

### **Pillar I: Modal Shift – Restructuring Mobility Patterns and Managing Demand**

The first pillar of the Common Transport Policy focuses on restructuring mobility by reducing reliance on private vehicles in favour of public, shared, and active transport

modes. The *New EU Urban Mobility Framework* (European Commission, 2021b) reports that private cars account for 75% of urban trips across the EU, underscoring the need for a systemic transition toward more sustainable transport options. The objective for 2035 is to achieve dominance of low- and zero-emission transport modes, supported by expanded cycling infrastructure, public transit networks, and Mobility as a Service (MaaS) systems.

As Bednarz-Okrzyńska (2024) demonstrates, modal shift yields the highest emission reduction per unit of public expenditure, up to 2.5 times more than subsidies for electric vehicles. The *Driving Urban Transitions Roadmap* frames cities as “laboratories of systemic resilience,” where changes in mobility behaviour underpin both social cohesion and infrastructural adaptability (Berger et al., 2023).

According to Paradowska (2013b) and Motowidlak (2022), the effectiveness of modal shift depends on the integration of “hard” infrastructural interventions with “soft” behavioural policy tools, such as education, choice architecture, co-decision-making, and public engagement. Unlike the technological pillar, modal shift relies on endogenous resources – mobility culture, local cooperation networks, and institutional capacity – rather than on imported technologies or raw materials. It is therefore the only pillar that simultaneously reduces external dependencies and reinforces social cohesion and systemic resilience (cf. Koralova-Nozharova, 2021).

## **Pillar II: Electrification – Technological Transition and the Risk of Dependency Shift**

The second pillar concerns the electrification of transport and the development of alternative fuels infrastructure. As part of the *Fit for 55* package, the EU has introduced key legislative instruments, including:

- Regulation (EU) 2023/1804 on Alternative Fuels Infrastructure (AFIR), which defines minimum infrastructure requirements along the TEN-T corridors;
- Regulation (EU) 2019/631, which sets CO<sub>2</sub> emission performance standards for new passenger cars and light commercial vehicles;
- The expansion of the Emissions Trading System (ETS2) to cover road transport and buildings;

- The Social Climate Fund, which aims to offset the costs of the energy transition for low-income households (European Commission, 2021a; CISL, 2021).

Electrification is a central component of the transport sector's strategy for emissions reduction. However, as Pardi (2024) notes, its geoeconomic implications are ambivalent. The production of lithium-ion batteries, semiconductors, and rare earth processing remains highly concentrated in East Asia (particularly in Taiwan, China, South Korea, and Japan) creating a technological lock-in and a new form of dependency shift, where reliance moves from fossil fuels to critical raw materials and digital components.

The *Making Transport Fit for 55* report (European Commission, 2022) emphasizes that without the parallel decarbonization of electricity sources, the climate benefits of electrification will remain limited. Moreover, the electric vehicle (EV) transition may amplify social and financial pressures, especially in regions with lower adaptive capacities (Koralova-Nozharova, 2021). For this reason, despite its strategic significance, the electrification pillar must be complemented by modal shift strategies and the development of localized energy systems to avoid weakening the EU's geoeconomic resilience.

### **Pillar III: Digitalisation – Smart Systems and Mobility Governance**

The third pillar of the Common Transport Policy focuses on the development of digital transport ecosystems, including Intelligent Transport Systems (ITS), integrated data spaces (*EU Mobility Data Space*), and *Mobility as a Service* (MaaS). The goal is to enhance transport system efficiency through traffic optimization, multimodal planning, and smart energy management.

According to *Making Transport Fit for 55* (European Commission, 2022), digitalisation can reduce indirect emissions by 15–20% by improving transport flows, reducing congestion, and optimizing the use of infrastructure resources. Digitalisation also serves as a behavioural enabler of modal shift, empowering users to make more sustainable transport choices through real-time data access, integrated ticketing, and user-oriented digital services such as micromobility and shared vehicle applications (European Commission, 2021b; Berger et al., 2023). However, increased digitalisation introduces new risks of digital dependency, particularly on global providers of cloud infrastructure,

AI algorithms, and proprietary software – risks explicitly acknowledged by the European Commission in its communication on the *European Mobility Data Space* (European Commission, 2023a).

Therefore, digitalisation functions as a supporting pillar. While it does not eliminate dependency risks, it enhances the efficiency and interoperability of the other two pillars. Its key value lies in integration: it enables data sharing across sectors, supports synergistic planning, and allows real-time monitoring of policy outcomes (European Commission, 2021b; Berger et al., 2023).

Table 1 compares the strategic objectives, policy instruments, limitations, and resilience-building potential of each pillar in the context of strengthening systemic resilience in the European Union.

**Table 1. Comparative Overview of the Three Pillars of the EU Common Transport Policy (CTP)**

<b>Pillar</b>	<b>Strategic Objective</b>	<b>Key Policy and Legal Instruments</b>	<b>Main Risks and Constraints</b>	<b>Impact on the EU's Systemic Resilience</b>
<b>1. Modal Shift</b> (behavioural change and mobility restructuring)	Emission reduction through the adoption of low-emission, shared, and active transport modes; integration of mobility with health, social, and spatial goals.	<ul style="list-style-type: none"> <li>• European Green Deal (COM(2019) 640 final)</li> <li>• New EU Urban Mobility Framework (COM(2021) 811 final)</li> <li>• Sustainable Urban Mobility Plans (SUMP 2.0)</li> <li>• Driving Urban Transitions Roadmap (Berger et al., 2023)</li> <li>• Soft tools: education, participation, spatial planning, behavioural communication</li> </ul>	<ul style="list-style-type: none"> <li>• Behavioural barriers (habits, car as status symbol)</li> <li>• Weak public transport integration</li> <li>• Social resistance to private vehicle restrictions</li> </ul>	<b>High</b> – reduces emissions, enhances social resilience and energy independence; avoids dependency shift; strengthens social capital and civic co-responsibility.

<b>2. Electrification / EV Transition</b> (technological transformation)	Replacing fossil fuels with electricity and alternative sources to achieve climate neutrality and modernize the EU automotive sector.	<ul style="list-style-type: none"> <li>• Fit for 55 Package (COM(2021) 550 final)</li> <li>• Regulation (EU) 2023/1804 (AFIR)</li> <li>• Regulation (EU) 2019/631 (CO<sub>2</sub> standards)</li> <li>• ETS2 (road transport emissions trading)</li> <li>• Social Climate Fund</li> </ul>	<ul style="list-style-type: none"> <li>• Dependence on imports of rare earths, batteries, semiconductors (<i>dependency shift</i>)</li> <li>• High energy and infrastructure costs</li> <li>• Risks of technological lock-in and social exclusion</li> </ul>	<b>Medium / Low</b> – strong emissions impact, but increases material and tech dependencies; builds technological, not social, resilience.
<b>3. Digitalisation of Mobility</b> (data ecosystems and system integration)	Improving efficiency, fluidity, and multimodality through digitalisation, automation, and data interoperability.	<ul style="list-style-type: none"> <li>• Making Transport Fit for 55 (European Commission, 2022)</li> <li>• Digital Transport and Logistics Forum (DTLF)</li> <li>• EU Mobility Data Space</li> <li>• ITS Directive (2010/40/EU, recast 2023)</li> <li>• Mobility-as-a-Service (MaaS) concepts</li> </ul>	<ul style="list-style-type: none"> <li>• Cybersecurity threats, digital dependency on global platforms</li> <li>• Lack of data interoperability across countries</li> <li>• Digital inequality and technological exclusion</li> </ul>	<b>Medium</b> – improves efficiency and operational flexibility, but reinforces digital dependence; enhances traffic management rather than strategic autonomy.

**Source:** Own elaboration based on European Commission (2019, 2021a, 2021b, 2022, 2023); Berger et al. (2023); Bednarz-Okrzyńska (2024); Pardi (2024); Motowidlak (2022); Butnaru-Troncotă (2020).

In summary, a comparative analysis of the three pillars of the EU's Common Transport Policy reveals significant differences in their roles and impacts on the Union's systemic resilience. Modal shift emerges as the pillar with the highest adaptive and social effectiveness, as it is fundamentally driven by behavioural transformation rather than technological change. Unlike the other pillars, it does not create new material or digital dependencies but instead relies on local resources – public space, shared infrastructure, and social capital. This makes modal shift the only pillar that reduces external dependencies without deepening the dependency shift, building resilience through

changes in demand and mobility behaviour rather than through technological innovation alone.

Moreover, only a balanced synergy among all three pillars, with modal shift playing a leading role, can realistically achieve systemic resilience in European mobility. For this reason, the EU's Common Transport Policy should not be viewed solely as a set of engineering or technological measures, but as a behavioural governance tool that shapes citizen choices and strengthens civic agency (Emirbayer & Mische, 1998), an idea that lies at the heart of the *Homo Urbanus Mobilitatis Sustinens* (HUMS) model proposed in this study.

This interpretation directly paves the way for the next section, which explores the theoretical and practical foundations of behaviour-based interventions, as opposed to those centered exclusively on technological change. It is within this dimension that transport policy intersects with behavioural economics and *nudge+* theory, offering a new understanding of how the European Union can build resilience through intelligent and ethically grounded influences on individual decision-making.

### **2.3. Behavioural Public Policy and Behavioural Economics**

Contemporary *behavioural public policy* (BPP) represents the evolution of behavioural economics into the domains of public administration and social policy. Its core premise is to apply insights about bounded rationality, heuristics, and emotional influences in citizens' decision-making to design more effective and ethically grounded public interventions (Thaler & Sunstein, 2008, 2021; Oliver, 2013). In contrast to classical economic models based on the rational *homo oeconomicus*, the behavioural approach acknowledges that decisions are shaped by social context, emotional cues, cognitive availability, and cultural norms (Thaler, 2015). BPP is therefore not merely a collection of tools, but an interdisciplinary method that integrates cognitive psychology, ethics, and public governance. Its primary goal is to support decisions aligned with individuals' long-term interests and the common good (Thaler & Sunstein, 2008; Oliver, 2017; OECD, 2019).

The foundations of behavioural economics in public policy are closely tied to the concept of *libertarian paternalism* (Thaler & Sunstein, 2008). The authors argue that the

state can design “choice architectures” that gently guide citizens toward better decisions without restricting their freedom. A classic example involves default options, such as automatic enrolment in savings plans or preselected public transport modes in urban mobility applications. As Thaler (2015) points out, the effectiveness of such interventions lies in leveraging cognitive shortcuts and various biases, including framing effects.

Oliver (2013, 2017) introduced behavioural public policy as a field bridging economics, psychology, and ethics. In his more recent monograph, Oliver (2023) offers a critical review of nudging, highlighting the need to combine interventions with deliberation, reflection, and democratic legitimacy. Ewert (2020) and Ewert et al. (2021) emphasize that excessive focus on individual decisions can obscure institutional and social dimensions, reducing long-term policy effectiveness. Similarly, Straßheim and Korinek (2018) note that nudging requires robust administrative frameworks and transparent procedures to prevent political instrumentalization.

At the institutional level, the behavioural approach has been adopted by leading international organizations. The OECD (2019, 2020a, 2021, 2022) has developed the *BASIC Toolkit* and ethical guidelines for policy design. The European Commission has integrated these principles into policymaking in the fields of transport, energy, and environmental regulation under the European Green Deal framework (European Commission, Joint Research Centre, 2024). These developments reflect a growing institutional recognition of the behavioural approach as an effective and ethical instrument for managing social change.

It is important to note, however, that approaches within behavioural economics vary in the degree to which they intervene in citizens’ decision-making processes. *Nudging*, based on the concept of *choice architecture*, involves structuring the decision environment in ways that gently guide behaviour in a desirable direction, without relying on mandates, prohibitions, or financial incentives (Thaler & Sunstein, 2008). Nudges primarily target automatic cognitive processes (System 1, Kahneman, 2012) and are applied in such areas as default preferences for public transport in digital interfaces, pedestrian infrastructure signage, or gamified eco-friendly behaviour in urban apps (see e.g. Junghanns, 2024; Baggio et al., 2021; Klementschtz & Batiajew, 2020).

An alternative approach is *boosting*, which focuses not on modifying the environment but on enhancing individuals' cognitive skills and self-regulation capacities (System 2, Kahneman, 2012). Rather than steering decisions, boosts enable citizens to make informed, reflective, and critical choices (Grüne-Yanoff & Hertwig, 2016; Hertwig & Grüne-Yanoff, 2017; Hertwig et al., 2025; Espinosa et al., 2022). Examples include carbon footprint self-assessment tools and training programs on sustainable urban travel (Espinosa et al., 2022; OECD, 2022). A growing body of research has also introduced a hybrid concept – *nudge+* – discussed later in this subsection. It combines elements of choice architecture with the intentional development of reflective decision-making capacities.

The ethical debate surrounding nudging and boosting centres on the tension between effectiveness and autonomy. Oliver (2023) and Paradowska (2025) warn that nudging may reduce opportunities for reflection and result in *technocratic paternalism*, while boosting enhances autonomy at the expense of short-term efficiency. Taylor (2023) argues that behavioural interventions must comply with the principle of transparency to avoid what he terms *libertarianism without liberty*. Similarly, OECD (2019) and Straßheim and Korinek (2018) emphasize that ethical behavioural policy requires proportionality and informed consent from citizens.

Despite these controversies, *choice architecture* remains a central component of urban and transport policy. It operationalizes psychological insights through spatial and technological design (Thaler & Sunstein, 2008). In practice, it includes interventions such as redesigning public spaces to prioritize walking and cycling, highlighting green mobility options in apps, and using visual cues in ticketing systems (Ranchordás, 2020; Forberger et al., 2019; Loidl et al., 2023).

Across European cities, such interventions are embedded within sustainable urban mobility strategies (SUMP 2.0). Melin et al. (2025) argue that nudging in mobility can increase the share of public transport use by 10–20% and reduce car travel. Empirical studies further confirm that the effectiveness of choice architecture depends on its alignment with local cultural contexts and the level of citizen engagement (Junghanns, 2024; Mauro et al., 2022; Zimmermann et al., 2023).

Moreover, the digitalization of mobility introduces a new dimension – *digital nudging*. Forberger et al. (2019) and Ranchordás (2020) observe that smart city interfaces,

transport apps, and urban information systems can reinforce pro-environmental decisions, but they also raise concerns regarding privacy and algorithmic paternalism. OECD (2021) and EIT Urban Mobility (2025) stress that digital behavioural tools must be linked with education and transparency to maintain public trust. Empirical research on app-based recommendation systems shows that digital prompts can increase users' willingness to shift from driving to public transport, although their effectiveness is influenced by travel time and previous app experiences (Zimmermann et al., 2023).

As previously indicated, integrative approaches have emerged in response to the limitations of classical behavioural interventions. These approaches combine automatic decision processes with reflective cognition. The *nudge plus* concept (Banerjee & John, 2021) is a significant development in this evolution. It incorporates elements of deliberation into the intervention itself, enabling individuals to consciously evaluate both intent and consequences. The authors argue that “nudge plus restores consumer autonomy and agency,” blending the efficiency of traditional nudging with the ethical legitimacy of boosting.

Oliver (2023) describes this model as *behaviourally informed regulation*, where behavioural stimuli are embedded within broader democratic and deliberative processes. Espinosa et al. (2022) consider *boost* to be a component of *nudge+* that enhances citizens' cognitive reflection and decision-making resilience. Dorigoni and Bonini (2025) further develop the idea of a *gentle push*, a soft intervention that appeals to collective and community-based values in pursuit of the common good.

Empirical studies by Banerjee et al. (2022), Baggio et al. (2021), and Loidl et al. (2023) demonstrate that integrated interventions (those combining informational, spatial, and social components) achieve more durable outcomes than isolated behavioural cues. In the EU context, the *nudge+* concept has been partially incorporated into official policy documents and urban mobility plans (European Commission, 2021b), where citizen behaviour is treated not merely as a target of intervention but as a resource for urban resilience.

Crucially, the development of behavioural public policy reflects a broader transformation in political science, from technocratic steering to participatory and reflexive governance. The conceptual progression from nudging through boosting to *nudge plus* (Banerjee & John, 2021; Oliver, 2023; Hertwig et al., 2025) suggests that effective

social change requires not only behavioural prompts, but also the cultivation of cognitive, ethical, and communal capacities. In urban policy, this implies that behavioural interventions can support systemic resilience by fostering reflexivity, trust, and self-regulation.

#### **2.4. Resilience and Antifragility**

Amid rising complexity and systemic uncertainty across urban, energy, and transport infrastructures, the concept of *resilience* has become a central paradigm in contemporary public policy, including the EU's Common Transport Policy. Resilience no longer implies stability or a return to equilibrium. Instead, it denotes a system's capacity to adapt, transform, and learn in the face of disruption (Linkov et al., 2014; Folke, 2016). According to the European Commission (2020), resilience underpins both lasting sovereignty and social cohesion, and its development requires integration across technological, institutional, and societal dimensions.

In scholarly discourse, systemic resilience is defined as the capacity to preserve core functions while undergoing structural transformation in response to stressors (Walker & Salt, 2012; Duit et al., 2010). As Folke (2016) notes, it is a dynamic process where survival depends less on resistance and more on the ability to reorganize and learn. Resilience, in this sense, is not merely a technical attribute but a characteristic of *social-ecological systems*, encompassing interdependencies between people, technology, and the environment (Adger, 2000).

At the urban level, resilience acquires operational significance. As argued by Meerow et al. (2016), urban resilience reflects a city's ability to maintain critical functions (i.e. mobility, energy, public health) under climatic, economic, and social pressures. Data from the European Environment Agency confirm that cities are not only most exposed to environmental stressors but also among the most capable of developing innovative adaptation mechanisms (EEA, 2024b). In this view, resilience extends beyond infrastructure and includes *social competence*: the collective capacity of urban communities to self-organize, cooperate, and respond effectively to change (UNDRR, 2021).

The concept of resilience originates in systems ecology (Holling, 1973), where it described an ecosystem's ability to sustain function despite disturbances. Over time, the term evolved to include economic, institutional, and societal dimensions (Folke, 2016;

Duit et al., 2010). In the work of Walker and Salt (2012), three interrelated facets of resilience are highlighted: *persistence* (the ability to endure), *adaptability* (the ability to adjust), and *transformability* (the ability to initiate structural change). Adger (2000) further emphasizes that social resilience is closely tied to social capital, trust, and cooperation – key enablers of collective rather than individual responses to crisis.

As emphasized by Linkov et al. (2014), resilience functions as a metaparadigm that bridges disciplines from engineering to the social sciences. Adaptive capacity is no longer seen as a purely technical parameter but as a function of relational networks, information flows, and learning capabilities embedded in social systems. The OECD (2020b) conceptualizes this as *systemic resilience*, where individual, institutional, and collective levels co-produce the ability for coordinated adaptation and self-regulation. Similarly, the World Economic Forum (2022) refers to resilience as a *muscle* – a competency developed through anticipatory learning and investment in preparedness rather than post-crisis reaction. This marks a shift from reactivity to proactivity, from defensive resilience to using disruptions as drivers of innovation and transformation.

This shift aligns closely with Taleb's (2012) concept of *antifragility*, which extends traditional resilience thinking. Antifragile systems not only withstand shocks but improve because of them. Unlike resilience, which centres on function preservation, antifragility involves the capacity to evolve and gain from volatility. Woods (2015) and Linkov & Trump (2019) advance this notion in management science, suggesting that systems capable of learning from error and adjusting flexibly tend to exhibit greater long-term stability than those relying on redundancy alone.

From a public policy perspective, fostering antifragility entails building institutions and governance frameworks that convert uncertainty into learning and adaptive growth. Folke (2016) frames this as *transformative resilience*, i.e. the capacity to reframe goals and strategies in response to systemic crises. OECD (2020b) and the World Economic Forum (2022) underscore that socio-technical resilience hinges less on technological safeguards and more on the co-creative capacity of citizens and institutions to engage in participatory learning and shared solution-building.

According to the European Commission (2020), the EU's strategic resilience must be transformative in scope, encompassing energy and technological sovereignty along-

side social cohesion. Hériaud et al. (2025) argue that resilience capacity across Europe is marked by regional asymmetries: while capital regions display stronger adaptive capabilities, peripheral areas remain more exposed to economic and climatic stressors. Complementary findings from the EEA (2024b) indicate that effective adaptation requires synergistic action between physical, cognitive, and social mechanisms that enable just transitions and inclusive learning processes.

Within this conceptual framework, the proposed HUMS model can be interpreted as a pathway to *behavioural antifragility*, a form of resilience grounded not in technological redundancy but in social adaptability and cognitive flexibility. Unlike traditional models, HUMS shifts the resilience paradigm from infrastructure and technology to the behavioural sphere, emphasizing the agency of urban communities.

While *technological resilience* focuses on preserving critical infrastructures, *behavioural antifragility* strengthens systems through reflexivity, participation, and shared responsibility. As Adger (2000) notes, societies characterized by high levels of trust and collective learning are more resilient than those reliant on control mechanisms alone. HUMS thus offers a hybrid model, bridging conventional resilience thinking with emerging frameworks of antifragility by re-centring public policy on human behaviour and communal capacity.

The evolution from stability to resilience to antifragility reflects a broader epistemological shift in how socio-technical systems are conceptualized. Resilience enables adaptation, antifragility enables strengthening, and behavioural antifragility enables learning, reflection, and co-creation. In the context of urban mobility, this means that transport systems become more robust not in spite of crises, but because of them, provided that disruptions are leveraged to drive behavioural and normative transformation.

## **2.5. Geoeconomic Dependencies and Vulnerabilities**

Contemporary European Union policy operates in an increasingly complex environment where economic, security, and technological dimensions are deeply intertwined. In this context, the concept of *geoeconomics*, namely the use of economic tools to achieve strategic political objectives, has gained significant prominence. As noted by

Scholvin and Wigell (2018), geoeconomics merges instruments such as trade, investment, resource control, and technological regulation with the logic of geopolitical competition. In the 21st century, the boundary between economic policy and security has become blurred, and economic instruments have evolved into a form of *economic statecraft* – the strategic management of interdependence (Wigell et al., 2018).

The European Union, traditionally perceived as a *civilian* or *normative* power, is increasingly becoming a geo-economic actor. Its regulatory influence (often referred to as the *Brussels effect*) must now be complemented by capacities related to economic security and technological sovereignty (Beaucillon, 2023; Beaucillon & Poli, 2023; Fiott, 2018). As great-power competition intensifies, economic dependencies have become instruments of geopolitical leverage, described as *weaponized interdependence* by Farrell and Newman (2019). Geoeconomics no longer describes a liberal world of trade but a risk management system where security is defined by control over supply chains, strategic resources, and advanced technologies.

Despite growing ambitions toward strategic autonomy, the EU remains heavily dependent on external sources of energy, raw materials, and technology. Leal-Arcas (2016) emphasizes that the EU's energy and trade structure is long shaped by imported fossil fuels and critical minerals essential for its green transition. Romanova (2021) argues that the shift from dependence on Russian gas to reliance on Chinese rare earths represents a *dependency shift*, not its resolution.

To address these vulnerabilities, the latest EU initiatives, including the *European Economic Security Strategy* (COM(2023) 249 final) and the *Critical Raw Materials Act* (Regulation (EU) 2024/1252), aim to strengthen resilience through diversification of supply, recycling, and regional value chain development (European Commission, 2023a, 2023b, 2024). However, as the OECD (2025) notes, global value chains have become increasingly fragile and exposed to geopolitical disruptions, necessitating a shift in policy logic from efficiency to resilience.

A particularly salient domain for this transformation is the automotive sector and electric mobility. Pardi (2024) highlights that although the EU's automotive industry is adapting to climate neutrality goals, its transition to electromobility is deepening technological dependency on Asia – especially regarding battery production and semicon-

ductors. This trend results in an *upmarket drift*, where production concentrates in premium segments at the expense of affordability and transport accessibility. Thus, while environmentally sustainable, the transition may intensify social inequalities and geo-economic vulnerability within Europe.

Moreover, as Leonard and Shapiro (2021) point out, the EU excels in exporting regulatory norms but continues to import critical technologies and strategic components. This paradox – *normative power, material dependence* – exposes a growing asymmetry between the Union’s normative influence in global governance and its limited control over the material foundations of its sovereignty.

In response to these challenges, the European Union is advancing a new paradigm of *geo-economic resilience*, understood as the ability to maintain economic functions and positions within global value networks despite disruptions (World Economic Forum, 2022). Rather than aiming for autarky, the EU promotes resilience through diversification, friend-shoring, and reindustrialization of strategic sectors such as semiconductors, battery technologies, and hydrogen systems (OECD, 2025; European Commission, 2023b, 2023c).

In this framework, geo-economic resilience is systemic and multidimensional. As Fiott (2018) and Beaucillon (2023) emphasize, technological sovereignty is not an end in itself but a precondition for preserving strategic autonomy in a globally interdependent environment. Similarly, the IRENA (2024) report suggests that future energy security will rely on decentralized renewable sources and digital infrastructures, rather than fossil-based supply chains.

Nevertheless, current EU strategies remain largely focused on technological and institutional dimensions of resilience, often overlooking its cognitive and social foundations. This results in what could be termed *resilience without reflection*, i.e. an increased capacity to absorb shocks, but not necessarily to learn from them. Only by integrating a behavioural dimension, emphasizing societies’ ability to adapt, collaborate, and innovate, can resilience evolve into lasting *antifragility*.

Dominant interpretations of geoeconomics tend to focus on state-level strategies, institutions, and global supply chains, while neglecting micro-level processes such as social learning, trust-building, and cooperation, which are central to a system’s adap-

tive capacity. This paper proposes *behavioural resilience* as a complementary conceptual lens – one that reframes resilience not solely as a structural state but as a cognitive and cultural competence of societies. This shift from *resilience through control* to *resilience through learning* allows for a more reflexive and participatory understanding of systemic robustness.

The World Economic Forum (2022) highlights that fostering resilience in socio-economic systems requires strengthening not only physical and institutional assets but also social capital, reflective capacities, and innovation-oriented responses. In this regard, the HUMS framework contributes to geoeconomic resilience theory by introducing a behavioural, cognitive, and cultural dimension. It conceptualizes resilience not merely as structural diversification but as a shared societal capacity for co-creation, collective learning, and adaptive governance.

This evolving understanding of resilience – from technical robustness to *geoeconomic resilience* – illustrates the strategic transformation underway in the European Union. Within this trajectory, the concept of *behavioural resilience* may become a key pillar of social antifragility. The following sections elaborate the *Homo Urbanus Mobilitatis Sustinens* (HUMS) model as a normative proposal that integrates psychology, sociology, and economics into public policy. By reframing agency not as freedom of choice but as the capacity for participation in shaping mobility systems, HUMS lays a foundation for a resilient, inclusive, and cognitively sustainable Europe.

### **3. THE HUMS MODEL – HOMO URBANUS MOBILITATIS SUSTINENS**

#### **3.1. Methodological Foundations and Construction Procedure of the HUMS**

##### **Model**

Contemporary urban mobility systems require new conceptual frameworks that not only describe existing practices but also define the forms of mobility that are socially and ecologically desirable. The HUMS model – *Homo Urbanus Mobilitatis Sustinens* – is proposed as such a framework: a normative lens that integrates systemic (micro, meso, macro), behavioural, axiological, and cultural dimensions. Unlike technocratic models, HUMS views individuals not as passive users of infrastructure but as active co-creators of sustainable mobility, engaged in processes of learning, reflection, and adaptation.

The HUMS model emerged from a long-term research process and theoretical reflection carried out between 2007 and 2023. It builds upon insights from behavioural economics, sustainable mobility, and systemic urban resilience. Its foundations lie in a critical reinterpretation of the *homo oeconomicus* paradigm in light of current social and environmental challenges and in the development of the *homo sustinens* concept: a human being oriented toward collective responsibility and the common good. At its core, the HUMS model is rooted in an anthropological critique of the dominant figure of *homo oeconomicus* – a rational, utility-maximising individual abstracted from social and cultural contexts. By contrast, HUMS introduces the figure of *Homo Urbanus Mobilitatis Sustinens*: a reflective urban actor whose mobility behaviours are not only economically motivated but also socially embedded, normatively guided, and shaped by shared meanings. This conceptual shift enables the integration of behavioural, institutional, and value-based dimensions into the analysis of mobility decisions, redefining urban citizens not as consumers of mobility options but as co-creators of urban resilience (cf. Nevens et al., 2013).

Thus, HUMS functions as a normative and transformative conceptual tool. Rather than describing existing behaviour, it is intended to guide public policy towards desired directions of change. Methodologically, the model was developed through a multi-stage process involving:

1. Extended desk research and theoretical analysis, drawing on key contributions from behavioural public policy (John & Stoker, 2019; Banerjee & John, 2021), behavioural economics (Thaler & Sunstein, 2008, 2021; Oliver, 2017), resilience theory (Seibert et al., 2024; Bluszcz et al., 2025), geoeconomics (Fiott, 2018; Maisonneuve, 2023; Pardi, 2024), and the concept of open strategic autonomy (Held & McGrew, 2007; European Commission, 2023c).
2. Systemic conceptual synthesis, which structured the model across micro, meso, and macro levels, mapping the interrelations between motivations, competencies, practices, and institutional environments, following the internal logic of the HUMS framework.
3. Beyond conceptual synthesis, the research draws on the author's long-term empirical and desk studies on the behavioural and institutional determinants of sustainable urban mobility, conducted across multiple Polish cities between

2011 and 2021. This body of work has explored the social acceptance of transport innovations, stakeholder cooperation, behavioural drivers of modal choice, and mechanisms for promoting sustainable mobility (Paradowska, 2011, 2012, 2013a, 2013b, 2014, 2016, 2017, 2018, 2019, 2020, 2021a, 2021b, 2025; Paradowska & Platje, 2012).

4. Empirical inspiration from the NCN MINIATURA 6 research project (National Science Centre, Poland, 2022–2023), which tested the impact of nudging, nudge+, and boosting interventions on drivers' willingness to switch from private car use to more sustainable modes of transport. The study, based on a CAWI survey of 400 respondents, examined the effectiveness of messages appealing to social values, environmental concerns, and personal benefits. The findings indicated that interventions combining cognitive and value-based stimuli were most effective, supporting the premise that motivation and competence integration is critical for influencing transport decisions.

The HUMS model thus evolved as a conceptual synthesis of theory and practice, interweaving cognitive, normative, and systemic layers in the analysis of urban mobility behaviour. Importantly, HUMS is an interpretive and normative model. It draws on three core inputs: empirical findings from the MINIATURA 6 study, synthesis of literature in behavioural economics, geoeconomics, and resilience theory, and a systemic analysis of the links between individual choices, sustainable mobility and urban structures.

The model underwent conceptual validation, which involved comparing its assumptions with empirical research outcomes and existing urban policy frameworks, such as Sustainable Urban Mobility Plans (SUMP), the Fit for 55 package, and the New EU Urban Mobility Framework. A foundational element was the theoretical reorientation from *homo oeconomicus* to *homo sustinens*, allowing the model to incorporate not only cognitive rationality but also civic responsibility and community values.

HUMS is thus the result of a complex cognitive process that integrates theoretical reflection, testing of behavioural mechanisms in real-world decision contexts, and systemic analysis. This approach enables the formulation of public policies that not only address current socio-environmental challenges but also enhance urban systemic resilience by strengthening both civic and institutional capabilities.

As mentioned above, the HUMS model was conceived not only as a normative or analytical tool but also as a translational framework. It serves as an intermediary between academic knowledge, public policy, and civic practice. By integrating behavioural insights, systems thinking, and participatory approaches, HUMS facilitates the translation of complex socio-technical dynamics into actionable public strategies. In doing so, it enables mutual learning across scientific, political, and social domains, reinforcing its applicability in real-world urban governance. This translational capacity positions HUMS as a model of civic knowledge infrastructure – one that empowers citizens and policymakers alike to engage reflexively with the challenges of sustainable mobility. Moreover, unlike many technocratic models, HUMS views individuals not as passive users of infrastructure but as active co-creators of sustainable mobility, engaged in processes of learning, reflection, and adaptation. While this transformative potential is essential, it remains secondary to the model's primary normative function: HUMS defines what sustainable mobility ought to be, not merely how it might emerge.

### **3.2. The Transformative and Normative Nature of the HUMS Model**

The HUMS model falls within the category of normative models, whose primary function is not merely to describe existing realities but to indicate directions for transformation toward a more sustainable, equitable, and resilient mobility system. Following the classification by Bunge (1963, 1998), Cartwright (1983), and Morgan and Morrison (1999), models can serve descriptive, explanatory, or normative purposes. While descriptive models reconstruct reality and explanatory ones reveal underlying mechanisms, normative models establish frameworks and prescriptions for desired actions (Sovacool & Hess, 2017). HUMS clearly belongs to the latter category, as it aims to design conditions under which sustainable mobility can be co-created by citizens, institutions, and communities, rather than being a top-down policy output (cf. e.g. Nevens et al., 2013; Paradowska, 2016).

In this regard, HUMS operates as a mediator between theory and practice, aligning with Morgan and Morrison's (1999) notion of models as translational tools that bridge scientific understanding and social intervention. Rather than reflecting “what is,” HUMS envisions “what ought to be” in order for mobility systems to enable durable transformation aligned with both social and ecological goals.

Amid escalating geoeconomic pressures and global fragmentation, HUMS also functions as a system learning framework. In this view, resilience is not only a structural property but a cognitive capability of political systems, enabling adaptive regulation in evolving contexts (Folke, 2016; Linkov & Trump, 2019). Within the literature, this is described as *resilience as capability*: the ability of systems to convert crisis experiences into knowledge and collective learning.

Framed this way, HUMS advances the paradigm of systemic resilience across micro, meso, and macro levels, viewing mobility behaviours as a form of *behavioural capital*, i.e. a cognitive and social resource that enhances the system's ability to learn and adapt (Banerjee & John, 2021; Banerjee & Mitra, 2023; John & Stoker, 2019). Behavioural capital refers to a society's capacity to generate shared patterns of reflective action that foster not only environmental goals but also strategic autonomy. Accordingly, citizen behaviour is not merely an outcome of policy but a feedback component in Europe's broader learning system, where individual reflection and shared responsibility form a kind of *soft resilience infrastructure*.

As emphasized by Banerjee and John (2021) and Banerjee and Mitra (2023), political systems grounded in *empowered behavioural systems* demonstrate greater capacity for *policy self-correction* – that is, the ability to adjust and recalibrate policy in response to evolving circumstances (cf. Paradowska, 2025). The HUMS framework facilitates learning across the interface of institutions, communities, and individuals, conceptualizing *resilience governance* as a process of mutual cognitive adaptation rather than hierarchical control.

In this sense, HUMS aligns with the vision articulated by the European Commission (2021c), which stresses the need to foster “reflective and learning societies” as a foundation for the EU's strategic resilience and freedom to act. The model thus fits within the paradigm of *learning resilience*, where the critical factor is not merely technological modernization but the cognitive capacity of societies to interpret change and co-create systemic responses. As such, HUMS offers a meta-framework for sustainable mobility policy, connecting individual behavioural foundations with the geoeconomic resilience of broader systems.

This integrative logic enables HUMS to be conceptualised as a cognitive infrastructure of resilience – a dynamic architecture that empowers individuals, communities, and

institutions to collectively interpret complex challenges, co-produce knowledge, and generate adaptive responses. By embedding behavioural capital within participatory, reflective, and learning-oriented governance frameworks, HUMS advances a systemic understanding of resilience grounded in cognition, cooperation, and co-responsibility.

The model's normative dimension is inspired by the concept of *Homo sustinens* (Siebenhüner, 2001), portraying the human being as a cooperative, empathetic actor capable of long-term ecological reasoning. As Kiełczewski (2016) observes, the “sustainable human” does not operate solely under instrumental rationality but is guided by *axiological rationality* – a value-oriented capacity to subordinate actions to the common good. This perspective is further aligned with Sen's (1999) and Nussbaum's (2011) capabilities approach, which emphasizes the role of individual freedom, agency, and moral development in fostering just and resilient societies. The notion of *Homo sustinens* is further developed by Łuszczuk (2009), Wamsler (2018), and Hansen and Nielsen (2023), who argue that sustainable development depends less on transforming economic structures and more on shifting attitudes, habits, and cultural norms.

A similar perspective appears in the concept of *Homo energeticus* (Graczyk, 2019), which frames individuals as active participants in energy transition – co-producers of systems rather than passive consumers (Ostrom, 1996). HUMS translates this approach into the realm of urban mobility, positioning the citizen not merely as a transport user but as a co-creator of its cognitive and social resilience.

Accordingly, the HUMS model integrates insights from four disciplinary fields:

- Psychology, which explores motivations, attitudes, and perceived accessibility;
- Sociology, which examines social practices, norms, and mobility cultures (Sheller & Urry, 2006);
- Behavioural economics, which highlights bounded rationality and cognitive costs (Chng, 2021);
- Public policy, which defines institutional frameworks that can foster shared responsibility (King et al., 2002).

The operation of the HUMS model can be illustrated by examining how a change in perception within one domain cascades through others. The model's layered structure

links motivations, competencies, practices, and institutional environments across the micro, meso, and macro levels, allowing the analysis of how shifts in one sphere can trigger systemic transformations. This enables the analysis of how changes in one layer can trigger systemic shifts across others. For instance, a transformation in public perception of urban cycling, from being viewed as marginal or unsafe to being considered healthy, modern, and climate-conscious, can significantly affect urban mobility practices. Such a perceptual shift enhances motivation, which in turn leads individuals to acquire new competencies (e.g. route planning, safety awareness) and engage in new practices (e.g. regular cycling). Institutional support, such as the provision of dedicated bike lanes, secure parking, and public awareness campaigns, further reinforces this change. As Shove et al. (2012) argue, practices are shaped by the alignment of meanings, skills, and material infrastructures. The HUMS model builds on this insight to offer a dynamic framework for understanding and influencing mobility behaviour in urban systems. Similarly, research by Mattioli et al. (2016) and Schwanen et al. (2012) confirms that even subtle shifts in perceived convenience or reliability can substantially alter habitual mobility patterns, highlighting the interdependence of perceptual, cognitive, and institutional variables in driving systemic change.

### **3.3. The Structure and Meta-Systemic Dimension of the HUMS Model: From Individual Behaviour to Europe's Strategic Resilience**

The architecture of the HUMS model is designed as a multi-dimensional framework for analysing mobility behaviours. As highlighted above, it integrates four functional layers – motivations, competences, practices, and institutional environment – across three systemic levels: micro (individual), meso (community), and macro (system/policy). This structure enables the identification of interdependencies among personal decisions, social norms, and institutional frameworks.

This configuration is illustrated in Table 2, which presents the distribution of key HUMS components in relation to each analytical level.

**Table 2. Visualization of the Four-Layer Structure of the HUMS Model Across Three Analytical Levels**

<b>Layer / Level</b>	<b>Micro (Individual)</b>	<b>Meso (Community)</b>	<b>Macro (System / Policy)</b>
<b>Motivations</b>	Pro-environmental values, attitudes, sense of agency	Group norms, shared responsibility, culture of sharing	Strategic narratives (e.g. European Green Deal, SDGs)
<b>Competences</b>	Knowledge, trip planning skills, digital literacy, perceived accessibility	Local education, co-learning, participatory engagement	Transport education programs, mobility digitalization strategies
<b>Practices</b>	Daily mobility choices (e.g. walking, cycling, public transport use)	Civic initiatives, car-sharing, co-mobility practices	Modal shift policies, infrastructure regulations
<b>Institutional Environment</b>	Service accessibility, perceived safety, infrastructure integration	SUMPs, public consultations, local planning and collaboration networks	EU and national legal, financial, and fiscal frameworks for mobility governance

**Source:** Own elaboration based on Barceló et al. (2005), Geels (2012), Van Wee & Maat (2003), Senge (2006), Paradowska (2025a)

At the micro level, the concept of *perceived accessibility* plays a pivotal role. Rather than denoting the physical availability of transport infrastructure, it reflects an individual’s subjective sense of being able to participate in social life (Paradowska, 2020). This makes it a cognitive indicator of integration with the mobility system and a proxy for agency and trust.

At the meso level, collective learning and shared action become essential. Local communities, such as schools, neighbourhood networks, or civic organizations, act as transmitters of values and knowledge, fostering the internalization of sustainable mobility goals. These communities form what Senge (2006) refers to as *learning communities*, shaping behavioural norms through collaboration.

At the macro level, institutional and strategic policy frameworks come into focus, shaped by dominant narratives and civilizational goals. As argued by Holden et al. (2020), transport policies are not merely technical toolkits but expressions of societal aspirations – *grand narratives* that signal collective direction. The HUMS model builds on this premise by framing mobility as a shared good, both cognitive and cultural.

From this perspective, interdependencies between micro, meso, and macro levels are emergent, not linear. They arise from dynamic interactions, which over time contribute to what can be described as a *meta-systemic resilience layer*. This layer does not represent a separate level of analysis but rather the synergistic quality of relations among behaviours, institutions, and narratives.

As such, the HUMS structure is not limited to analytical categorization. It provides a basis for understanding how everyday decisions, such as mode choice, willingness to engage in shared transport, or participation in planning processes, accumulate into macrostructural outcomes. These outcomes include fossil fuel consumption, energy self-sufficiency, democratic data governance, or institutional trust. In this sense, HUMS operationalizes the concept of *resilience as capability* (Folke, 2016; Linkov & Trump, 2019), demonstrating that Europe's resilience is closely linked to the *behavioural sovereignty* of its citizens – their ability to act reflectively, learn collectively, and co-shape development trajectories. The model thus extends beyond infrastructure and institutions to encompass a meta-systemic layer that is cognitive, cultural, and geo-economic in nature.

As highlighted, the HUMS model demonstrates how individual mobility decisions can accumulate into systemic effects that shape public transport integration, reduce fossil fuel demand, and support local energy self-sufficiency. Mobility is thus reframed not only as an environmental issue but can be considered an important pillar of Europe's geoeconomic resilience. In this sense, HUMS integrates three interrelated dimensions of systemic resilience:

1. **Energy sovereignty**, aligned with the logic of *Fit for 55* and the *European Green Deal*, where managing mobility demand becomes a tool for enhancing system adaptability.
2. **Digital autonomy and data governance**, consistent with the *European Digital Strategy* and the *AI Act*, supporting democratic oversight of digital infrastructure.
3. **Strategic autonomy**, understood as the EU's capacity to independently navigate global uncertainties and shape its own developmental pathways (Borrell, 2020).

As Beaucillon (2023) notes, Europe's strategic autonomy today goes beyond military capacity. It includes the societal ability to define goals, values, and development narratives. HUMS operationalizes this by viewing mobility systems as *experimental learning ecosystems* (Evans et al., 2016), where individual decisions generate systemic transformation at the meta-level.

Consequently, HUMS serves not only as a tool for designing local mobility policies but also as a framework for building learning-based sovereignty, a cognitive and cultural form of independence in the face of geoeconomic pressures. In this perspective, mobility becomes a vector of learning policy, and resilience an emergent effect of synergy between reflective citizens and adaptive institutions. The model aligns closely with the European Commission's (2021c) vision of "reflective and learning societies" as a foundation of long-term strategic agency (*freedom to act*) under global volatility. HUMS contributes to Europe's *cognitive resilience infrastructure*, enabling system learning amid uncertainty, change, and multi-layered complexity.

These conclusions are supported by the author's empirical research conducted under the MINIATURA 6 grant (National Science Centre, Poland), which examined mobility-related decision-making among car users aged 31–40 in Wrocław. The data indicate that reinforcing the reflective component via *nudge+* strategies enhances the durability of behavioural change and fosters the development of *empowered behavioural systems* capable of cognitive adaptation and self-regulation (cf. Banerjee & John, 2021; Banerjee et al., 2022; Banerjee & Mitra, 2023). These findings affirm the assumptions behind HUMS and demonstrate the feasibility of shaping *Homo Urbanus Mobilitatis Sustinens* as an active participant in learning systems, rather than a passive recipient of infrastructural policy.

Ultimately, HUMS provides a coherent framework connecting everyday individual actions to macrostructures of strategic governance. Mobility is no longer just an infrastructural domain but becomes a space of cognitive and cultural policy, shaping Europe's capacity to learn, respond, and co-create global system responses. The model captures the dynamic interplay between micro-level behaviour and institutional structures, offering a platform for integrating mobility policies with cultural and cognitive processes. It is precisely this multi-layered architecture and adaptive logic across levels that grants HUMS its innovative value as both an analytical and design-oriented tool.

## 4. DISCUSSION AND IMPLICATIONS FOR THE EU'S GEOECONOMIC RESILIENCE

### 4.1. HUMS as an Applied Framework for Public Policy

The HUMS model, as presented in detail in Section 3, functions not only as an analytical tool for diagnosing contemporary urban mobility systems but also as a design-oriented framework for enabling their transformation. Its practical relevance stems from its normative and systemic nature, because HUMS does not simply describe existing practices but proposes directions for change rooted in values of the common good, sustainability, and resilience. At its core lies the assumption that mobility is not merely a domain of technical infrastructure, but a space where behaviours, values, and social competences are actively shaped.

In this context, HUMS can be positioned as a tool of resilience governance, i.e. an emerging approach to public management focused on strengthening the adaptive, self-regulatory, and learning capacities of systems (Folke, 2016; Linkov & Trump, 2019). It reframes mobility as a space of interaction between citizen behaviour and public institutions, where cognitive competences, participation, and a culture of shared responsibility play pivotal roles (Banerjee & Mitra, 2023). Through this lens, the model supports the development of policies rooted in reflective interventions, education, and collaborative mechanisms – such as *nudge+*, *boost*, citizen science, and public deliberation (Banerjee & John, 2021; Banerjee et al., 2022, Paradowska, 2025).

Applying HUMS within public policy also requires embedding decision-making in a meta-cognitive infrastructure – a set of institutional, cultural, and technological mechanisms that enable societies to process knowledge, adapt to change, and co-create developmental trajectories. As Beaucillon (2023) highlights, the capacity for such learning has become a key resource underpinning the EU's strategic autonomy, understood not only in terms of political or technological independence, but as a societal competence to generate informed responses to complex civilizational challenges.

In this view, HUMS becomes more than a tool for designing local mobility strategies, it is part of a broader process of building learning-based sovereignty (Evans et al., 2016). This cognitive-cultural form of sovereignty is grounded in reflective citizens, learning communities, and institutions capable of adaptive policy correction. In doing so, the

model contributes directly to the EU's freedom to act (European Commission, 2021c), by enabling the creation of resilient, integrated, and participatory mobility systems.

The utilitarian nature of the Homo Urbanus Mobilitatis Sustinens (HUMS) model stems from its grounding in systems thinking, which forms its core theoretical and methodological basis. HUMS does not treat mobility as an isolated societal domain but frames it as a component of a broader socio-technical system in which individual decisions co-produce the dynamics of economic, cultural, and institutional processes. In this respect, the model draws on classical systems theory (Luhmann, 1990; Meadows, 2008; Senge, 2006; Geels, 2004), where changes within one subsystem can generate both reinforcing and counterbalancing effects across others, influencing the efficacy of public policy.

HUMS advances the logic of systemic interdependencies by emphasizing that urban mobility is shaped by other spheres of daily life, such as work, education, services, and social interaction, requiring policy integration across these domains. As Banister (2008) argues, sustainable mobility policy must extend into spatial, energy, and social planning in order to meaningfully transform behaviour patterns. Consistent with socio-technical systems theory (Emery & Trist, 1960; Geels, 2004), HUMS views cities as dynamic learning systems in which behavioural shifts co-evolve with technological and institutional innovation.

In line with classical system theory, the effectiveness of public interventions depends on understanding feedback loops, both positive (reinforcing) and negative (stabilizing) (Meadows, 2008). HUMS incorporates this logic, suggesting that behavioural action can trigger processes of social self-organization that enhance the adaptive capacity of urban systems. However, as Bertolini (2020) notes, such interventions must be aligned with institutional and spatial transformation to avoid policy fragmentation (Hynes et al., 2020). HUMS is thus not a closed model but an open adaptive system rooted in the interdependence between individuals, communities, and political structures.

The model further assumes that mobility behaviours are not solely driven by rational individual choices but reflect underlying mental models and social beliefs formed through long-term cultural processes. In this regard, HUMS draws on the Stage/Readiness Models (Prochaska & DiClemente, 1983; Bamberg, 2013), which allow for the

tailoring of behavioural interventions (nudge, nudge+, boost) to varying levels of cognitive and value-based readiness among citizens. HUMS synthesizes these approaches to advocate for a paradigm shift from the Dominant Social Paradigm (DSP) toward the New Environmental Paradigm (NEP) (Dunlap & Van Liere, 2008), where mobility is redefined as a shared social responsibility rather than an individual right.

As such, HUMS contributes to the scholarship on complex adaptive systems (Holland, 1992; Folke, 2016) and learning organizations (Senge, 2006), offering a framework that integrates behavioural and systemic dimensions in public policy. This approach supports the design of interventions that enhance the resilience of urban mobility systems by simultaneously engaging values, competences, practices, and institutions – the four core layers constituting *Homo Urbanus Mobilitatis Sustinens*.

#### **4.2. Three Application Scenarios: From Framework to Implementation**

As underlined above, the HUMS model is a normative framework designed not to describe existing behaviours but to guide transformative and reflexive approaches to mobility policy. Its four-layer structure, comprising motivations, competences, practices, and the institutional environment, mapped across micro, meso, and macro levels, enables the operationalization of complex constructs such as behavioural resilience, learning-based sovereignty, and the cognitive infrastructure of sustainability within applied policymaking.

Unlike traditional models based on linear causality, HUMS incorporates dynamic feedback loops, emphasizing that everyday mobility decisions – modal choices, travel frequency, and willingness to share – can aggregate into macrostructural geo-economic outcomes. These include reductions in fossil fuel demand, enhanced urban energy self-sufficiency, and decreased infrastructural pressure (Banister, 2008; Lyons, 2018). This approach aligns with the paradigm of *resilience through demand reduction*, which positions behavioural change (not only technological development) as a central pillar of systemic resilience.

The following subsections present three illustrative scenarios that demonstrate how HUMS can be adapted to various public policy challenges related to urban mobility and strategic resilience. Each scenario highlights a distinct facet of the model:

- **Scenario 1** explores cultural transformation in mobility, showing how collective practices and perceived accessibility foster modal shift;
- **Scenario 2** focuses on the digital governance of mobility, emphasizing the role of social data, information infrastructure, and participatory tools;
- **Scenario 3** centres on policy learning, illustrating how reinforcing citizens' cognitive and social competences contributes to behavioural resilience.

The use of a scenario-based approach, rather than a rigid typology, reflects the model's multidimensionality and flexibility. HUMS can be tailored to diverse local contexts, decision-making scales, and transformation goals. These scenarios do not exhaust all potential applications but serve as analytical lenses connecting theoretical architecture with practical implementation.

In line with the logic of *resilience governance* (Folke, 2016; Linkov & Trump, 2019), the scenarios support cities' capacities for adaptive policy self-correction and for aligning interventions across micro, meso, and macro levels. They also contribute to building *meta-cognitive infrastructure* (Beaucillon, 2023; Evans et al., 2016), a shared capacity for reflection and collaboration, seen increasingly as a core asset for the European Union's strategic autonomy (Borrell, 2020; European Commission, 2021c).

### **4.3. Modal Shift as a Vehicle for Cultural Transformation in Urban Mobility**

#### ***Mobility as a Social, Not Merely Logistical, Practice***

Contemporary mobility systems are not neutral transport infrastructures but culturally embedded social practices that shape norms, identities, and forms of urban participation (Sheller & Urry, 2006). Modal shift, from private car dominance toward more sustainable modes, therefore reflects not just access to technological alternatives but a deeper cultural reconfiguration. Shifting travel modes requires more than infrastructure upgrades; it involves reshaping societal values, norms, and perceptions related to movement.

#### ***Operationalizing HUMS: Micro and Meso Dimensions***

Within the Homo Urbanus Mobilitatis Sustinens (HUMS) framework, modal shift is analysed through motivational and perceptual layers at the micro level and communal practices at the meso level, which collectively generate systemic effects. Perceived

accessibility, for instance, extends beyond transport schedules to include feelings of safety, control, and symbolic value assigned to mobility modes (Paradowska, 2020). Thus, modal change depends not only on “hard” investments but also on cognitive–behavioural interventions that reframe how people interpret and value transport options.

At the meso level, community-based mobility forms, such as car-sharing, public bike systems, shared transport services, and public space redesign supporting micromobility, act as cultural catalysts. While often local, these practices reinforce social cohesion, inclusivity, and reframe dominant urban lifestyles. As Sheller and Urry (2006) argue, mobility lies at the core of broader “mobility systems” that circulate not only people but also meanings and identities.

### ***Implementation Examples and Systemic Outcomes***

Numerous European cities demonstrate the impact of HUMS-aligned interventions based on demand reduction through cultural and behavioural change. Examples include traffic-calmed zones (e.g., *woonerfs*, Tempo 30), shared mobility platforms (e.g., Nextbike, Traficar), and integrated *Mobility-as-a-Service* (MaaS) systems. These reduce pressure on transport and energy infrastructure while enhancing civic agency and co-responsibility for urban wellbeing (see e.g. Bertolini, 1999; Banister, 2008; CEUTP, 2023; Smeds, 2021).

In HUMS, such initiatives build a *behavioural infrastructure of sovereignty* – a foundation for long-term systemic resilience (Smeds, 2021; Knowles & Ferbrache, 2019). Energy use reduction, emission cuts, less spatial dominance by cars, and stronger local networks are not only environmental goals but expressions of the EU’s geo-economic self-sufficiency and social resilience.

### ***Cultural Modal Shift as a Form of Systemic Security Policy***

Aligned with the logic of *resilience through demand reduction*, transforming mobility patterns toward culturally and modally sustainable systems constitutes a strategic policy tool (Knowles & Ferbrache, 2019; Taylor, 2017). HUMS illustrates that everyday citizen decisions, shaped by values, norms, and lived experience, can accumulate into macro-level outcomes that enhance both environmental and geo-economic resilience across the EU. Modal change, in this light, is less a technical transition and more a signal of a system’s capacity for self-organization and cultural adaptation.

#### **4.4. Digital Resilience and Data Sovereignty in Mobility Governance**

##### ***Data as a Component of Resilience Infrastructure***

In the digital era, data functions as a core strategic asset shaping urban mobility systems and their capacity to respond to environmental, technological, and societal disruptions. The digital layer, comprising sensor data, behavioural models, risk mapping, and algorithmic governance, has become integral to systemic resilience (European Commission, 2022; Beaucillon, 2023). Data now defines the cognitive environment of public decision-making, influencing how risk, sustainability, and security are conceptualized and managed.

Urban mobility governance increasingly hinges not just on Intelligent Transport Systems (ITS), but on *data sovereignty*: the ability of local communities to govern how information is generated, shared, and applied. HUMS brings added value by providing an integrated framework for participatory, transparent, and resilience-oriented data governance.

##### ***Operationalizing HUMS: From Technical Data to Participatory Governance***

Within HUMS, data intersects both the institutional layer (regulatory frameworks, knowledge-sharing standards) and the competence layer (citizens' and institutions' capacities to interpret and use data). At meso and macro levels, the model advances *data co-governance*, a participatory process involving citizens, public administrators, experts, and private stakeholders.

HUMS expands the scope beyond technical data to include *social data* – information on mobility habits, comfort levels, safety perceptions, and perceived accessibility. Integrating these within a reflexive knowledge architecture allows data to fuel institutional learning, policy self-correction, and the reinforcement of public trust.

This approach aligns with the development of *Local Digital Twins* – urban simulation platforms that model policy impacts. As Orozco-Messana (2022) and Ketzler et al. (2020) highlight, such models are more effective when enriched with behavioural layers capturing social norms, competences, and values influencing mobility decisions. HUMS contributes this integration.

## ***Data Sovereignty and EU Policy Agendas***

HUMS supports the implementation of the EU Digital Strategy and the AI Act, promoting safe, fair, and transparent data ecosystems. By positioning cities as agents of digital sovereignty and citizens as co-creators of informational infrastructures, the model operationalizes principles of *data justice*, ensuring equal access, participatory governance, and ethical use of data (Taylor, 2017; European Commission, 2021c).

Furthermore, the HUMS framework operationalises digital nudge+ mechanisms that integrate data-driven feedback with reflective user engagement, fostering behavioural shifts toward sustainable mobility. By linking digital participation with behavioural adaptation, HUMS contributes to strengthening the EU's geoeconomic resilience through the promotion of socially embedded and autonomous mobility systems.

Beyond integrating traffic and energy metrics, HUMS incorporates cognitive and perceptual data, such as trust, agency, and spatial quality. This multidimensional integration enables the design of mobility systems that are not only efficient but also socially resilient. As Huntjens (2021) notes, the adaptive capacity of cities depends on their ability to merge technical and social intelligence.

### ***Systemic Outcomes: Enhancing Adaptability Through Data***

As a cognitive-institutional framework, HUMS reconfigures mobility into a learning ecosystem characterized by information flows, feedback loops, and reflexivity. Transparent data practices build public trust, reduce policy risk, and enable real-time course correction. This model of *resilience governance* emphasizes decentralizing knowledge rather than centralizing control, making data accessible, intelligible, and actionable for diverse actors.

Following Folke (2016) and Linkov & Trump (2019), adaptive self-regulation hinges on a system's capacity to learn from the data it generates. HUMS facilitates this by embedding citizens in data interpretation processes – not merely as sources, but as contributors to political knowledge.

Ultimately, digital infrastructure becomes not a tool of surveillance, but a shared space of decision-making. This establishes the foundation for *digital resilience*, anchored in competence, trust, and democratic oversight.

## **4.5. Systemic Learning and Behavioural Resilience**

### ***Urban Mobility as a Reflexive Learning Environment***

As underlined above, in the face of complex geo-economic challenges, urban mobility systems must be understood not only as transport infrastructures but as arenas of social learning, where individuals, communities, and institutions co-develop adaptive capacities (Meadows, 2008; Hynes et al., 2020). The concept of *behavioural resilience*, as framed within the HUMS model, refers to the capacity for reflective action under uncertainty, where citizens' behaviours generate systemic knowledge rather than merely respond to stimuli.

*Systemic learning* entails more than data absorption. It involves reinterpreting established patterns, critically reassessing public policy outcomes, and adjusting strategies through institutional and social feedback (OECD, 2023; Linkov & Trump, 2019). HUMS operationalizes this capacity across micro (individual choices), meso (community practices), and macro (policy frameworks) levels.

### ***Operationalizing HUMS: Boosting Adaptive Competencies***

Within HUMS, behavioural resilience is not static but results from boosting citizens' cognitive and social skills. This includes fostering reflective decision-making under incomplete information (Grüne-Yanoff & Hertwig, 2016; Hertwig & Grüne-Yanoff, 2017; Banerjee & John, 2021). This approach resonates with recent IEA findings, which highlight the centrality of skill development and social inclusion in achieving effective and equitable energy transitions (IEA, 2022). Recent analyses confirm that behavioural change is indispensable for achieving net-zero goals, with the IEA estimating that nearly 40% of emission reductions required by 2050 will rely on changes in how individuals use energy and transport (IEA, 2021). HUMS embeds the process of reflective decision-making in the competence and practice layers, highlighting the importance of mobility education, real-time feedback via digital tools, participatory evaluations, and citizen science.

At the micro level, these interventions support autonomous decision-making. At the meso level, they help form *learning communities* that share experiences and co-produce knowledge (Huntjens, 2021, Ostrom, 1996)). Empirical findings from the MINIA-TURA 6 project support this logic: behavioural interventions that incorporate reflection lead to required shifts in daily mobility practices.

### ***Systemic Effects: Policy Self-Correction and Adaptive Coherence***

From a resilience governance perspective (Folke, 2016), a central outcome of behavioural resilience is *policy self-correction*, the capacity to revise strategies in response to evolving behaviours and contextual shifts. HUMS fosters this through feedback mechanisms that connect citizen behaviour with institutional action, circulating knowledge across system actors to enhance responsiveness and learning.

Mobility systems leveraging reflexive social data, participatory evaluation, and digital dialogue tools are better equipped to avoid policy missteps, adapt to local contexts, and increase public support for change (Banister, 2008; Lyons, 2018). As Hertwig (2023) observes, boosting enhances system adaptability not through control but through co-responsibility.

The social and institutional trust cultivated in these processes becomes a strategic asset, enabling not only more effective mobility governance but also a broader culture of resilience built on collaboration and adaptive innovation. The most robust systems, as OECD (2020b) notes, are those capable of transforming information into collective action and redefining goals in real time.

### ***HUMS as a Framework for Cognitive Co-Resilience***

HUMS can thus be viewed as a cognitive-institutional architecture that supports urban societies in managing uncertainty through co-produced knowledge rather than centralized expertise. Behavioural resilience, in this model, is not merely resistance to crises but the ability to learn from them and convert them into catalysts for reflective transformation across individual and systemic levels (Taleb, 2012; Spaargaren, 2011).

HUMS enables a shift from reactive to reflective policy, from external incentives to internal motivation, and from demand management to co-creation of mobility preferences. As such, it offers a framework for *strategic socio-cognitive resilience*, essential to sustaining the European Union's adaptive capacity amid energy, digital, and societal transitions.

#### **4.6. Limitations and Implementation Challenges of the HUMS Model**

The Homo Urbanus Mobilitatis Sustinens (HUMS) model presents an innovative synthesis of behavioural, geo-economic, and systemic perspectives in the design of sustainable urban mobility policies. As a theoretical metaframework, HUMS holds normative potential by emphasizing the cognitive and decision-making capacities of citizens as systemic assets. However, this potential must be considered alongside practical implementation constraints, which emerge across five interconnected dimensions: systemic, cognitive, epistemic, institutional, and cultural.

##### ***Systemic and Structural Barriers***

Urban mobility is embedded in broader socio-economic structures and does not operate in isolation (Bertolini, 2023; Meadows, 2008, Sheller & Urry, 2006). Shifting mobility behaviours often requires reconfiguring other domains, including public services, education, employment, and housing. As a systemic framework, HUMS must navigate interdependencies across sectors. Research by Banister (2008) and Bertolini (2020) highlights that fragmented planning undermines policy effectiveness, particularly between transport, spatial, and energy domains. Similarly, Hynes et al. (2020) identify *policy fragmentation* as a key barrier to integrated transition. For HUMS to be viable, implementation must be aligned with systemic feedback loops and cross-sector coordination.

##### ***Cognitive and Behavioural Constraints***

Behavioural change relies not only on infrastructure but also on awareness, motivation, and learning capacity. According to the COM-B model (Michie et al., 2011), effective change requires capability, opportunity, and motivation. HUMS addresses these factors in its competence layer, but implementation depends on tools that reflect citizens' diverse mental models (Hertwig & Grüne-Yanoff, 2017). Lehto (2025) warns that overly paternalistic interventions may reduce autonomy rather than enhance it. Therefore, HUMS must avoid behavioural universalism and instead promote contextual, inclusive, and pluralistic approaches to intervention design.

##### ***Epistemic and Conceptual Limitations***

As a normative and open-ended model, HUMS does not prescribe fixed solutions but provides a reflexive framework for interpretation (Shove, 2010; Spaargaren, 2011). Its effectiveness thus depends on local actors' ability to translate its concepts into situated

practices. The model does not resolve structural–agency tensions or ethical dilemmas related to balancing efficiency and participation (Lehto, 2025). What may appear as cognitive empowerment for some could be perceived as a new form of control for others. This limitation does not disqualify HUMS; rather, it underscores the need for ongoing epistemic dialogue and critical reflection on behavioural tools.

### ***Institutional and Financial Challenges***

Implementing HUMS requires not only political will and cognitive capacity but also stable financial structures and institutional support. Innes and Booher (2010) and the OECD (2019) note that many public institutions face limited adaptability and coordination deficits. As a learning-based model, HUMS demands iterative processes, robust funding, and clear performance indicators. Its effectiveness may be compromised by the insufficient integration of Sustainable Urban Mobility Plans (SUMP) with EU-level funding mechanisms (European Commission, 2021b).

### ***Political and Cultural Barriers***

Finally, HUMS faces challenges stemming from political and cultural diversity across Europe. Jordan and Huitema (2014) emphasize that innovation in policy is rarely linear and heavily influenced by local institutional dynamics. Although designed to be inclusive, the model may be perceived differently depending on prevailing developmental narratives. In Northern Europe, it might be embraced as a tool of empowerment, whereas in parts of Eastern Europe it could be viewed as externally imposed (Borrell, 2020; Beaucillon, 2023). It is therefore crucial to treat HUMS not as a one-size-fits-all implementation tool, but as a flexible and adaptive framework whose effectiveness depends on local legitimation and internalization.

The limitations outlined above are both systemic and methodological, pointing to the need for continued empirical and comparative research. However, these challenges do not undermine the relevance of HUMS as a normative framework. On the contrary, recognizing these constraints is a prerequisite for its responsible and effective application. In an era marked by rising technological and resource dependencies (including *dependency shift*), HUMS offers a unique integrative perspective that links everyday mobility choices to the European Union’s broader geo-economic strategies. Its value lies not in universality, but in adaptability and its potential to shape public policies through the lens of open, strategic autonomy.

## 5. CONCLUSIONS

The aim of this article was to present the *Homo Urbanus Mobilitatis Sustinens* (HUMS) model as a conceptual framework that integrates behavioural and geo-economic dimensions in analysing the European Union's strategic resilience. With reference to the guiding research questions, the study demonstrated that:

- (1) sustainable urban mobility policies can meaningfully support the EU's strategic autonomy by strengthening systemic resilience and reducing resource dependencies,
- (2) the HUMS model reframes mobility behaviours from an ecological to a geo-economic perspective, treating them as a form of behavioural capital,
- (3) HUMS can serve as a policy design framework for behavioural resilience, complementing the technological transition outlined in the Fit for 55 package and the European Green Deal (European Commission, 2022, 2023c; Fiott, 2018).

In contrast to conventional approaches primarily focused on infrastructure and technology (European Commission, 2019, 2021a, 2021b), this model emphasizes that long-term resilience stems from the integration of social competencies, cognitive patterns, and institutional mechanisms for cooperation. Accordingly, it affirms that Europe's systemic resilience begins at the level of individual choices and everyday habits embodied in *Homo Urbanus Mobilitatis Sustinens*.

First, HUMS redefines the concept of mobility as an important component of geo-economic resilience, arguing that citizens' transportation choices shape not only emission profiles but also the degree of external technological and material dependencies (dependency shift) (Maisonneuve, 2023; Pardi, 2024). In this way, the model advances existing theories of strategic autonomy (Held & McGrew, 2007; Fiott, 2018) by incorporating a cognitive-behavioural dimension.

Second, behavioural change constitutes the core of adaptive urban systems, as shown by research in behavioural public policy (John & Stoker, 2019; Banerjee & John, 2021). In the HUMS framework, behavioural capital consists of values, habits, and motivations that enhance societal resilience and enable sustainable adaptation under climate and technological pressures (Lehto, 2025).

Third, integrating HUMS into modal shift policies enables the practical application of the resilience through demand reduction paradigm (Seibert et al., 2024), which holds that reducing demand for high-energy mobility is as vital as technological modernization. This approach expands the scope of sustainable transport theory (Koralova-Nozharova, 2021; Motowidlak, 2022) by embedding it within both cognitive and geographic contexts.

Finally, HUMS offers a theoretical architecture for integrating micro, meso, and macro levels of resilience analysis. It allows cities to be conceptualized as microstructural systems in which local citizen decisions contribute directly to the EU's broader geographic resilience architecture (Berger et al., 2023; European Commission, 2023c).

From a public policy perspective, HUMS can function as a tool for behavioural transformation design. It underscores the need to balance infrastructure investments with soft measures, including education, co-decision-making, and digital participation (Oliver, 2017; OECD, 2019). In practice, this implies that Sustainable Urban Mobility Plans (SUMP) and Fit for 55 programs should incorporate behavioural and communication components – such as nudge+ and deliberative public consultations – as integral to policy implementation (Thaler & Sunstein, 2008; Grüne-Yanoff & Hertwig, 2016; Hertwig & Grüne-Yanoff, 2017).

HUMS can also serve as a diagnostic and evaluation instrument. By integrating data on mobility behaviours, energy systems, and social contexts, it enables the assessment of a city's level of behavioural resilience, and thus its capacity to adapt to resource and energy crises. This operationalizes the notion of open strategic autonomy, understood not as isolation, but as the capacity for interdependent self-regulation (Fiott, 2018; Held & McGrew, 2007).

The presented model is conceptual and theoretical in nature, which constitutes both its strength and its primary limitation. HUMS has not yet been empirically tested across diverse urban contexts, and its application in quantitative analyses requires the development of operational indicators for behavioural capital and behavioural sovereignty. Another limitation is the lack of comparative data on the long-term impact of behavioural policies on systemic change in urban mobility. These challenges point to the need for further empirical research to verify the model's effectiveness and scalability.

Future studies will focus on testing the model's effectiveness and its empirical applicability in the analysis and development of sustainable urban mobility policies across EU cities. Particular attention will be paid to examining the relationship between behavioural capital and emerging digital mobility ecosystems, such as digital twin cities and Mobility-as-a-Service platforms, that are increasingly shaping new forms of geo-economic dependence (European Commission, 2023b; Tedeschi, 2024). Another research direction involves the development of integrated behavioural resilience indicators, which could be incorporated into monitoring systems for the implementation of the European Green Deal (Bluszcz et al., 2025; Kochskämper & Monstadt, 2025).

The HUMS framework also offers normative implications for the design of EU-level mobility and energy policies by promoting behavioural sovereignty as a cornerstone of open strategic autonomy.

In conclusion, the analysis confirmed that the HUMS model successfully addresses the research objectives and responds to the guiding questions posed at the outset. It demonstrates that *Homo Urbanus Mobilitatis Sustinens* is not merely a theoretical construct, but a foundational concept for reimagining the EU's strategic autonomy, where citizens' mobility behaviours become a key geo-economic asset.

The novel contribution of this article lies in its paradigm shift from infrastructure- and technology-focused resilience frameworks to a systemic-behavioural approach, where mobility is understood as a co-creative process in building both societal and geo-economic resilience. HUMS thereby introduces a new interpretive meta-framework, integrating micro, meso, and macro levels into a coherent logic of adaptive learning for European systems.

Europe's resilience begins with the individual, with the capacity for cooperation, reflection, and conscious participation in the transformation process. In this light, behavioural sovereignty emerges not only as a public policy objective but also as a foundational pillar of European identity in an era of deep and complex interdependencies (European Commission, 2023b; Maisonneuve, 2023; Pardi, 2024).

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# Ordnungspolitische Diskurse

## Discourses in Social Market Economy

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Eine Liste der Diskussionspapiere von 2007 bis 2024 findet sich in früheren Papern.

A list of discussion papers covering the years 2007–2024 is provided in earlier papers.

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