

Legal Pathways for Urban Mobility Resilience : A Content Analysis of Policy Documents for Istanbul's Transport Systems

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Abstract

Urban transport systems face escalating disruption risks by challenging resilience in megacities like Istanbul. This study systematically evaluates the presence and coherence of resilience-related strategies across multiple policy levels within Istanbul's transportation policy and legislative frameworks. Employing content analysis on 14 national and 21 local policy documents, main policy themes and granular sub-themes were first identified. Benchmarks for urban mobility resilience were then developed. Subsequently, these benchmarks were applied to assess gaps within each identified main policy theme across both national and local documents. The analysis reveals critical policy gaps which highlight inconsistencies. Our findings pinpoint areas for legal and policy reform to strengthen Istanbul's transport resilience against increasing threats, which ensures system continuity and public safety.

Keywords: content analysis, disaster preparedness, Istanbul's transportation system, policy frameworks, urban mobility resilience

Introduction

The increasing vulnerability of urban transport systems to both natural hazards and human-induced disruptions poses a critical challenge for modern cities. Urban areas, as hubs of economic, social, and infrastructural complexity, rely heavily on effective and resilient transport systems to maintain their functionality during and after disruptive events. As climate change intensifies the frequency and severity of extreme weather events, such as floods and earthquakes, ensuring the resilience of transport systems becomes a key priority in urban sustainability efforts (Priolo et al., 2023).

The problem addressed by this research is the insufficient integration of disaster risk preparedness within the existing legislative and policy frameworks for urban transport planning. Despite the importance of resilience in maintaining urban functionality, many transport systems remain vulnerable to cascading failures due to inadequate coordination between policy frameworks, infrastructure design, and disaster risk management strategies (Mattsson and Jenelius, 2015). This gap poses significant risks, especially in highly urbanized regions such as Istanbul, which faces both seismic threats and climate-related hazards (Priolo et al., 2023). Transport network disruptions can paralyze entire regions, which leads to severe economic losses, compromised public safety, and disruptions in essential services.

Transport networks are interconnected with other critical infrastructure systems which amplify the consequences of their failure (Yang et al., 2022). As cities continue to grow and densify, particularly in hazard-prone regions, addressing these vulnerabilities by assessing the content and structure of current policies at various governance levels becomes essential for sustainable urban development and public safety.

This paper aims to answer the following questions:

1. Which governance strategies and interventions are most effective for enhancing disaster resilience in urban transport systems?
2. How are disaster preparedness and resilience integrated into Istanbul's transport policy and legislative frameworks by examining the distribution of efforts across different policy levels and key thematic areas?

The primary objectives of this research are to systematically map and analyze the extent to which Istanbul's transport policies address disaster preparedness and resilience, including a detailed thematic breakdown of policy provisions at national and local scales. This study also seeks to identify critical gaps and areas for improvement in existing policies based on this internal analysis while proposing strategic recommendations for

enhancing Istanbul's transport resilience through integrated planning and policy adjustments. Ultimately, this research contributes to the broader discourse on resilient urban systems by emphasizing the role of transport infrastructure in disaster risk reduction and by providing a detailed examination of a major city's policy landscape by offering insights for policymakers aiming to enhance urban resilience. Interpretations regarding international perspectives are also discussed in the conclusion to contextualize the findings. The following section will focus on establishing a theoretical foundation by exploring key concepts, metrics, and international frameworks for transport system resilience within policy frameworks.

Understanding Transport System Resilience: Key Theories and Metrics

Transport resilience theory provides a conceptual basis for understanding how urban transport systems can withstand and recover from disruptions caused by natural disasters, climate events, and human-induced crises. Resilience, in this context, refers to the capacity of a system to resist, absorb, adapt to, and recover from external shocks while continuing to provide essential services (Bešinović, 2020). The resilience of this underlying transport system is a critical determinant of broader mobility resilience, which concerns the ability of individuals and goods to maintain necessary movement and access during and after such events.

The concept has evolved from ecological and systems theory, with Holling (1973) introducing resilience as a system's ability to absorb disturbances without shifting to a different functional state. Bruneau et al. (2003) expanded this understanding in infrastructure systems by defining the "4R" framework of robustness, redundancy, resourcefulness, and rapidity as key attributes of resilience in critical infrastructure.

Robustness refers to a transport system's ability to endure disruptions without significant performance degradation while redundancy involves the availability of alternative routes and transport modes to ensure service continuity during disruptions. Resourcefulness captures the capacity to mobilize resources and implement strategies for crisis response, and rapidity highlights the system's ability to restore normal operations quickly following disruptions (Bruneau et al., 2003; Bešinović, 2020). These dimensions together define the structural and operational stability of transport networks under stress, which directly impacts the continuity of mobility for the urban population.

Resilience indicators are essential tools for measuring and evaluating how effectively a transport system manages disruptions and, consequently, supports sustained mobility. These indicators can be categorized across three critical phases of disruption management: pre-event, during-event, and post-event capacities. Pre-event indicators assess proactive measures like risk assessments, disaster mitigation strategies, and infrastructure design for hazard resistance (Yang et al., 2022). During-event indicators evaluate absorptive capacity, focusing on network capacity, travel delays, and the availability of alternative routes while a disruption occurs (Murray-Tuite, 2006; Leobons et al., 2019). Post-event indicators measure recovery effectiveness by examining how quickly and efficiently normal operations are restored and whether long-term disruptions to overall mobility are minimized (Yang et al., 2022).

Transport resilience also operates across multiple dimensions that reflect the diverse aspects of urban mobility systems. Physical resilience pertains to the structural integrity and durability of infrastructure against hazards like floods and earthquakes. Operational resilience deals with maintaining service functionality and minimizing disruptions during crises. Social resilience ensures equitable access to mobility and protection for vulnerable populations, while economic resilience focuses on minimizing financial losses and ensuring recovery funding. Governance and policy resilience, though explored separately in the next section of the literature review, plays a crucial role in supporting effective resilience planning and implementation that ultimately enhances mobility for all users (Yang et al., 2022; Mattsson and Jenelius, 2015).

The theoretical principles of transport resilience, including the "4R" framework, resilience indicators, and multi-dimensional analysis, will form the foundation for the content analysis of Istanbul's transport policy documents in this study. This theoretical basis will assist in developing coding categories for assessing how well disaster preparedness and strategies for achieving mobility resilience are integrated into the city's transport policies and will contribute to identifying existing gaps and areas for improvement.

International Policy Frameworks for Transport Resilience: Implications for Istanbul, Türkiye

In response to growing challenges posed by climate change, rapid urbanization, and increasing natural and man-made disasters, various international frameworks have been developed to guide cities in enhancing the resilience of their transport systems. These frameworks emphasize proactive risk reduction, sustainability, and equitable urban mobility, recognizing that resilient transport systems are essential for maintaining the functionality of urban areas during and after disruptive events. This section reviews key international frameworks and strategies that serve as foundational references for operationalizing transport resilience strategies in urban mobility planning.

The Sendai Framework for Disaster Risk Reduction (2015-2030) is a global standard emphasizing proactive disaster risk management. It outlines four key priorities for action: understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction, and enhancing disaster preparedness for effective response and recovery. Within transport resilience, the framework calls for the integration of risk reduction principles into infrastructure planning and the reinforcement of critical infrastructure such as transportation networks to withstand extreme events. The Sendai Framework stresses the importance of multi-level governance and coordination among policymakers, planners, and emergency responders (UNDRR, 2015).

Complementing the Sendai Framework, the European Green Deal (2019) provides a comprehensive policy roadmap aimed at achieving climate neutrality by 2050. A core component is the reduction of transport-related emissions by 90% while promoting sustainable and resilient mobility systems. The Green Deal underscores the dual need for both climate change mitigation—through emission reductions—and adaptation, ensuring urban infrastructure, including transport systems, can withstand climate impacts such as floods and heatwaves. It also emphasizes multimodal and low-emission transport networks, urging the adoption of clean energy technologies and digitalization to support sustainable urban mobility (European Commission, 2019).

Building on these climate resilience goals, the EU Urban Agenda and its associated Transport Resilience Guidelines further operationalize resilience by providing detailed frameworks for city-level transport planning. The Urban Agenda fosters cooperation among member states, cities, and stakeholders to improve the quality of life in urban areas through integrated planning processes. The guidelines encourage cities to adopt Sustainable Urban Mobility Plans (SUMP) that integrate disaster risk reduction measures into their transport strategies. They emphasize risk-informed decision-making, stakeholder engagement, and the need for cities to align transport resilience efforts with broader sustainability goals, such as those outlined in the Sustainable Development Goals (European Commission, 2021).

A significant contribution to the resilience planning discourse is the 100 Resilient Cities Initiative (100RC), which introduced seven key principles for urban resilience: reflectiveness, robustness, redundancy, flexibility, resourcefulness, inclusiveness, and integration. Applied to urban mobility, these principles guide the development of systems that can withstand and recover from shocks while maintaining essential services. Cities like Rotterdam and Singapore have implemented these principles by investing in modular infrastructure, data-driven flood management systems, and flexible public transit networks that can adapt during crises (100 Resilient Cities, 2015).

The CIVITAS Initiative and its publication Planning for More Resilient and Robust Urban Mobility offers further strategic guidance by integrating resilience principles into Sustainable Urban Mobility Planning (SUMP) processes. The guide emphasizes the importance of preparedness, risk assessment, and policy coherence across multiple governance levels. It also promotes measures such as multimodal networks, improved public transport integration, and the use of climate-resilient materials in infrastructure development (POLIS & Rupprecht Consult, 2021).

Finally, the Sustainable and Smart Mobility Strategy by the European Commission presents a forward-looking roadmap for the transport sector, aligning with the European Green Deal's goals. It emphasizes digital transformation, climate adaptation, and crisis preparedness. Key strategies include promoting multimodal transport hubs, expanding low-emission zones, and incorporating climate risk assessment tools into infrastructure planning processes. The strategy highlights the need for both long-term systemic transformation and short-term adaptive measures in urban mobility planning (European Commission, 2021).

While these global frameworks provide a cohesive set of principles and strategies for operationalizing transport resilience and emphasize integrated governance, proactive risk management, sustainability, and equitable mobility access, their application must be contextualized for local challenges. The Turkish context, in particular, underscores the importance of aligning these international principles with local disaster risk profiles. Türkiye faces unique vulnerabilities due to rapid urbanization, geographical exposure to seismic activity, and an ageing infrastructure system. Istanbul, as one of Türkiye's most densely populated urban centers, is highly exposed to disasters such as earthquakes and flash floods. Its location along the North Anatolian Fault, combined with increasing extreme weather events, creates complex challenges for its urban transport systems. Historical disasters such as the 1999 Marmara earthquake and recurrent flooding events have revealed systemic vulnerabilities in Istanbul's transport infrastructure, emphasizing the urgent need for a more resilient and adaptive mobility strategy (POLIS & Rupprecht Consult, 2021).

In recent years, Istanbul has initiated critical efforts to improve transport resilience, including seismic retrofitting of key infrastructures and the adoption of GIS-based disaster monitoring tools. However, significant gaps may still exist when considering comprehensive approaches to resilience, such as fully integrating principles like inclusiveness, ensuring vulnerable populations are prioritized in emergency transport planning, and flexibility, which involves creating alternative routes and modes of transport to maintain mobility under extreme conditions. The principles established in the international frameworks discussed above provide valuable insights that can help contextualize and inform the assessment of Istanbul's transport policies.

This review of theoretical background and international policy frameworks sets the stage for a detailed examination of Istanbul's own policy landscape. The insights gleaned from these global perspectives, combined with the theoretical understanding of resilience, will help frame the subsequent content analysis of Istanbul's transport policy documents. The next section will delve into Istanbul's current policy framework while the methodology will outline how its legislative frameworks will be analyzed to identify policy gaps and areas for strategic improvement in disaster risk reduction and resilient urban mobility planning based on its inherent characteristics and stated goals.

Istanbul's Current Policy Framework for Resilient Mobility: Opportunities, Gaps, and Limitations

Istanbul's urban mobility systems are critical not only for ensuring the city's daily operations but also for maintaining public safety and economic stability during and after crises. As a megacity located on the North Anatolian Fault and exposed to significant climate-related risks such as flooding and landslides, Istanbul faces unique challenges that make disaster resilience an essential focus. Rapid urbanization, aging infrastructure, and high population density further compound these risks, which places immense pressure on its transportation networks. These vulnerabilities highlight the importance of developing an integrated mobility resilience framework, as the ability to ensure the continuity of transport networks during disruptions is fundamental to safeguarding lives and enabling recovery efforts.

The policy framework governing Istanbul's mobility resilience is shaped by a combination of national and local strategies. At the national level, directives such as the National Earthquake Strategy and Action Plan (NESAP) and the Türkiye Disaster Risk Reduction Plan (TDRRP) provide overarching guidelines for disaster preparedness and risk reduction. These documents emphasize critical measures such as retrofitting transport infrastructure by establishing emergency logistics hubs, and integrating disaster response protocols into urban planning (IMM, 2024). Locally, the Istanbul Metropolitan Municipality (IMM) plays a pivotal role in implementing these strategies through initiatives like the Istanbul Provincial Disaster Risk Reduction Plan (IPDRRP) and the Istanbul Climate Change Action Plan (CCAP). IMM's Disaster Coordination Centre (AKOM) has key efforts to retrofit key transport structures, develop emergency evacuation routes, and deploy Geographic Information Systems (GIS) for real-time disaster monitoring (AKOM, 2024).

Despite these initiatives, Istanbul's mobility resilience framework faces significant gaps and limitations. Coordination between national and local entities, though formalized, is often fragmented. Overlapping responsibilities between institutions like IMM, the Disaster and Emergency Management Presidency (AFAD),

and district municipalities have led to delays in the implementation of resilience measures (IMM, 2024). Informal settlements, which house a large portion of Istanbul's vulnerable populations, remain inadequately integrated into disaster planning.

These settlements are frequently located in flood-prone or seismically vulnerable areas and lack access to critical infrastructure and emergency resources, leaving residents disproportionately exposed to risks (IPDRRP, 2024).

Technological advancements have introduced opportunities to enhance Istanbul's disaster preparedness. For example, the adoption of GIS and Intelligent Transport Systems (ITS) has improved real-time monitoring and enabled better emergency traffic management. However, the lack of centralized data-sharing platforms limits the integration of these tools across institutions, which impedes effective decision-making (IMM, 2024). While Early Warning Systems for earthquakes and floods are under development, their implementation remains inconsistent, with significant room for improvement. Additionally, partnerships with international organizations, such as the World Bank and the European Bank for Reconstruction and Development (EBRD), have supported projects like the Istanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) initiative, which has funded retrofitting and resilience measures for key public and transport infrastructure. Yet, these efforts have not been sufficient to address long-term funding needs, particularly for underserved areas (ISMEP, 2024).

The challenges faced by Istanbul's mobility resilience framework are symbolic of the broader issues encountered by rapidly urbanizing cities with high disaster risk profiles. In the context of this paper, In the context of this study, Istanbul serves as an essential example of how disaster preparedness and resilience can be integrated into mobility systems. Its experiences demonstrate that while technological advancements and international partnerships can support progress, sustainable resilience requires a cohesive policy framework that bridges gaps between national and local strategies. By analyzing Istanbul's mobility resilience framework, this research contributes to broader efforts to improve disaster preparedness in urban contexts, offering policymakers actionable recommendations for creating more adaptive and inclusive cities.

Methodology

This study employs a qualitative content analysis approach to analyze Istanbul's transport policy landscape by focusing on how disaster preparedness and mobility resilience are addressed across different policy levels and thematic areas. The aim is to map the presence and distribution of key resilience-related themes within selected national and local policy documents, ultimately visualizing these relationships to understand current policy emphases and potential gaps.

The dataset for this research comprises a comprehensive collection of 35 policy documents including 14 national-level (coded N1-N14) and 21 local-level (coded L1-L21) texts, selected for their direct relevance to disaster resilience, mobility preparedness, urban planning, and transport strategies pertinent to Istanbul. The initial identification of this collection of documents was based on two key deliverables of the Istanbul SUMP Stage II project: the Inception Report and the Analysis of Current Planning Practices. These documents, sourced from official government portals and institutional repositories, span a wide temporal range and cover both strategic frameworks and operational plans to ensure a comprehensive overview of governance approaches (Table 1). As acknowledged within the source project, this foundational list may be further enriched during related pilot initiatives such as the one focused on Istanbul's earthquake and flood risks (Pilot Project 5.5.1), which the first author is involved in.

Table 1. The list of selected policy documents

Document Code	Document Title	Year
N1	The Twelfth Development Plan	2024-2028
N2	Annual Presidential Programme 2025	2025
N3	Transport and Logistics Master Plan 2053	2053
N4	National Earthquake Strategy and Action Plan (NESAP)	2012 – 2023
N5	Türkiye Disaster Risk Reduction Plan (TDRRP)	2022 – 2030
N6	National Transportation Master Plan 2035	2017
N7	Türkiye Disaster Response Plan (TDRP)	2012 – 2023
N8	Road Traffic Safety Strategy Document and Action Plan	2021-2030
N9	National Intelligent Transportation Systems Strategy Document and Action Plan	2020-2023
N10	Accessible Transportation Strategy and Action Plan	2021-2025
N11	Türkiye Bicycle Route Network Master Plan	2021
N12	National Climate Change Action Plan	2010-2023
N13	Green Deal Action Plan of Türkiye	2021
N14	Integrated Urban Development Strategy and Action Plan (KENTGES)	2010-2023
L1	Istanbul Metropolitan Municipality Strategic Plan	2020-2024
L2	Istanbul Vision 2050 Strategy	2023-2050
L3	Istanbul SUMP I	2050
L4	Istanbul Provincial Disaster Risk Reduction Plan (IPDRRP)	2022
L5	Istanbul Provincial Disaster Logistic Plan	2013
L6	Istanbul Debris Management Plan Report	2021
L7	Fleet Management Emergency Action Plan	2018
L8	Istanbul Transportation Master Plan	2011
L9	Istanbul Public Transportation Master Plan	2019
L10	Marmara Region Spatial Development Strategic Framework	2030
L11	Istanbul Traffic Safety Master Plan	2016
L12	Istanbul Urban Transformation Strategy and Action Plan	2015-2025
L13	Istanbul Provincial Disaster Response Plan (IPDRP)	2019
L14	Istanbul Logistics Master Plan	2018
L15	Istanbul Local Level Disaster Evacuation and Relocation Planning Group Operational Plan	2024
L16	Istanbul Pedestrian Transportation Master Plan	2011
L17	Istanbul Bicycle Master Plan	2020
L18	Istanbul Parking Master Plan	2022
L19	Traffic Demand Management Plan for Historic Old City	2014
L20	Istanbul Climate Change Action Plan	2021 (2030-2050)
L21	Istanbul Green City Action Plan (GCAP) (Draft)	2025-2030

MAXQDA software was utilized primarily for efficient document management, facilitating navigation through the extensive dataset, searching for specific keywords and concepts related to resilience, and annotating relevant sections within the policy texts to support the thematic analysis. The core analytical process was developed through a two-stage process. First, a hybrid inductive-deductive thematic analysis was conducted, which results in featured main themes and granular sub-themes. To move beyond thematic identification to a critical evaluation, a five-point ordinal scale was then developed to serve as a benchmark for assessing policy gaps.

This scale utilizes a graduated color scheme to visually represent the strength of policy articulation for each main theme. The color intensity progresses across the five-point scale, where the lightest indicates no relevant or only an indirect strategy, and the darkest signifies the highest level of policy actionability and strength with an identifiable strategy supported by a defined performance indicator. The findings from this thematic mapping and visualization are then interpreted to identify patterns, current priorities, and potential areas for strengthening Istanbul's overall approach to resilient mobility.

Findings and Results

The policy landscape governing Istanbul's urban mobility resilience is a complex interplay of national directives and local implementation. The flow of policy focus, which provides a comprehensive visualization of the relationships between the two policy levels, 8 main themes identified in this study, and 30 granular sub-themes are mapped out with an alluvial diagram (Figure 1). The width of each flow is proportional to the intensity of policy attention, which allows for a visual assessment of strategic priorities, areas of convergence, and critical gaps.

The diagram immediately reveals a clear division of labor between the national and local policy levels. The national level predominantly focuses on establishing high-level frameworks and standards. A significant portion of its policy output streams into the themes of "National Strategic Frameworks & Standards" and "Disaster Specific Operations & Local Resilience". This flow further breaks down into granular sub-themes such as "NatDisasterFrameworks" (e.g., TDRP, TDRRP), "LongTermTransportVision" (e.g., Vision 2053), and setting national "TransportSafetyStandards" and "EvacRouteDesignStds". This pattern underscores the national role in setting the overarching strategic direction and legal foundation for disaster management and transport planning across the country.

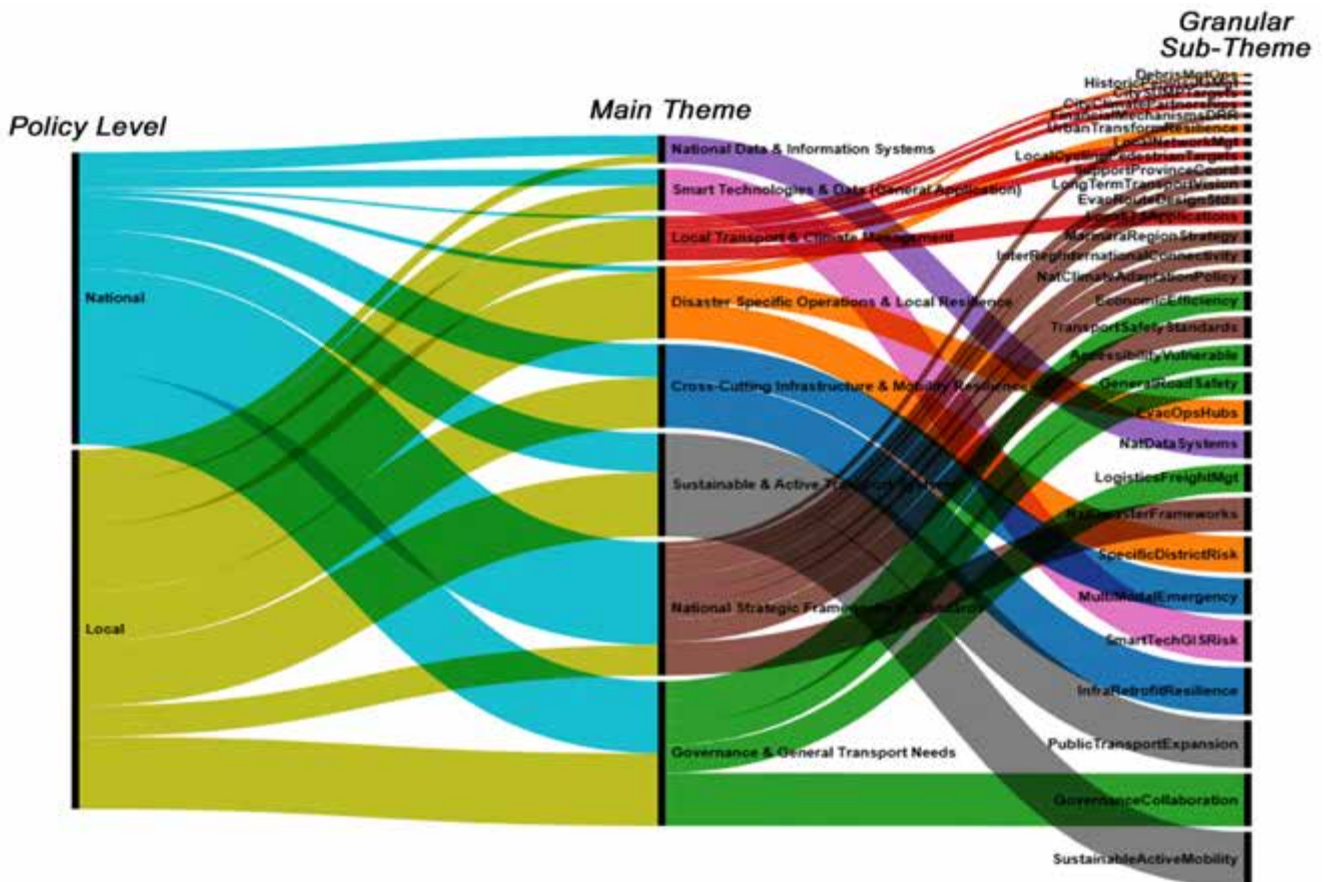


Figure 1. Alluvial diagram of main themes and granular sub-themes of national and local level policy documents (created by authors)

Conversely, the local policy level is overwhelmingly focused on governance, service delivery, and on-the-ground implementation specific to Istanbul. The two largest streams originating from the local level are directed toward “Governance & General Transport Needs” and “Sustainable & Active Transport Systems”. These flows are linked to highly operational sub-themes like “PublicTransportExpansion,” “GovernanceCollaboration,” and “SustainableActiveMobility,” which reflects the municipality’s direct responsibility for managing and expanding public transport by engaging with stakeholders, and promoting green mobility. Furthermore, the local level’s focus on place-based solutions is evident in sub-themes such as “CitySUMPTargets” and “LocalCyclingPedestrianTargets,” which are fed exclusively by the local policy stream.

While there is a clear divergence in primary roles, the diagram also highlights crucial areas of convergence. The ‘Disaster Specific Operations & Local Resilience’ theme is a key area of shared responsibility, receiving significant policy attention from both national and local levels. This combined flow addresses a wide array of sub-themes, including “MultiModalEmergency” operations, identifying “SpecificDistrictRisk,” and establishing “EvacOpsHubs,” indicating a necessary collaboration in crisis management. Similarly, “Cross-Cutting Infrastructure & Mobility Resilience” is another area of mutual focus, channeling policy effort into the critical sub-theme of “InfraRetrofitResilience” for key transport assets.

Most importantly, the diagram provides a stark visualization of the strategic gaps identified in this research. A critical disconnect is visible between disaster planning and sustainability. There are no significant flows connecting the main theme of “Disaster Specific Operations” with sustainability-oriented sub-themes like “LocalCyclingPedestrianTargets.” Likewise, the massive policy stream dedicated to “Sustainable & Active Transport Systems” does not meaningfully connect with disaster-related sub-themes, visually confirming that these two powerful policy agendas operate in parallel rather than in an integrated manner. This lack of integration represents a significant vulnerability in the overall resilience framework for Istanbul’s transport system.

Investigating the source of this vulnerability requires a deeper analysis of the documents themselves, beginning at the national level. The analysis of 14 national policy documents reveals a foundational, yet incomplete, legal and strategic framework for strengthening the resilience of Istanbul’s transport systems. The findings show a clear national trend toward data-driven governance and a dual focus on disaster resilience and sustainability. However, critical inconsistencies and gaps exist, which have direct consequences for a megacity like Istanbul (Figure 2).

A primary finding is the national shift towards measurable, evidence-based policymaking, which provides an essential foundation for Istanbul’s resilience efforts. Recent cornerstone documents like the Twelfth Development Plan (N1) and the Annual Presidential Programme (N2) mandate the creation of national data systems such as the Infrastructure Information System (see Article 605.6) and the Disaster Management and Decision Support System (DMDS). These national systems provide the essential data landscape upon which Istanbul’s municipal agencies must build their own resilience monitoring and decision-making tools. However, a significant gap is noted in TDRP (N7), which lacks a clear data analytics component by creating a potential challenge for Istanbul’s integrated emergency management.

The national policy landscape is strongly shaped by two parallel strategic pillars: disaster resilience and sustainable mobility. The resilience pillar offers direct legal pathways for action in Istanbul. N1 includes a specific mandate to increase the resilience of critical infrastructure in the Marmara Region (see Article 838.1), directly targeting Istanbul. This is reinforced by the TDRRP (N5), which calls for making urban infrastructure earthquake resistant (see Action D.6.3), a core task for the city. Similarly, the sustainability pillar with its national goals for reduced emissions (Green Deal Action Plan, N13) and a 6000 kilometre expansion of bicycle routes (Bicycle Route Network Master Plan, N11), provides the strategic backing for Istanbul to advance its own green transport initiatives.

Despite the individual strength of these two areas, a critical inconsistency emerges where they fail to connect, a gap that creates a direct vulnerability for Istanbul. The analysis shows that national disaster response frameworks, particularly the TDRP (N7) and the NESAP (N4), do not integrate sustainable transport modes into their operational plans. This national-level oversight is highly problematic for a densely populated megacity like Istanbul, where alternative transport modes like bicycles could be vital for maintaining mobility and delivering aid when primary road networks are compromised during a disaster.

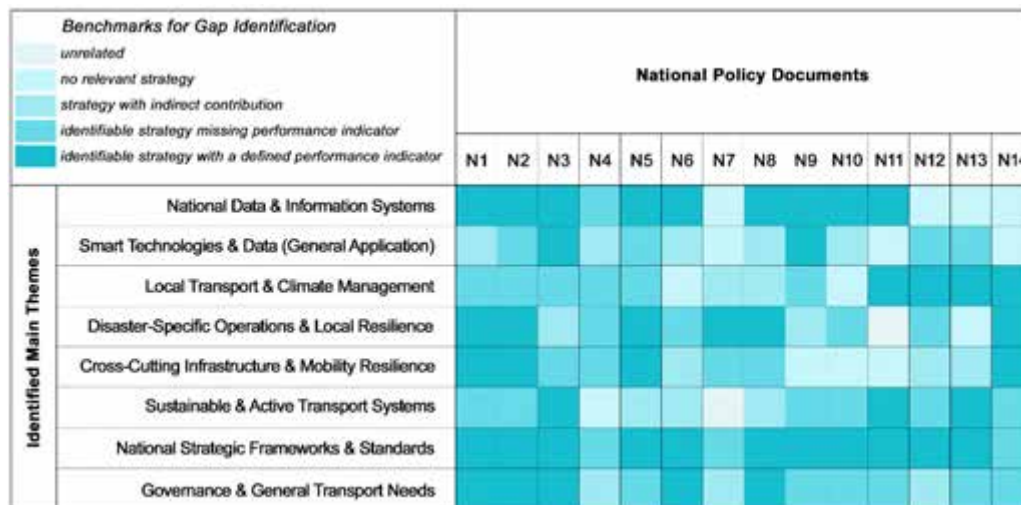


Figure 2. Assessment matrix for gap identification across national policy documents (created by authors)

The findings also highlight that while a clear policy evolution is underway, from older, non-metricized strategies like the NESAP to newer, key performance indicator-driven plans like the Twelfth Development Plan, the effectiveness of this national framework in protecting Istanbul hinges entirely on its translation into coherent local policy. National documents provide the top-down mandate, but their success depends on the creation of legally-binding, adequately funded, and technically sound municipal plans and actions. This points to the need for a deeper analysis of Istanbul's local documents to determine if these national strategies are being effectively implemented or if significant gaps in local legislation are undermining the city's transport resilience.

On the other hand, the analysis of 21 local policy and planning documents for Istanbul reveals a dynamic, ambitious, and highly operational policy environment. At this municipal level, strategic objectives are translated into actionable plans, which provide concrete legal pathways for enhancing urban mobility resilience. However, the analysis also uncovers significant inconsistencies, particularly in the integration of parallel policy streams, which creates vulnerabilities in the city's overall resilience framework. A defining characteristic of this local policy landscape is its robust and detailed approach to disaster operations (Figure 3).

The theme of 'Disaster-Specific Operations & Local Resilience' is exceptionally strong in the key operational plans. For instance, the IPDRRP (L4) moves beyond strategy to define measurable key performance indicators such as reduction in travel time during evacuation scenarios. This is further operationalized by the Istanbul Local Level Disaster Evacuation Operational Plan (L15), which provides granular detail on 204 transferring areas and additional 46 potential areas registered in DMDS for use during emergencies. Plans like the Istanbul Provincial Disaster Logistic Plan (L5), the Debris Management Plan (L6), and the Fleet Management Emergency Action Plan (L7) provide a comprehensive, multi-faceted framework for response and recovery, which indicates that Istanbul's legal and administrative capacity for managing a crisis is well-established and highly structured.

In parallel, the local documents demonstrate a powerful and measurable commitment to sustainable and active transport. This is a clear policy priority for the Istanbul Metropolitan Municipality (IMM). The IMM Strategic Plan (L1) sets ambitious, quantifiable targets such as increasing the total cycling infrastructure length from 266 km to 1,050 km and raising the share of rail transport in public transit from 20.6% to 30%. This vision is reinforced by dedicated documents like the Istanbul SUMP I (L3), the Istanbul Cycling Master Plan (L8), and the Pedestrian Master Plan (L9), all of which have identifiable strategies with a defined performance indicators for their core sustainability objectives.

However, a critical policy gap emerges where these two priorities should intersect. The city's strong sustainability agenda operates largely in isolation from its disaster resilience framework. While documents like the Bicycle Master Plan (L17) and Pedestrian Master Plan (L16) excel in promoting active transport, their summaries contain little to no mention of how these networks could be leveraged during an emergency. For disaster-related

themes, these plans either offer only an indirect contribution or have no relevant strategy at all, which creates a significant inconsistency. This failure to integrate the two pillars means that the legal and operational potential of Istanbul's growing active transport network as a resilient mobility option during a crisis remains unrealized.

Beyond these core themes, Istanbul's local governance is data-rich. Many key documents including L1, L4, and IPDRP (L13) demonstrate exceptional strategic maturity by defining clear, measurable performance indicators for their focus on creating and integrating data systems such as performance monitoring platforms and GIS-based risk maps. However, the application of this data through smart technologies is less mature. While many plans mention leveraging technology, they often lack specific, measurable outcomes. For example, the Vision 2050 Strategy (L2) and L5 refer to integrating smart technologies and advanced analytics systems, but do not define how the success of these implementations will be measured. This suggests a gap between the city's capacity for data collection and its ability to systematically deploy that data for smart, resilient operations.

Furthermore, the analysis reveals a mixed approach to vertical policy coherence. The city's disaster-specific plans (L4, L13, L15) show strong alignment with national frameworks by explicitly referencing documents like the TDRP. This formal, documented alignment provides a clear and measurable legal pathway for coordinated national-local disaster response. In contrast, most other local strategic documents including L1, L3, and various master plans, do not explicitly reference their alignment with corresponding national strategies. They operate in parallel with national goals rather than being formally nested within them, which results in what this study classifies as an indirect contribution. This suggests a potential gap in legal and administrative coherence, where ambitious local initiatives may not be fully harmonized with the broader national strategic direction, potentially leading to inconsistencies in long-term implementation. In summary, Istanbul's local policy landscape provides strong legal pathways for operational disaster response and sustainable transport. However, the findings pinpoint a critical need for policy reform to bridge the gap between sustainability and resilience planning. Integrating these two domains and ensuring greater vertical coherence between local and national frameworks are essential next steps to strengthen the resilience of Istanbul's transport systems against future disruptions.

		Local Policy Documents																				
		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20	L21
Identified Main Themes	National Data & Information Systems																					
	Smart Technologies & Data (General Application)																					
	Local Transport & Climate Management																					
	Disaster-Specific Operations & Local Resilience																					
	Cross-Cutting Infrastructure & Mobility Resilience																					
	Sustainable & Active Transport Systems																					
	National Strategic Frameworks & Standards																					
	Governance & General Transport Needs																					

Figure 3. Assessment matrix for gap identification across local policy documents (created by authors)

Conclusion

This study embarked on a thematic content analysis to evaluate the legal and strategic pathways for urban mobility resilience within the complex policy landscape governing Istanbul. By examining 35 national and local documents, the research aimed to map the coherence of resilience-related strategies, identify critical policy gaps, and pinpoint areas. The analysis confirms that while Istanbul possesses a sophisticated and highly operational policy environment for both disaster management and sustainable transport, significant vulnerabilities arise from the lack of integration between these two powerful, yet parallel, policy agendas.

The findings reveal a clear division of responsibility: national policies provide the foundational legal frameworks while local policies focus on operationalization. National documents such as the NESAP and the TDRRP establish

a strong mandate for resilience by emphasizing the retrofitting of critical transport infrastructure. At the local level, this translates into exceptionally robust and detailed operational plans such as the IPDRRP, which defines measurable key performance indicators like reduction in travel time during evacuation scenarios, and the Debris Management Plan, which outlines post-disaster logistics. Simultaneously, both policy levels demonstrate a powerful commitment to sustainable mobility. National documents like the Green Deal Action Plan and the Bicycle Route Network Master Plan set ambitious targets for emissions reduction and a 6,000-kilometre expansion of cycling routes. This is mirrored locally by the IMM Strategic Plan, which aims to increase cycling infrastructure from 266 km to 1,050 km, and by a suite of dedicated master plans for active transport. However, the most critical finding is the systemic failure to connect these two agendas. National disaster frameworks, particularly the TDRP, do not integrate sustainable transport modes into operational plans and assign municipalities limited direct responsibility. This national-level oversight is replicated locally, where active transport plans for cycling and pedestrians show little to no consideration for their potential role during emergencies.

These findings hold significant implications when contextualized within the international frameworks and theoretical principles of resilience. The strong multi-level governance structure for disaster planning in Istanbul aligns well with the priorities of the Sendai Framework for Disaster Risk Reduction, which emphasizes coordinated action across administrative levels. The city's detailed operational plans also reflect key attributes of the "4R" framework, particularly in building robustness through infrastructure retrofitting and ensuring resourcefulness through pre-planned crisis management. However, the lack of integration of active transport highlights a critical weakness in achieving redundancy and flexibility. Furthermore, while Istanbul's ambitious sustainability goals are consistent with the European Green Deal and SUMP principles, the analysis reveals that the city has not yet fully realized the integrated approach these frameworks advocate, where disaster risk reduction is a core component of sustainable mobility planning, not a separate activity.

To bridge these identified gaps and strengthen the legal pathways for resilience, this study proposes several key policy recommendations. This requires amending national frameworks like the TDRP to explicitly include roles for non-motorized transport in emergency response and mandating that local active transport plans incorporate disaster preparedness scenarios. Second, vertical policy coherence must be strengthened. While local disaster plans show strong alignment with national directives, other strategic documents like the IMM Strategic Plan operate in parallel, formalizing the alignment of all local strategies with national goals is essential. Finally, to bridge the gap between data collection and action, investment is needed in integrated smart city platforms that can utilize real-time data for both daily traffic management and dynamic crisis response.

While this study provides a comprehensive analysis of the policy landscape, it is limited to the content of the documents themselves and does not assess their on-the-ground implementation. Future research should therefore focus on evaluating the effectiveness of these policies through case studies and assessing the allocation of financial and human resources. Further studies could also explore the perceptions and preparedness of vulnerable communities to determine if these top-down strategies are effectively reaching those most at risk.

In brief, this research demonstrates that building urban mobility resilience in a megacity like Istanbul is not merely a technical or infrastructural challenge, but a profound issue of policy integration and governance. Closing the documented gaps between disaster planning and sustainable mobility is essential for creating a transport system that can not only withstand future shocks but also continue to serve the needs of all its citizens by providing system continuity and public safety against increasing threats.

Acknowledgement

This study was prepared and developed by the first author as part of the Urban Systems course, conducted by the second author, within the City and Regional Planning PhD program at the Istanbul Technical University Graduate School.

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