SCIENTIFIC OASIS

Journal of Intelligent Decision Making and Granular Computing

Journal homepage: www. jidmag.org
ISSN: 3042-3759

JIDMGC
Journal of Intelligent Decision Making and Granular Computing
Scientific Oasis
SCIO

When There Is No "Best" Solution: Decision-Making Conundrums in Istanbul's Urban Mobility

Fatih Canitez[1,*]

[1] Transport Strategy Centre, Department of Civil and Environmental Engineering, Imperial College London, UK

ARTICLE INFO

Article history:
Received 11 June 2026
Received in revised form 30 July 2026
Accepted 7 September 2026
Available online 11 September 2026

Keywords:
Urban Mobility; Decision-making; Transport Policy; Policy Trade-offs; Decision-making Under Uncertainty; Sustainable Mobility; Istanbul; Urban Transport Planning

ABSTRACT

Urban mobility policymaking is often framed as a search for optimal solutions to problems such as traffic congestion, inadequate public transport capacity, and unsustainable travel patterns. In practice, however, policymakers rarely operate in decision environments where a single solution can simultaneously satisfy all relevant objectives. Instead, urban mobility decisions involve competing priorities, uncertain outcomes, institutional constraints, and conflicting interests among different groups of transport users. This paper examines these challenges through the case of Istanbul, a megacity characterised by rapidly changing travel demand, extensive public transport networks, persistent congestion, and strong dependence on road-based mobility. Rather than evaluating a particular intervention numerically, the paper identifies and analyses a set of key policy dilemmas confronting urban mobility policymakers in Istanbul. These include the allocation of scarce road space between private and public transport, congestion relief versus sustainable mobility, large-scale infrastructure investment versus incremental interventions, system efficiency versus social equity, evidence-based policy versus political and institutional feasibility, and short-term improvements versus long-term transformation. The paper argues that these dilemmas should not be understood simply as failures to identify a technically optimal solution. Rather, they represent inherent characteristics of complex urban mobility decision-making, in which policy alternatives generate different combinations of benefits, costs, risks, and distributional consequences. Drawing on the Istanbul case, the paper develops a conceptual framework for understanding urban mobility policymaking as a process of making informed choices among imperfect alternatives under competing objectives and uncertainty. The framework highlights the importance of explicitly recognising trade-offs and decision contexts when designing and evaluating urban mobility policies.

1. Introduction

Urban mobility is increasingly recognised as a complex policy domain in which transport, environmental, economic and social objectives intersect. Cities are expected simultaneously to provide efficient movement, reduce congestion, improve accessibility, support public transport, limit environmental impacts, enhance road safety and promote social equity. These objectives are not necessarily mutually reinforcing. Measures designed to improve one dimension of urban mobility can

* *Corresponding author.*
E-mail address: fatihcanitez40@gmail.com

https://doi.org/10.31181/jidmgc21202652

generate adverse consequences in another, while their impacts may be distributed differently across places, population groups and transport modes. Consequently, urban mobility policymaking is rarely a matter of identifying and implementing a universally optimal intervention. It is more often a process of choosing among alternative courses of action whose advantages and disadvantages depend on the objectives, constraints and circumstances of the decision context [1–3].

This characteristic distinguishes urban mobility policy from relatively well-structured technical problems. In a conventional optimisation problem, the objective function and constraints can generally be specified before a solution is sought. Urban transport policy decisions are considerably less straightforward. The objectives themselves may be multiple and contested; different stakeholders may assign different values to the same outcomes; some consequences may be difficult to quantify; and the effects of interventions may depend on behavioural responses and wider changes in the urban system. Rittel and Webber [1] famously characterised many social and planning problems as "wicked" problems, arguing that they cannot necessarily be formulated in terms of objectively correct solutions. This perspective is particularly relevant to urban mobility because transport decisions affect not only movement within the transport system but also land use, economic activity, environmental conditions and social welfare.

The evolution of transport planning has further expanded the range of objectives that policymakers are expected to consider. Traditional transport planning placed considerable emphasis on mobility, travel-time savings and the efficient movement of vehicles. The emergence of the sustainable mobility paradigm broadened this agenda towards accessibility, environmental sustainability, liveability and reductions in automobile dependence [2]. Banister [2] argued that sustainable mobility requires a shift away from an exclusive focus on increasing mobility and speed towards a more integrated consideration of accessibility, modal choice, land-use patterns and environmental objectives. The result is a policy environment in which more objectives must be considered simultaneously, without necessarily providing an unambiguous basis for determining how those objectives should be prioritised.

Social equity illustrates this difficulty particularly clearly. Transport policies generate benefits and costs that are distributed unevenly across population groups, neighbourhoods and transport users. A policy that maximises aggregate efficiency may not necessarily improve accessibility for those with the greatest mobility needs, while an intervention designed to address distributional inequalities may involve costs in terms of overall efficiency or financial resources [3, 4]. Consequently, incorporating equity into transport decision-making is not simply a matter of adding another indicator to an evaluation framework. It requires policymakers to make judgements about whose needs should receive priority and how competing claims on limited transport resources should be reconciled [3, 4].

Uncertainty adds another fundamental dimension to these choices. Urban transport systems are dynamic socio-technical systems in which future travel demand, land-use patterns, economic conditions, technological developments, public preferences and behavioural responses cannot be predicted with complete confidence. Even where extensive data and sophisticated analytical models are available, the effects of a policy intervention may remain uncertain. Transport decision-makers may therefore face not only measurable risks but also uncertainty concerning the assumptions, scenarios and behavioural responses underlying their analyses [5, 6]. Cartenì *et al.,* [5], for example, demonstrate the importance of different uncertainty levels in transportation planning and emphasise the role of cognitive and participatory dimensions in decision-making. More broadly, Kwakkel *et al.,* [6] highlight the importance of explicitly identifying, classifying and communicating uncertainty in model-based policy analysis.

These characteristics mean that urban mobility policymaking cannot be reduced to a conventional optimisation exercise. Multicriteria decision-making approaches can help structure situations in which several objectives must be considered simultaneously, while transport models and appraisal techniques can provide evidence about the potential consequences of alternative policies. However, analytical methods cannot independently determine the relative importance of objectives that ultimately involve political, social or value-based judgements. Cascetta*et al.,* [7] consequently argue for a decision-making perspective that combines quantitative methods with stakeholder engagement and an understanding of the cognitive and institutional dimensions of transport planning. The distinction is important: analysis can inform decision-makers about what may happen under different alternatives, but it cannot by itself determine which consequences society should accept, which groups should receive priority, or what degree of uncertainty is tolerable.

Implementation introduces a further challenge. A policy that appears desirable when evaluated analytically may not be straightforward to implement. Transport policies depend on institutional responsibilities, financial resources, coordination between organisations, political support, stakeholder behaviour and the ability of implementing agencies to translate strategic objectives into operational measures. Research on local transport policy implementation has shown that barriers can arise from limited resources, unclear objectives, inadequate communication and coordination, as well as wider political and institutional conditions [8, 9]. More recent work has similarly emphasised the importance of context, collaboration, community engagement, funding and institutional capacity in implementing sustainable transport interventions [10]. Thus, the question facing a policymaker is not only whether an intervention is likely to generate desirable outcomes, but also whether those outcomes can realistically be achieved within the institutional and political environment in which the decision must be implemented.

The difficulty is particularly evident in major transport infrastructure decisions. Large infrastructure projects often involve substantial financial commitments, long implementation periods and considerable uncertainty concerning future demand and benefits. Research on megaprojects has documented systematic problems associated with cost overruns, benefit shortfalls and overly optimistic forecasts [11]. Such findings do not imply that major infrastructure investments are inherently undesirable. Rather, they demonstrate that decisions concerning large and irreversible investments must account for uncertainty, incentives and institutional processes in addition to conventional estimates of costs and benefits. The same principle applies to smaller interventions: their lower financial cost does not necessarily make their outcomes certain, politically feasible or universally desirable.

These challenges are particularly pronounced in large metropolitan areas, where the scale and diversity of mobility demand create numerous and sometimes contradictory policy pressures. Istanbul provides a compelling case in this respect. The city has a highly extensive and heterogeneous urban structure, substantial travel demand, persistent congestion pressures and a multimodal transport system comprising metro and other rail systems, buses, maritime transport and road-based travel. At the same time, Istanbul has experienced major investment in both public transport and road infrastructure while facing continuing pressures associated with motorisation, urban development and the need to improve sustainable mobility. Previous research has identified institutional fragmentation, competing policy priorities, financial constraints and the tension between infrastructure development and sustainable mobility as important dimensions of Istanbul's transport challenge [12].

The Istanbul case therefore provides an opportunity to examine urban mobility policymaking from a perspective that differs from the conventional evaluation of individual projects or interventions. Consider, for example, the decision to introduce a dedicated bus lane on a congested arterial road. Such an intervention may improve bus speeds, reliability and the attractiveness of public transport, while reducing road space available to general traffic and potentially increasing delays for some motorists. Similarly, a new road may increase capacity and improve accessibility to particular locations, while potentially generating additional traffic or reinforcing automobile dependence. A major rail investment may deliver substantial long-term benefits but require considerable financial resources and a lengthy implementation period, whereas a package of smaller interventions may generate more immediate but potentially less transformative benefits. These choices cannot be adequately understood through a single measure of transport performance because each involves a different combination of efficiency, sustainability, equity, political acceptability, cost, risk and time horizon.

The central issue, therefore, is not simply that Istanbul has numerous mobility problems. Rather, Istanbul's mobility problems create a series of difficult policy decisions in which improving one dimension of the transport system may require accepting deterioration, uncertainty or sacrifice in another. This raises a broader question about how urban mobility policymakers should conceptualise and navigate such decisions. Existing research provides extensive methods for forecasting, evaluating and prioritising transport interventions, but considerably less attention is often given to the underlying structure of the choices that policymakers face. In particular, the individual trade-offs between mobility, sustainability, equity, political feasibility, investment scale and time horizon are frequently examined separately rather than understood as interconnected dimensions of a common decision environment.

This paper therefore adopts a decision-making perspective to examine the major policy conundrums facing urban mobility decision-makers in Istanbul. Rather than attempting to identify or rank specific transport interventions through a numerical model, the paper asks a more fundamental question: what makes important urban mobility decisions difficult, and how can these difficulties be understood systematically? Six interrelated decision-making conundrums are examined: (i) road capacity versus public transport priority; (ii) congestion relief versus sustainable mobility; (iii) large-scale infrastructure investment versus incremental interventions; (iv) system efficiency versus social equity; (v) analytical evidence versus political and institutional feasibility; and (vi) short-term improvements versus long-term transformation.

The paper's contribution is consequently not to propose a new numerical optimisation or multicriteria model. Instead, it develops a conceptual perspective for understanding how policymakers navigate competing objectives, uncertain consequences and implementation constraints when making urban mobility decisions. By bringing together several recurring policy dilemmas within a common decision-making framework, the paper complements the extensive literature on transport modelling, project appraisal and multicriteria evaluation with greater attention to the context in which decisions are actually made. Istanbul provides a substantive case through which these issues can be illustrated, while the underlying argument is intended to be relevant to other large metropolitan transport systems facing similarly complex policy choices.

The remainder of the paper is organised as follows. Section 2 establishes the conceptual foundation by examining urban mobility as a complex decision-making problem, focusing on wicked problems, multiple and competing objectives, uncertainty, stakeholder interests and the limits of analytical rationality. Section 3 introduces the Istanbul case and describes the principal characteristics of its urban mobility system that make it a particularly relevant setting for examining policy decision-making. Section 4 analyses the six key decision-making conundrums. Section 5 synthesises these conundrums into a conceptual framework for urban mobility decision-making, showing how objectives, uncertainty, stakeholders, institutional constraints and time horizons interact in shaping policy choices. Section 6 discusses the implications of the framework for intelligent and evidence-informed urban mobility policymaking and considers how decision-making approaches can better acknowledge unavoidable trade-offs rather than obscure them behind apparently objective optimisation. Finally, Section 7 presents the conclusions, discusses the contribution and limitations of the study, and identifies directions for future research.

2. Urban Mobility as a Complex Decision-Making Problem

Urban mobility challenges become decision problems when policymakers must choose between multiple possible courses of action whose consequences are uncertain, multidimensional or unequally distributed. The central issue is therefore not simply whether a particular intervention is effective, but whether it is preferable to alternative interventions given the objectives, constraints and values of the decision maker. This distinction is particularly important in urban transport, where decisions simultaneously affect mobility, accessibility, economic activity, environmental performance, public finances and the distribution of benefits and costs across different groups and locations. Transport problems are consequently not merely technical problems requiring the identification of an appropriate engineering solution; they are also problems of choice, judgement and prioritisation [1, 7].

The complexity of these decisions is closely related to the nature of urban planning problems. Rittel and Webber [1] famously characterised many planning problems as “wicked problems”, in which there is no definitive formulation of the problem, no objectively correct solution and no straightforward way of determining whether a solution is ultimately successful. Urban mobility exhibits many of these characteristics. Congestion, for example, may be interpreted as a problem of insufficient road capacity, inefficient land use, inadequate public transport, excessive car dependence or inappropriate travel behaviour. Each interpretation can lead to different policy responses. The formulation of the problem therefore already involves a degree of judgement about what should be prioritised and what constitutes an acceptable outcome.

This is particularly evident in the growing emphasis on sustainable mobility. The sustainable mobility paradigm broadens the objectives of transport planning beyond the conventional concern with vehicle movement and network efficiency to include accessibility, environmental sustainability, liveability, safety and social inclusion [2]. While these objectives are individually desirable, they cannot always be maximised simultaneously. A policy that improves traffic flow may increase car dependency or consume roadspace that could otherwise be allocated to buses or cycling. Conversely, a policy that reallocates roadspace to sustainable modes may improve accessibility and environmental outcomes while increasing delays for some car users. The resulting problem is not necessarily one in which additional analysis will reveal a single superior solution. Rather, different alternatives may perform better against different objectives.

This observation has important implications for the use of decision-making and optimisation methods in transport planning. Multi-criteria and multi-objective approaches can help decision-makers structure competing objectives and make trade-offs more transparent [7]. However, the existence of multiple criteria does not eliminate the underlying normative question of how those criteria should be valued or prioritised. There is therefore no meaningful concept of the “best” allocation of transport resources without first specifying what the decision is intended to achieve and whose interests are being prioritised. A technically sophisticated model can compare alternatives according to a defined set of criteria, but it cannot by itself determine whether efficiency should take precedence over equity, environmental performance over short-term economic benefits, or the interests of current users over those of future generations.

Trade-offs also have an important distributional dimension. Urban transport policies rarely affect all users in the same way. The benefits of a new road, rail line or bus-priority scheme may be concentrated in particular areas or among particular groups, while the associated costs may be distributed more widely. A policy that improves overall system efficiency may impose higher costs on particular communities, income groups or road users. Conversely, an intervention targeted at disadvantaged groups may improve social equity without maximising aggregate efficiency. Transport equity therefore requires attention not only to the total benefits generated by an intervention but also to who receives those benefits, who bears the costs and how accessibility is distributed [3, 4]. These questions introduce explicit or implicit value judgements that cannot be resolved through technical optimisation alone.

Uncertainty adds another layer of complexity. Transport decisions frequently involve long time horizons, while the conditions under which infrastructure and policies operate can change substantially. Future travel demand, population distribution, land-use patterns, economic conditions, technological development, energy prices and travel behaviour are all uncertain. In addition, uncertainty may arise from the models used to represent transport systems and from incomplete knowledge about how individuals and institutions will respond to interventions [5, 6]. Some uncertainties can be represented probabilistically, whereas others are characterised by "deep uncertainty", where decision-makers cannot confidently assign probabilities to future states or may disagree about the appropriate representation of the system itself [13–15].

Under such conditions, decision-making should not necessarily be based on identifying a single most likely future and optimising policy around it. Instead, policies may need to be assessed according to their robustness across a range of plausible futures. Adaptive approaches seek to address this challenge by linking present decisions with monitoring, learning and the possibility of future adjustment [13–15]. Dynamic adaptive policy pathways, for example, provide a framework for identifying alternative sequences of actions and specifying conditions under which a change in policy direction may become necessary [15]. This perspective is particularly relevant to urban mobility, where major infrastructure and policy decisions can create long-lasting commitments while the underlying transport system continues to evolve.

The complexity of decision-making is also shaped by the limitations of the decision-makers themselves. Policymakers operate under constraints of time, information, analytical capacity, institutional responsibility and financial resources. They therefore cannot evaluate every possible alternative or anticipate every consequence of a decision. Cascetta*et al.,* [7] describe transport planning in terms of cognitive rationality, recognising that decision-makers may act rationally within the limits of their information, perceptions and institutional context without possessing the information required to identify a globally optimal solution. Different stakeholders may also understand the same transport problem differently because they experience its consequences differently and assign different importance to competing objectives.

Consequently, transport decisions are rarely made by a single actor operating independently. They typically involve political authorities, transport operators, planning agencies, infrastructure providers, businesses, residents and other stakeholder groups, each of whom may have different interests, responsibilities and degrees of influence. Stakeholder engagement can improve the understanding and legitimacy of decisions, but it can also reveal conflicts that cannot be resolved simply through additional technical analysis [7]. Institutional arrangements are equally important. Responsibilities for transport, land use, infrastructure and public space may be distributed across different organisations, creating coordination problems and competing priorities.

Moreover, an analytically attractive policy is not necessarily an implementable policy. The implementation of local transport policy can be constrained by institutional fragmentation, limited resources, lack of coordination, political opposition, weak policy support and difficulties in translating strategic objectives into operational practice [8, 9]. Recent research on implementation of active and sustainable transport interventions similarly emphasises the importance of institutional context, community engagement, participation, partnerships, collaboration and funding [10]. These factors mean that the feasibility of an intervention must be considered alongside its expected technical performance. A theoretically optimal solution that cannot obtain sufficient political or institutional support may be less useful than a somewhat less ambitious alternative that can actually be implemented and sustained.

Time adds a further dimension to these choices. Urban mobility policies often produce effects over very different timescales. A measure designed to address an immediate congestion problem may conflict with a long-term objective of reducing car dependence. Conversely, a transformative policy may produce substantial long-term benefits while imposing significant adjustment costs or delivering limited short-term improvements. Policymakers must therefore decide not only what outcomes they value, but also how they balance present and future objectives. This creates a tension between interventions that are politically and practically attractive in the short term and those that may contribute more substantially to long-term system transformation [2, 13–15].

Taken together, these characteristics suggest that intelligent decision-making in urban mobility should not be understood simply as the search for an optimal solution. An intelligent decision process should perform at least four functions. First, it should make the objectives of the decision explicit, including whose interests and which dimensions of performance are being prioritised. Second, it should make important trade-offs visible rather than concealing them behind a single aggregate measure of performance. Third, it should recognise uncertainty and consider how alternative decisions perform under different plausible future conditions. Fourth, it should incorporate the institutional, political and practical context within which the decision must be implemented. These principles do not eliminate difficult choices, but they can make those choices more transparent, structured and defensible.

From this perspective, a good decision does not necessarily correspond to the alternative that produces the highest predicted performance under a single set of assumptions. It may instead be the alternative that performs acceptably across a range of plausible futures, distributes benefits and costs in a defensible manner, is sufficiently feasible to implement and can be adapted as circumstances change. This shifts the focus of decision-making from optimisation alone towards robustness, transparency, legitimacy and adaptability.

In this paper, such situations are referred to as decision-making conundrums. A decision-making conundrum arises when alternative courses of action cannot be unambiguously ranked without making explicit choices about objectives, affected groups, uncertainty, institutional constraints or time horizons. The existence of a conundrum does not necessarily indicate that policymakers lack information or that analytical methods have failed. Rather, it reflects the inherent complexity of decisions in which several legitimate objectives and perspectives coexist and cannot all be maximised simultaneously.

This conceptualisation provides the basis for examining Istanbul's urban mobility challenges. Istanbul represents a particularly rich context for this purpose because its rapid urban development, high travel demand, extensive public transport network, major infrastructure investments and persistent congestion have generated numerous situations in which policymakers must choose between competing objectives and imperfect alternatives [12]. The following sections examine six major decision-making conundrums that emerge from this context: road capacity versus public transport priority; congestion relief versus sustainable mobility; large-scale infrastructure investment versus incremental interventions; system efficiency versus social equity; analytical evidence versus political and institutional feasibility; and short-term improvements versus long-term transformation.

3. Istanbul’s Urban Mobility Context

Istanbul provides a particularly relevant setting for examining complex urban mobility decision-making. With a population of 15.75 million in 2025, the city is one of the largest metropolitan areas in Europe and a major economic, cultural and transport centre connecting Europe and Asia [16]. Its geographical structure, rapid urban development and concentration of economic activity create a mobility system in which very large travel flows must be accommodated across a geographically constrained metropolitan area. The Bosphorus divides the city into two continents, while major employment, residential and commercial centres are distributed across both sides and increasingly towards the metropolitan periphery. These characteristics make the provision of efficient and accessible mobility a fundamental component of Istanbul's urban functioning.

The scale and complexity of Istanbul's transport system are reflected in the coexistence of several major modes and infrastructure networks. The city has an extensive bus system, the Metrobus bus rapid transit system, suburban rail, metro, tram, ferry and other modes of public transport, alongside a large and continuously expanding road network. Rail investment has expanded particularly rapidly in recent years. Metro Istanbul currently operates 18 rail lines with a combined length of 245.75 km and reports more than three million passenger journeys per day; the wider urban rail system in Istanbul extends to approximately 402.6 km [17]. IETT, meanwhile, reported operating 6,786 buses, including private public buses, across 851 routes and carrying approximately five million passenger journeys per day in 2024 [18]. Istanbul therefore cannot be characterised simply as a car-oriented city lacking public transport infrastructure. Rather, it is a city with a substantial and increasingly sophisticated public transport system that nevertheless continues to experience severe road congestion and competing demands for scarce urban space.

One of the defining characteristics of Istanbul's mobility context is the simultaneous pressure for additional transport capacity and a transition towards more sustainable forms of mobility. Rapid metropolitan development has generated continuing demand for travel, while motorisation and automobile use have contributed to persistent congestion. Recent traffic data illustrate the scale of the problem. According to the 2025 TomTom Traffic Index, Istanbul had an average congestion level of 62%, with a 10-km journey taking an average of 22 minutes and 54 seconds. During evening rush hour, the average time for a 10-km journey increased to 32 minutes and 37 seconds, and drivers lost an estimated 112 hours to rush-hour traffic over the year [19]. These figures should not be interpreted as a complete measure of the city's transport performance, since congestion indicators depend on methodology and observed road travel. Nevertheless, they illustrate the continuing significance of road congestion as a policy concern.

At the same time, Istanbul has made substantial investments in public transport. The expansion of metro lines, the development of the Metrobus system, the integration of rail and ferry services and the continued improvement of bus services have increased the capacity and geographical reach of sustainable modes. Major projects such as Marmaray have also strengthened cross-Bosphorus rail connectivity. The coexistence of these developments with continuing investment in highways and major road infrastructure is important for understanding Istanbul's policy environment. Earlier research on the city's sustainable mobility policies found that different infrastructure projects could support different and sometimes conflicting mobility objectives: while Marmaray contributed to a shift towards rail for Bosphorus crossings, projects such as the Eurasia Tunnel and Yavuz Sultan Selim Bridge were associated with increased road capacity and automobile accessibility [12]. The issue is therefore not simply whether Istanbul should invest in transport infrastructure, but what type of capacity should be prioritised, where it should be provided and what longer-term mobility behaviour it is expected to encourage.

The spatial structure of Istanbul further intensifies these choices. The metropolitan area has expanded considerably beyond the traditional historic and central districts, producing long-distance commuting patterns and a dispersed distribution of housing, employment and services. This creates substantial demand for radial and cross-city travel while also increasing the importance of interchange between modes. The city's geography makes some transport connections particularly strategic: the Bosphorus crossings, major east–west corridors and links between peripheral residential areas and employment centres can carry very large passenger and traffic flows. As a result, an intervention in one part of the network can have consequences beyond its immediate geographical location. A road expansion may alter traffic flows on parallel routes; a new rail connection may change passenger demand on buses; and the reallocation of roadspace to public transport may affect both bus performance and general traffic conditions.

Istanbul's mobility challenges are therefore closely connected to the interaction between land use, transport infrastructure and travel demand. Earlier research has highlighted the importance of this interaction in explaining the city's difficulty in achieving a sustainable mobility transition [12]. The problem is not simply that infrastructure capacity is insufficient. New capacity can influence travel behaviour, land-use development and the attractiveness of different modes, potentially generating additional demand. Similarly, expanding public transport can improve accessibility and reduce dependence on private cars, but its effectiveness depends on network coverage, service quality, interchange conditions, affordability and the spatial distribution of activities. Transport investment consequently has effects that extend beyond the immediate performance of the infrastructure itself.

Institutional conditions add another layer to this context. Istanbul's transport system involves multiple organisations with different responsibilities for infrastructure, operations, planning and regulation. The Istanbul Metropolitan Municipality and its subsidiaries play major roles in urban public transport and local infrastructure, while central government institutions have significant responsibilities for national transport infrastructure and major investment projects. The resulting institutional landscape means that transport policy is not determined by a single decision-maker pursuing a single objective. Different organisations may have different priorities, investment cycles and strategic perspectives. Previous research has identified fragmented governance, conflicting policy priorities and financing constraints as important challenges for implementing sustainable mobility policies in Istanbul [12]. These institutional characteristics are directly relevant to the decision-making perspective adopted in this paper because they influence not only what alternatives can be considered but also which alternatives are politically and institutionally feasible.

The city's experience with major infrastructure investment provides a further illustration of this complexity. Istanbul has pursued large-scale transport projects intended to improve connectivity, increase capacity and support economic development. Such projects can generate substantial benefits by reducing travel times, improving accessibility and connecting previously disconnected parts of the metropolitan area. However, their impacts cannot be evaluated solely in terms of the immediate transport benefits they produce. Large infrastructure investments also involve considerable financial commitments, long implementation periods and potentially irreversible changes to land use and travel behaviour. They may therefore compete with smaller-scale interventions that could deliver more immediate improvements to existing networks. The choice between these approaches is consequently a decision about not only infrastructure performance but also risk, opportunity cost, timing and the desired trajectory of the urban transport system.

The same complexity is evident in the allocation of scarce urban roadspace. Istanbul's major corridors must accommodate private cars, buses, Metrobus, freight, taxis, pedestrians and, increasingly, cycling and other forms of micromobility. Giving greater priority to one use can necessarily reduce the space or capacity available to another. Public transport priority can increase the efficiency of high-capacity modes and improve the movement of large numbers of passengers, but may be perceived as reducing capacity for general traffic. Conversely, maintaining or expanding general traffic capacity may improve conditions for motorists in the short term but can conflict with objectives related to modal shift, emissions and sustainable mobility [2, 12]. Roadspace allocation is consequently not merely an engineering question about how much capacity is available; it is a policy choice concerning which forms of mobility should receive priority.

These characteristics make Istanbul particularly suitable for analysing urban mobility as a decision-making problem rather than simply as a collection of transport performance indicators. The city faces persistent and interconnected challenges involving congestion, accessibility, public transport capacity, automobile dependence, environmental sustainability, infrastructure investment and social equity. At the same time, different policy alternatives can produce different combinations of benefits and costs, and their outcomes depend on uncertain future conditions and institutional circumstances. Istanbul therefore provides an appropriate empirical setting in which to examine situations where policymakers cannot simultaneously maximise every desirable objective.

Importantly, the purpose of using Istanbul in this paper is not to claim that the city's mobility challenges are unique. Many rapidly growing metropolitan areas face similar tensions between road capacity, public transport investment, sustainability, equity and political feasibility. Istanbul is instead used as an illustrative case through which these broader decision-making challenges can be made concrete. Its scale, geographical complexity, substantial public transport system, continuing congestion and history of both large-scale and incremental transport interventions make the underlying trade-offs particularly visible.

The Istanbul context can therefore be understood as a system in which structural pressures generate recurring choices over capacity, priority, investment, distribution and timing. These choices rarely have consequences that are entirely positive or negative. Instead, an intervention may improve one dimension of urban mobility while creating costs, risks or constraints in another. The central question is consequently not simply which intervention works, but which objectives should be prioritised, for whom, over what time horizon and under what assumptions about the future. The next section examines six decision-making conundrums that arise from these conditions and considers why none can be resolved through technical optimisation alone.

4. Key Decision-Making Conundrums in Istanbul

The urban mobility context described above creates a series of recurring choices for Istanbul's policymakers. These choices cannot be reduced to straightforward questions of whether a particular project or intervention is technically effective. Rather, they involve competing objectives, uncertain consequences, distributional effects, institutional constraints and different expectations about the future of the city. Six interrelated decision-making conundrums are particularly important: road capacity versus public transport priority; congestion relief versus sustainable mobility; large-scale infrastructure investment versus incremental interventions; system efficiency versus social equity; analytical evidence versus political and institutional feasibility; and short-term improvements versus long-term transformation. These should not be interpreted as six independent problems. They overlap and reinforce one another, meaning that a decision intended to resolve one conundrum may intensify another.

One of the most persistent choices concerns the allocation of scarce roadspace between general traffic and public transport. Istanbul has a very large demand for road travel, while buses remain an essential component of the city's public transport system. The conventional response to recurring congestion is to increase road capacity, either by widening existing corridors, constructing new roads or developing major infrastructure connections. However, roadspace allocated to general traffic is space that cannot simultaneously be allocated to buses, cycling or other higher-occupancy modes. The alternative is to prioritise public transport, for example through dedicated bus lanes, bus-priority measures or the expansion of Metrobus-type systems. Istanbul's current transport planning policy explicitly recognises public transport priority as a means of improving mobility and sustainability [20]. More recently, the Istanbul Sustainable Urban Mobility Plan (SUMP) has included specific work on identifying and prioritising bus-priority corridors, with technical analyses and stakeholder discussions being used to assess potential routes [21, 22]. These developments demonstrate that the question is not merely whether bus lanes are technically feasible, but which corridors should receive priority and what consequences this choice will have for other road users.

The underlying conundrum is therefore not simply “cars versus buses”. A road corridor performs several functions simultaneously, and different users value those functions differently. A general traffic lane may carry fewer people per hour than a high-capacity bus lane, yet its removal can generate additional delay for remaining car users and potentially affect freight, taxis and other essential trips. Conversely, a bus-priority intervention can improve the reliability and attractiveness of public transport and move substantially more people within the same physical space. The decision depends on the objective against which the corridor is evaluated. If the objective is to maximise vehicle throughput, one solution may appear preferable; if the objective is to maximise passenger throughput, accessibility or the efficiency of scarce urban roadspace, another may be superior. This is precisely the type of situation in which an apparently technical infrastructure decision becomes a question of competing policy objectives.

A closely related but broader conundrum concerns congestion relief versus sustainable mobility. Congestion is highly visible and politically salient, making reductions in travel time an intuitive policy objective. Yet policies designed primarily to increase road capacity can have effects that extend beyond their immediate congestion benefits. Previous research on Istanbul has shown how major infrastructure projects have supported different and sometimes conflicting mobility objectives: Marmaray has strengthened rail connectivity and encouraged sustainable travel across the Bosphorus, while projects such as the Eurasia Tunnel and Yavuz Sultan Selim Bridge have increased road capacity and facilitated automobile travel [12]. This illustrates the difficulty of pursuing congestion reduction and sustainable mobility simultaneously when the instruments used to achieve one objective can work against the other.

The conundrum is particularly difficult because congestion itself is not necessarily an adequate measure of urban mobility performance. A city could reduce congestion while increasing automobile dependence, total vehicle kilometres, emissions or spatial inequality. Conversely, a policy that deliberately reduces road capacity or makes car travel less attractive could initially increase congestion for some users while improving public transport performance, reducing car dependence or encouraging a shift towards more sustainable modes. The sustainable mobility paradigm therefore challenges the assumption that faster car travel is always an indicator of better transport performance [2]. Istanbul's current SUMP objectives explicitly combine congestion reduction with reducing automobile dependency and increasing public transport and active-mode shares, illustrating that the policy challenge involves several objectives simultaneously rather than congestion alone [20].

This leads to a fundamental decision-making question: should congestion be treated primarily as a symptom to be eliminated or as one consequence of a wider urban mobility system whose overall performance must be improved? The answer has major implications for investment. If congestion is regarded as the principal problem, additional road capacity may appear attractive. If the objective is to provide accessible, sustainable and efficient mobility, resources may instead be directed towards public transport, demand management, walking, cycling, integrated land-use planning or a combination of interventions. Neither perspective is entirely irrational. The conundrum arises because each reflects a different interpretation of what the transport system is ultimately expected to achieve.

A third conundrum concerns the choice between large-scale infrastructure investment and incremental interventions. Istanbul has extensive experience of major transport megaprojects, including rail investments, bridges, tunnels and large road schemes. Such projects can transform connectivity and create substantial new capacity. They can also have strategic importance extending beyond transport, influencing land development, economic activity and the spatial structure of the metropolitan area. However, major infrastructure requires substantial financial resources, long planning and construction periods and commitments that may be difficult to reverse. Its benefits may also depend on assumptions about future population, travel demand, land use and technological development that are inherently uncertain [11, 13–15].

Incremental interventions present a contrasting approach. Improvements to existing bus services, bus-priority measures, junction optimisation, interchange improvements, pedestrian facilities, traffic management and targeted roadspace reallocation may require less investment and can often be implemented more rapidly. They may also allow policymakers to test an intervention, monitor its effects and modify it before committing to a larger-scale programme. This characteristic is particularly valuable under uncertainty and is consistent with the logic of adaptive policymaking [13–15]. Yet incremental interventions can also be criticised for addressing symptoms rather than structural problems. A collection of relatively small improvements may not provide the capacity or network transformation required by a rapidly growing metropolitan area.

The choice is therefore not simply between “big projects” and “small projects”. It concerns different approaches to managing uncertainty, risk and opportunity. Large-scale projects can create transformative benefits but may lock the city into a particular development trajectory. Incremental measures can provide flexibility and learning but may lack the scale required to change that trajectory. The decision depends partly on expectations about the future and partly on the degree to which policymakers value flexibility relative to transformative potential. Istanbul's recent transport planning process illustrates that this choice remains active: the SUMP implementation process has explicitly addressed the prioritisation of transport investments using multi-criteria and cost-benefit approaches, alongside stakeholder evaluation of project feasibility and impacts [22, 23]. The analytical challenge is therefore not simply to identify projects with the highest predicted benefits, but to determine an appropriate portfolio and sequencing of interventions under uncertainty.

A fourth conundrum concerns system efficiency versus social equity. Transport systems are frequently evaluated using aggregate indicators such as travel time, operating cost, passenger numbers, capacity utilisation or economic benefits. These measures are important, but they do not reveal how benefits and costs are distributed across the population. An intervention can improve aggregate efficiency while disproportionately benefiting already well-connected areas or higher-income users. Conversely, a policy targeted at disadvantaged communities may generate substantial social benefits even if its aggregate transport efficiency is relatively modest [3, 4].

This issue is especially important in a metropolitan area as spatially and socio-economically diverse as Istanbul. Long-distance commuting, differences in accessibility between central and peripheral areas, variations in public transport availability and differences in the ability of households to afford private mobility mean that transport policies can have markedly different effects on different groups. Transport justice therefore requires decision-makers to consider not only how much mobility is generated but also who gains access to employment, education, healthcare and other opportunities as a result of a policy [4]. The Istanbul SUMP reflects this broader conception of transport performance by including objectives relating to affordability, inclusion and accessibility alongside efficiency and environmental objectives [20].

The conundrum arises because equity and efficiency do not always point towards the same intervention. A transport investment may generate the greatest aggregate time savings by serving a high-demand corridor that is already relatively well connected, while a less heavily used peripheral corridor may have greater significance for improving accessibility among disadvantaged communities. Similarly, maintaining very low public transport fares can improve affordability but place additional financial pressure on operators and public budgets. A purely efficiency-oriented decision framework may undervalue these distributional considerations, while a purely equity-oriented framework could overlook the need for a financially and operationally sustainable system. The decision-maker must therefore determine how different forms of benefit should be valued and how competing claims should be balanced.

A fifth conundrum concerns the relationship between analytical evidence and political and institutional feasibility. Modern transport planning provides increasingly sophisticated tools for forecasting demand, evaluating alternatives and assessing costs and benefits. These tools can improve the quality and transparency of decisions, but analytical evidence does not operate independently of institutions and political processes. A technically attractive alternative may encounter opposition from affected users, require coordination between organisations, exceed available funding or conflict with existing policy commitments. Conversely, a politically feasible intervention may not be the alternative that performs best according to conventional analytical criteria.

This distinction is particularly relevant in Istanbul because transport responsibilities and investments involve multiple institutional actors. The city's transport system is shaped by the Istanbul Metropolitan Municipality and its affiliated operators, central government institutions, infrastructure agencies and other public and private stakeholders. Previous research has identified fragmented governance, conflicting policy priorities and financing constraints as significant barriers to achieving sustainable urban mobility in Istanbul [12]. More recent planning processes have sought to address this institutional complexity through participatory workshops and stakeholder engagement. For example, the Istanbul SUMP has involved stakeholders in evaluating transport investment priorities, while bus-priority planning has incorporated technical analysis alongside feedback from local stakeholders [21–23].

The decision-making implication is that evidence should not be understood as a substitute for political judgement. Analytical methods can estimate likely consequences, reveal trade-offs and identify robust alternatives, but they cannot determine whether a particular distribution of costs and benefits is politically acceptable. Nor can they guarantee implementation. Research on transport policy implementation has demonstrated that institutional capacity, coordination, resources, political support and stakeholder relationships can substantially influence whether policies are translated from formal plans into practice [8–10]. Consequently, the most analytically attractive option may not be the most effective policy if its implementation is unlikely to succeed.

The sixth conundrum concerns the tension between short-term improvements and long-term transformation. Urban mobility systems evolve over decades, while political decision-making often operates over much shorter periods. Policymakers are consequently under pressure to demonstrate visible improvements in congestion, journey times and service quality, even when the underlying problems require long-term structural change. Measures that produce immediate benefits may therefore be attractive even when they do little to alter the underlying trajectory of the transport system. Conversely, policies designed to produce long-term transformation may require substantial investment, behavioural change and institutional commitment before their benefits become visible.

This tension is closely related to uncertainty. The further into the future a policy is expected to operate, the greater the uncertainty surrounding demand, technology, land use, demographics and travel behaviour [13–15]. A large infrastructure project designed around today's assumptions may become less appropriate if those assumptions change substantially. At the same time, postponing investment in anticipation of uncertainty can itself create risks, particularly when existing infrastructure is approaching capacity or when transport deficiencies constrain economic and social development. Decision-makers therefore face a difficult balance between acting now and preserving flexibility for the future.

The logic of adaptive policymaking provides one possible response to this dilemma. Rather than attempting to determine a complete and irreversible transport strategy for an uncertain future, policymakers can identify short-term actions that contribute towards long-term objectives while establishing indicators or thresholds that signal when a change of direction may be necessary [13–15]. This approach does not eliminate the need for long-term planning. Instead, it recognises that long-term strategies may need to contain multiple pathways and opportunities for adjustment. For Istanbul, this perspective is particularly relevant because the city's 2040 mobility planning process explicitly considers alternative scenarios and evaluates them in terms of feasibility, long-term impacts, sustainability, infrastructure, accessibility and economic transformation [24].

The six conundrums are closely interconnected. A decision to increase road capacity can affect the sustainability of the transport system, influence the distribution of benefits between car users and public transport users, require substantial capital investment and shape the city's long-term development trajectory. A decision to introduce a dedicated bus lane can improve public transport efficiency and accessibility but create short-term opposition from motorists and businesses affected by reduced general traffic capacity. A major metro investment can increase accessibility and reduce dependence on private cars but may compete for financial resources with a portfolio of smaller interventions that could produce more immediate benefits. Similarly, prioritising a peripheral area on equity grounds may produce lower aggregate passenger benefits than investing in a high-demand central corridor.

These interactions demonstrate why Istanbul's mobility challenges should not be approached as a collection of isolated optimisation problems. The decision-maker is often choosing among packages of interventions whose consequences extend across several objectives and time horizons. The relevant question is therefore not simply which alternative has the highest score, but how the alternative changes the balance among competing objectives, how robust its benefits are under uncertainty, who gains and who bears the costs, and whether the intervention can be implemented and adapted over time.

The central implication is that there may be no single “best” solution to many of Istanbul's most important mobility decisions. Different alternatives can be preferable under different objectives, assumptions and stakeholder perspectives. This does not imply that all decisions are arbitrary or that analytical methods have little value. On the contrary, evidence and decision-support methods are essential for revealing consequences, structuring alternatives and making trade-offs explicit. However, their role is to inform judgement rather than eliminate it. The six conundrums identified here therefore represent recurring situations in which intelligent decision-making requires policymakers to move beyond the search for a technically optimal intervention and explicitly confront the values, uncertainties, distributional effects and institutional conditions embedded in the choice.

5. A Conceptual Framework for Urban Mobility Decision-Making

The six conundrums identified in the previous section suggest that urban mobility decision-making cannot be adequately represented as a simple process of identifying a problem, comparing alternatives and selecting the option with the highest overall performance. Rather, decisions emerge from the interaction of objectives, alternatives, stakeholders, uncertainties, institutional conditions and time horizons. This section brings these dimensions together into a conceptual framework for understanding how policymakers can make more informed and defensible choices when no alternative is clearly superior. The framework is not intended to replace established analytical methods such as cost-benefit analysis, multi-criteria decision-making or transport modelling. Instead, it provides a broader structure within which such methods can be used and interpreted.

The first element of the framework is the definition of the decision problem. A mobility problem should not be defined solely in terms of the most visible symptom. For example, traffic congestion may be framed as insufficient road capacity, inadequate public transport, inefficient traffic management, excessive automobile use or an imbalance between the location of jobs and housing. Each framing implies a different set of possible interventions and therefore a different decision problem. Similarly, declining bus speeds can be treated as an operational problem for the bus system or as a consequence of the allocation of scarce roadspace between buses, private vehicles, pedestrians and other users. The definition of the problem therefore represents an important decision in itself. As transport planning is characterised by multiple interacting objectives and stakeholders, the framing of the problem can substantially influence which alternatives subsequently appear attractive [5, 7].

The second element is the explicit identification of objectives and affected interests. Conventional transport appraisal frequently relies on a relatively small number of aggregate indicators, such as travel time, vehicle operating costs, investment costs or changes in demand. These indicators remain important, but they cannot by themselves determine whether an intervention is desirable. Urban mobility decisions can simultaneously affect accessibility, congestion, environmental performance, public transport quality, road safety, affordability, spatial development and social equity. Moreover, improvements for one group may impose costs on another. Making these objectives explicit is therefore essential to reveal the value judgements embedded in the decision. Approaches to transport justice and equity have similarly emphasised the importance of considering who benefits from and who bears the costs of transport interventions rather than relying exclusively on aggregate system performance [3, 4, 25, 26].

The third element is the generation and characterisation of alternatives. The choice should not necessarily be restricted to a comparison between two conventional alternatives, such as building a new road or doing nothing. Urban mobility problems can often be addressed through combinations of infrastructure investment, public transport priority, demand management, pricing, land-use measures, operational improvements and changes in roadspace allocation. Importantly, alternatives should also be characterised according to their reversibility, implementation requirements, expected life, potential for lock-in and ability to be modified in the future. A large infrastructure project and a bus-priority intervention may both contribute to improving mobility, but they represent fundamentally different types of decisions in terms of financial commitment, spatial consequences, implementation time and flexibility. The decision framework should therefore recognise that alternatives are not simply competing projects but potentially different strategic pathways.

The fourth element is multi-dimensional evaluation under uncertainty. Once alternatives have been identified, their consequences should be examined across the range of objectives established in the previous stages. This does not imply that all dimensions must be converted into a single numerical score. Indeed, attempting to reduce fundamentally different effects to a single value can conceal rather than resolve important value judgements. Instead, analytical methods should be used to make the consequences, assumptions and trade-offs associated with each alternative transparent. Transport models, scenario analysis, cost-benefit analysis and multi-criteria methods can provide valuable evidence, but their outputs should be interpreted in relation to the uncertainties surrounding demand, economic conditions, technological change, behavioural responses and future policy conditions [5, 6].

This distinction is particularly important when uncertainty is substantial. A decision that performs extremely well under one assumed future may be less attractive than an alternative that performs reasonably well across several plausible futures. The objective should therefore not always be to identify the alternative with the highest expected performance, but to understand the robustness and vulnerability of different choices. Research on adaptive transport policymaking has emphasised the value of taking immediate actions while establishing mechanisms through which future decisions can be modified as new information becomes available [13, 14]. Similarly, dynamic adaptive policy pathways distinguish between decisions that can be taken now and future decisions that depend on how conditions evolve [15]. This perspective is particularly relevant to Istanbul, where demographic change, economic development, technological developments and changing travel behaviour may alter the performance of today's interventions over time.

The fifth element is institutional and political feasibility. An analytically attractive alternative cannot be considered a viable decision if there is no realistic mechanism through which it can be implemented. Transport decisions frequently involve multiple public institutions, operators, private actors and affected communities. Responsibilities for roads, public transport, land use, investment and regulation may be distributed across different organisations, while political priorities can change during the lifetime of a project. Consequently, feasibility should be considered alongside technical performance rather than after the preferred alternative has already been identified. The transport planning literature has increasingly recognised stakeholder engagement, political commitment and process management as integral components of decision quality rather than external considerations [5, 7]. Implementation research similarly demonstrates that institutional barriers can prevent technically sound transport policies from producing their intended outcomes [8–10].

The sixth element is distributional assessment. Equity should not be treated as an additional criterion considered only after efficiency has been maximised. It should be incorporated into the decision process from the beginning. In Istanbul, for example, a transport intervention can have substantially different consequences for residents depending on where they live, their access to public transport, their dependence on private vehicles, their income, their employment location and the availability of alternative travel options. A road intervention may reduce travel times for some motorists while increasing delays or reducing the quality of the urban environment for other users. Conversely, reallocating roadspace to public transport may improve accessibility for a large number of passengers while imposing visible costs on some road users. The relevant question is therefore not simply whether an intervention improves aggregate mobility, but how its benefits and costs are distributed across different groups and locations [3, 4, 25].

The seventh element is temporal sequencing and adaptation. Urban mobility decisions should not necessarily be regarded as isolated choices made at a single point in time. Some interventions create conditions that constrain future choices, while others preserve flexibility. A major infrastructure investment may establish a long-lived physical structure around which subsequent development and travel patterns become organised. A smaller intervention, by contrast, may provide an opportunity to test an approach before committing to a larger investment. This distinction introduces the concept of sequencing: the relevant decision may be not only which intervention should be implemented, but also which intervention should be implemented first, what should be monitored, and under what conditions should the next intervention be triggered. Adaptive policy approaches provide a useful basis for this type of reasoning by linking present actions to future signals and possible adjustments [13–15].

Taken together, these elements constitute a decision-making cycle rather than a linear optimisation procedure. The process begins with defining the problem, but the definition may be revisited as evidence and stakeholder perspectives develop. Objectives may be clarified or reprioritised when conflicts become apparent. Alternatives may be modified as technical, institutional or financial constraints are identified. Evaluation may reveal uncertainties that require additional analysis, while stakeholder engagement may expose distributional consequences that were initially overlooked. Finally, implementation provides new evidence that can inform subsequent decisions. The process is therefore iterative and adaptive rather than strictly sequential.

The framework can be represented as a cycle with five principal stages: (1) define the decision problem; (2) clarify objectives and affected interests; (3) develop and characterise alternatives; (4) evaluate performance, trade-offs, uncertainty, equity and feasibility; and (5) decide, implement, monitor and adapt. Four considerations—stakeholders, uncertainty, distributional effects and institutional feasibility—should operate across all five stages rather than being treated as separate steps. This structure reflects the argument that intelligent decision-making is concerned not simply with ranking alternatives, but with understanding why alternatives differ, who is affected, how certain the evidence is, whether implementation is realistic and how the decision can remain responsive to future conditions.

Figure 1 synthesises these elements into an iterative decision-making framework for complex urban mobility problems. The framework begins with defining the decision problem and clarifying the objectives and interests involved, before progressing to the development and characterisation of alternative courses of action. These alternatives are then evaluated not only in terms of their expected performance, but also with respect to trade-offs, uncertainty, equity and implementation feasibility. The process culminates in a decision that is implemented, monitored and adapted as conditions and evidence evolve. Importantly, stakeholders, uncertainty, distributional effects and institutional and political feasibility are treated as cross-cutting dimensions of the entire process rather than as isolated stages. The circular structure reflects the fact that urban mobility decisions are rarely final: monitoring and experience can lead to a redefinition of the problem, a revision of objectives or the development of new alternatives. The framework therefore conceptualises intelligent decision-making as an iterative process of learning and adjustment rather than a one-off exercise in selecting an optimal alternative.

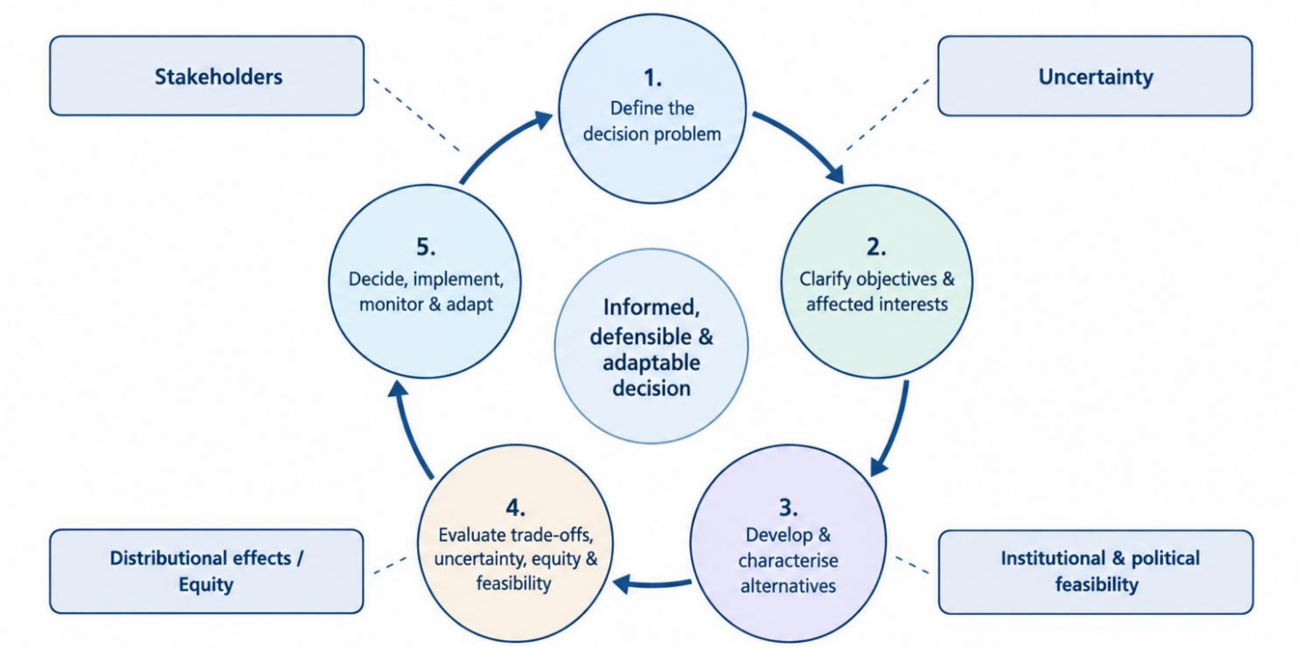

Fig 1. Conceptual framework for decision-making in complex urban mobility problems

The six Istanbul conundrums identified in Section 4 can be mapped onto this framework. The road capacity versus public transport priority conundrum primarily concerns the definition of objectives, the generation of alternatives and the distribution of benefits and costs across road users. The congestion relief versus sustainable mobility conundrum highlights the need to distinguish between immediate performance improvements and broader long-term objectives. The infrastructure investment versus incremental intervention conundrum is closely related to sequencing, flexibility and uncertainty. The efficiency versus equity conundrum demonstrates why aggregate performance cannot be separated from distributional effects. The analytical evidence versus political and institutional feasibility conundrum highlights the interaction between technical evaluation and implementation conditions. Finally, the short-term improvement versus long-term transformation conundrum emphasises the temporal dimension of decision-making and the importance of adaptive strategies.

The framework therefore changes the central question from “Which intervention is the best?” to “Which decision is most appropriate given the objectives, uncertainties, affected interests, institutional conditions and future choices available to decision-makers?” This is not merely a semantic distinction. It recognises that a technically superior alternative may be politically infeasible, that an economically efficient alternative may generate unacceptable distributional effects, that a sustainable intervention may produce limited short-term congestion benefits, or that a large infrastructure project may perform well under current assumptions while creating substantial long-term lock-in. Conversely, an intervention that is not optimal according to any single criterion may nevertheless represent the most defensible choice when its robustness, equity, feasibility and adaptability are considered together.

For Istanbul, this perspective suggests that decision quality should ultimately be assessed not by whether policymakers discover a universally optimal transport solution, but by whether they establish a transparent and defensible process for navigating competing objectives and uncertainty. The purpose of decision-support methods is consequently not to eliminate judgement from urban mobility policymaking. Rather, their role is to improve that judgement by making assumptions explicit, revealing trade-offs, identifying uncertainty, testing alternatives and clarifying the consequences of different choices. In complex urban mobility systems, intelligent decision-making is therefore less about finding a perfect solution than about constructing a decision process capable of producing informed, equitable, feasible and adaptable choices.

6. Discussion

The conceptual framework developed in this paper has a broader implication for how urban mobility problems are understood and addressed. The central argument is not that analytical methods are insufficient or that optimisation-based approaches have no role in transport planning. Rather, the argument is that such methods operate within a wider decision-making environment in which the objectives to be pursued, the alternatives to be considered, the distribution of benefits and costs, the degree of uncertainty and the feasibility of implementation cannot be determined by technical analysis alone. Transport decision-making therefore requires both analytical capability and institutional judgement. This interpretation is consistent with research emphasising the cognitive and participative dimensions of transport planning, in which the quality of the decision-making process is itself an important determinant of planning outcomes [5, 7].

The six conundrums identified for Istanbul illustrate why this distinction matters. Each conundrum can potentially be represented as a conventional optimisation problem. Road capacity and public transport priority, for example, can be compared through indicators of travel time, passenger throughput or network performance. Infrastructure projects can be evaluated through cost-benefit analysis. Alternative policies can be ranked through multi-criteria analysis. However, none of these techniques can independently determine how much priority should be given to a bus passenger relative to a private vehicle user, how much present congestion relief should be valued against future sustainability, or what level of distributional inequality is acceptable in pursuit of aggregate efficiency. These are not simply missing variables in an analytical model. They are questions concerning the objectives and values that define the decision itself.

This observation does not imply that urban mobility decisions are arbitrary. On the contrary, the framework provides a basis for making such decisions more transparent and more accountable. A decision can be considered more defensible when the problem has been clearly defined, relevant objectives have been identified, affected groups have been recognised, alternatives have been systematically examined, uncertainties have been acknowledged and implementation conditions have been considered. In this sense, the quality of decision-making depends not only on the quality of the information available to policymakers but also on whether the process allows that information to be interpreted within its appropriate institutional and social context.

The Istanbul case also demonstrates the importance of distinguishing between technical uncertainty and normative disagreement. Some uncertainties concern the future behaviour of the transport system and can potentially be reduced through better data, modelling or monitoring. Future travel demand, modal choice, technological adoption and economic conditions, for example, may all differ from current expectations. Other disagreements cannot be resolved through additional data because they concern competing objectives or preferences. Stakeholders may agree about the likely consequences of reallocating roadspace while disagreeing fundamentally about whether those consequences are desirable. Treating such disagreements as if they were merely technical uncertainties risks creating a false impression that better modelling will eventually produce a universally accepted answer. The literature on uncertainty in transport planning instead suggests the importance of flexible and open approaches capable of accommodating alternative futures and revisiting decisions as circumstances change [6, 13–15].

This distinction is particularly relevant to the sustainable mobility transition in Istanbul. The city's current planning agenda explicitly combines objectives relating to public transport, active mobility, congestion, accessibility and urban development. These objectives can reinforce one another in some circumstances but can also generate tensions when translated into specific interventions. For example, increasing public transport priority may support modal shift and accessibility while requiring roadspace to be reallocated from private vehicles. Similarly, reducing parking supply may contribute to sustainable mobility objectives while generating opposition from affected users and businesses. The existence of such tensions does not demonstrate that the policy is misguided. Rather, it demonstrates that sustainable mobility is itself a multi-objective decision problem in which different objectives may have to be balanced rather than simultaneously maximised.

The framework also highlights the importance of distribution in evaluating transport decisions. Aggregate improvements in mobility can conceal substantial differences between locations and population groups. A policy that reduces average travel time across the metropolitan area may provide relatively little benefit to households with poor access to employment centres, while a policy that improves public transport accessibility in peripheral areas may produce benefits that are not fully captured by conventional travel-time measures. Transport justice research has therefore argued for greater attention to who benefits from transport investments, who bears their costs and whether interventions improve people's effective opportunities to participate in social and economic life [3, 4, 26]. For a metropolitan area as spatially and socio-economically diverse as Istanbul, this dimension is particularly important.

This does not mean that efficiency should be abandoned in favour of equity. Rather, efficiency and equity should be recognised as potentially complementary but sometimes competing dimensions of decision quality. The framework consequently avoids prescribing a universal weighting between them. Such a weighting would itself represent a normative decision that depends on the objectives and institutional context of the specific policy. Instead, the framework requires distributional consequences to be made visible alongside efficiency outcomes. This allows policymakers and stakeholders to confront the underlying trade-off explicitly rather than allowing it to remain hidden within an aggregate performance measure.

A further implication concerns the relationship between evidence and implementation. Transport policy frequently involves a gap between what appears desirable in analytical terms and what can realistically be delivered. Institutional responsibilities may be fragmented, financial resources may be constrained, political priorities may change and affected groups may resist particular interventions. Previous research on transport policy implementation has demonstrated that these barriers can substantially influence whether local transport policies achieve their intended outcomes [8, 9]. The Istanbul experience similarly demonstrates the importance of stakeholder engagement and institutional coordination within contemporary mobility planning. The Istanbul SUMP process has involved public institutions, experts and other stakeholders in workshops and participatory activities, while more recent implementation work has incorporated multi-criteria analysis, cost-benefit analysis and stakeholder feedback into project prioritisation.

This suggests that participation should not be regarded simply as a mechanism for obtaining public acceptance after a technically preferred solution has been identified. Participation can contribute to the decision itself by revealing local knowledge, identifying overlooked impacts, exposing implementation barriers and clarifying competing priorities. In this respect, stakeholder engagement can improve not only the legitimacy of a decision but also the information on which the decision is based. Nevertheless, participation does not automatically resolve conflicts. Stakeholders may have unequal resources and influence, and consensus may not be achievable. The purpose of participatory decision-making should therefore be understood as improving transparency, understanding and accountability rather than guaranteeing agreement [5, 7].

The framework also has implications for the role of intelligent decision-making methods. Intelligent decision-making should not be interpreted narrowly as the automated identification of an optimal alternative. In complex urban mobility environments, intelligence may instead lie in the capacity of a decision process to recognise competing objectives, distinguish different forms of uncertainty, incorporate multiple perspectives, identify vulnerable groups, test the robustness of alternatives and adapt decisions as new evidence emerges. This interpretation is particularly compatible with the broader scope of intelligent decision-making, in which decision-support methods can be used not only to rank alternatives but also to structure information, reveal relationships and support human judgement.

This perspective also clarifies the potential role of numerical MCDM methods in the framework. Such methods remain valuable when alternatives need to be compared across multiple criteria, particularly where decision-makers need a transparent structure for examining trade-offs. However, the framework suggests that MCDM should generally be located within a wider decision process rather than treated as the decision process itself. Criteria selection, weighting, threshold definition and interpretation of results all involve choices that precede or follow the mathematical ranking. Consequently, a technically sophisticated MCDM model can still produce a poor policy decision if the underlying decision problem has been incorrectly framed, relevant stakeholders have been excluded, distributional effects have been overlooked or implementation constraints have been ignored.

The same argument applies to increasingly sophisticated data-driven and computational tools. Greater availability of real-time data, simulation, artificial intelligence and digital modelling can improve the evidence available to transport decision-makers, but it does not eliminate the fundamental conundrums identified in this paper. Better prediction does not determine normative priorities. More detailed modelling does not necessarily resolve conflicts between stakeholder groups. Greater computational capacity does not remove institutional constraints. Indeed, the increasing sophistication of analytical tools may make it even more important to distinguish between what a model can establish empirically and what must ultimately be decided through political and institutional judgement.

The framework therefore suggests a different interpretation of the notion of a “best” solution. In a relatively well-defined engineering problem, it may be meaningful to search for an optimal solution under specified constraints. In an urban mobility policy problem, however, the constraints themselves may be contested, the objectives may conflict and future conditions may be uncertain. An alternative that is optimal under one set of assumptions may become inferior when those assumptions change. A more appropriate objective is therefore often to identify a decision that is sufficiently robust, equitable, feasible and adaptable across a range of plausible conditions. This does not eliminate the need to make choices. Instead, it changes the basis on which choices are justified.

For Istanbul, this approach has practical implications. First, major mobility decisions should be preceded by explicit problem framing rather than allowing the most visible symptom—particularly congestion—to determine the intervention automatically. Second, project appraisal should make distributional consequences more visible alongside aggregate efficiency indicators. Third, large and potentially irreversible investments should be assessed in relation to alternative incremental or adaptive interventions. Fourth, institutional and political feasibility should be incorporated into decision processes at an early stage rather than treated as an implementation issue after project selection. Fifth, monitoring should be regarded as part of the decision process, creating opportunities to modify policies when evidence indicates that their assumptions or expected effects are no longer valid. These principles are broadly consistent with Istanbul's current SUMP direction, which combines data-driven planning, stakeholder collaboration, sustainable mobility objectives and monitoring and evaluation activities.

The conceptual framework nevertheless has limitations. First, it does not provide a numerical procedure for ranking alternatives. Its purpose is to structure and improve the decision process rather than to produce a single quantitative decision rule. Second, the framework does not prescribe how conflicting objectives should be weighted, because such choices are inherently context-dependent. Third, although Istanbul provides a rich and relevant illustration, the six conundrums are not unique to Istanbul and their relative importance may differ across cities with different institutional, geographical and socio-economic conditions. Finally, the framework is conceptual and would benefit from empirical application to specific Istanbul decisions. Future research could therefore apply the framework to particular cases—such as dedicated bus-lane implementation, major transport investment prioritisation, parking policy or cross-Bosphorus capacity decisions—to examine how different stakeholders define the problem, how objectives conflict, how uncertainty affects choices and how decisions evolve through implementation.

Despite these limitations, the framework makes a distinct contribution by bringing together dimensions that are often considered separately in urban transport decision-making. Efficiency, sustainability, equity, uncertainty, stakeholder participation, institutional feasibility and temporal adaptability are frequently addressed through different analytical or policy literatures. The present framework treats them as interconnected dimensions of the same decision process. Its principal contribution is consequently not a new optimisation algorithm but a conceptual reorientation: from searching for a universally optimal intervention towards structuring decision processes that are transparent about objectives, explicit about trade-offs, sensitive to distribution, aware of uncertainty and capable of adaptation.

The Istanbul case demonstrates why such a reorientation is necessary. The city's mobility challenges are sufficiently complex that almost every major intervention creates both benefits and costs, opportunities and constraints, and immediate effects and longer-term consequences. The appropriate response is therefore not to abandon analytical decision-support but to embed it within a broader conception of intelligent policymaking. When there is no “best” solution in an absolute sense, the quality of a mobility policy depends on the quality of the reasoning, evidence, participation and institutional processes through which a particular choice becomes justified.

7. Conclusions

Urban mobility policymaking is often presented as a search for the most effective solution to problems such as congestion, inadequate public transport capacity, environmental impacts and unequal accessibility. This paper has argued that, in complex metropolitan environments, this framing is often too narrow. The central challenge is not simply to identify the technically optimal intervention, but to make defensible choices when objectives conflict, future conditions are uncertain, benefits and costs are unevenly distributed, and implementation depends on political and institutional conditions.

Using Istanbul as an illustrative case, the paper identified six recurring decision-making conundrums: road capacity versus public transport priority; congestion relief versus sustainable mobility; large-scale infrastructure investment versus incremental interventions; system efficiency versus social equity; analytical evidence versus political and institutional feasibility; and short-term improvements versus long-term transformation. These conundrums are interconnected rather than independent. A decision concerning roadspace allocation, for example, can simultaneously affect congestion, public transport performance, equity, political feasibility and the longer-term development of the transport system. Consequently, treating each issue as an isolated optimisation problem can obscure important interactions and trade-offs.

The paper's main conceptual contribution is a framework for understanding urban mobility decision-making as an iterative and adaptive process. The framework consists of five principal stages: defining the decision problem; clarifying objectives and affected interests; developing and characterising alternatives; evaluating trade-offs, uncertainty, equity and feasibility; and deciding, implementing, monitoring and adapting. Stakeholders, uncertainty, distributional effects and institutional and political feasibility operate across the entire process. This structure shifts attention from the search for a universally optimal alternative towards the construction of decisions that are informed, defensible, feasible and adaptable.

An important implication is that analytical decision-support methods should be understood as instruments for improving judgement rather than mechanisms for eliminating judgement. Transport modelling, cost-benefit analysis, multi-criteria decision-making and other analytical approaches can provide valuable evidence about the consequences of alternative interventions. However, they cannot independently determine normative priorities, resolve conflicts between affected groups or guarantee political and institutional feasibility. Intelligent decision-making therefore requires the integration of analytical evidence with explicit objectives, stakeholder perspectives, distributional considerations and an understanding of uncertainty.

The Istanbul case also demonstrates that the absence of a single “best” solution should not be interpreted as an absence of rationality. On the contrary, recognising competing objectives and uncertainty can lead to more transparent and rigorous decision-making. A decision may be considered more robust when its assumptions are explicit, its trade-offs are understood, its distributional consequences are visible, its implementation requirements are realistic and mechanisms exist for monitoring and adaptation. This is particularly important in a metropolitan system such as Istanbul, where geographical constraints, rapid urban development, extensive public transport investment and persistent congestion create strong interactions between individual transport policies and the wider urban system.

The framework proposed in this paper is conceptual and does not provide a numerical ranking procedure or a universal method for resolving competing objectives. Its purpose is to provide a decision structure within which different analytical and participatory methods can be applied. Future research should therefore examine the framework through empirical applications to specific Istanbul mobility decisions. Potential applications include the prioritisation of dedicated bus corridors, evaluation of major transport investments, allocation of scarce roadspace, parking and demand-management policies, and the assessment of alternative long-term mobility scenarios. Such applications could investigate how different stakeholder groups define the decision problem, how preferences change under alternative assumptions, which uncertainties are most consequential and how decisions evolve during implementation.

Ultimately, the key message is that complex urban mobility policymaking is not always a problem of finding the right answer. It is often a problem of choosing among alternatives that each embody different advantages, disadvantages, risks and consequences. In such circumstances, the quality of decision-making depends not only on the sophistication of the analytical tools employed, but also on the quality of the reasoning and institutional process surrounding their use. When there is no universally “best” solution, intelligent urban mobility decision-making should seek not perfection, but informed, transparent, equitable, feasible and adaptable choices.

Acknowledgement
This research was not funded by any grant.

Conflicts of Interest
The authors declare no conflicts of interest.

References
[1] Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4(2), 155–169. https://doi.org/10.1007/BF01405730
[2] Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, 15(2), 73–80. https://doi.org/10.1016/j.tranpol.2007.10.005
[3] Manaugh, K., Badami, M. G., & El-Geneidy, A. M. (2015). Integrating social equity into urban transportation planning: A critical evaluation of equity objectives and measures in transportation plans in North America. *Transport Policy*, 37, 167–176. https://doi.org/10.1016/j.tranpol.2014.09.013
[4] Martens, K. (2017). *Transport justice: Designing fair transportation systems*. Routledge. https://www.routledge.com/Transport-Justice-Designing-fair-transportation-systems/Martens/p/book/9780415638326
[5] Cartenì, A., Marzano, V., Henke, I., & Cascetta, E. (2022). A cognitive and participative decision-making model for transportation planning under different uncertainty levels. *Transport Policy*, 116, 386–398. https://doi.org/10.1016/j.tranpol.2021.12.013
[6] Kwakkel, J. H., Walker, W. E., & Marchau, V. A. W. J. (2010). Classifying and communicating uncertainties in model-based policy analysis. *International Journal of Technology, Policy and Management*, 10(4), 299–315. https://doi.org/10.1504/IJTPM.2010.036918
[7] Cascetta, E., Cartenì, A., Pagliara, F., & Montanino, M. (2015). A new look at planning and designing transportation systems: A decision-making model based on cognitive rationality, stakeholder engagement and quantitative methods. *Transport Policy*, 38, 27–39. https://doi.org/10.1016/j.tranpol.2014.11.005

[8] McTigue, C., Monios, J., & Rye, T. (2018). Identifying barriers to implementation of local transport policy: An analysis of bus policy in Great Britain. *Utilities Policy*, 50, 133–143. https://doi.org/10.1016/j.jup.2017.12.002

[9] McTigue, C., Rye, T., & Monios, J. (2020). Identifying barriers to implementation of local transport policy—Lessons learned from case studies on bus policy implementation in Great Britain. *Transport Policy*, 91, 16–25. https://doi.org/10.1016/j.tranpol.2020.03.002

[10] McCullogh, E., Moore, S. A., Maher, R., Jannati, N., Muosieryiri, M., Macpherson, A., ... & Fuller, D. (2026). Implementation science frameworks for active and sustainable transportation interventions with a focus on equity: A scoping review. *Transportation Research Interdisciplinary Perspectives*, 38, 102020. https://doi.org/10.1016/j.trip.2026.102020

[11] Flyvbjerg, B. (2009). Survival of the unfittest: Why the worst infrastructure gets built—and what we can do about it. *Oxford Review of Economic Policy*, 25(3), 344–367. https://doi.org/10.1093/oxrep/grp024

[12] Canitez, F., Alpkokin, P., & Kiremitci, S. T. (2020). Sustainable urban mobility in Istanbul: Challenges and prospects. *Case Studies on Transport Policy*, 8(4), 1148–1157. https://doi.org/10.1016/j.cstp.2020.07.005

[13] Marchau, V. A. W. J., Walker, W. E., & van Wee, G. P. (2010). Dynamic adaptive transport policies for handling deep uncertainty. *Technological Forecasting and Social Change*, 77(6), 940–950. https://doi.org/10.1016/j.techfore.2010.04.006

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

[15] Haasnoot, M., Kwakkel, J. H., Walker, W. E., & ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. *Global Environmental Change*, 23(2), 485–498. https://doi.org/10.1016/j.gloenvcha.2012.12.006

[16] Turkish Statistical Institute (TÜİK). (2026). *The results of address based population registration system – 2025*. Turkish Statistical Institute. https://veriportali.tuik.gov.tr/en/press/53899

[17] Metro Istanbul. (2026). *About us / Operation services*. Istanbul Metropolitan Municipality. https://www.metro.istanbul/en/content/about-us

[18] IETT. (2025). *İETT'nin "İlklerle Dolu" 2024 yılı faaliyetleri, İBB Meclisinde onaylandı*. Istanbul Electric Tramway and Tunnel Operations. https://iett.istanbul/arsiv/38316/ettnn-lklerle-dolu-2024-yl-faalyetler-bb-mecl

[19] TomTom. (2026). *Traffic index: Istanbul traffic report*. TomTom. https://www.tomtom.com/traffic-index/city/istanbul/

[20] Istanbul Sustainable Urban Mobility Plan. (2026). *Objectives of Istanbul SUMP*. https://www.globalfuturecities.org/sites/default/files/2021-09/Istanbul_SUMP_final.pdf

[21] Sectoral Operational Programme for Transport. (2025). *Second bus priority lanes workshop held in Istanbul*. Ministry of Transport and Infrastructure – Bus Priority Lanes Workshop.

[22] Istanbul SKUp. (2025a). *Transport investments workshop held*. İstanbul SKUp – Transport Investments Workshop.

[23] Istanbul SKUp. (2025b). *Shaping Istanbul's transport projects through collective wisdom*. İstanbul SKUp.

[24] Sectoral Operational Programme for Transport. (2025, January 14). *The future of transportation: Istanbul 2040 mobility scenarios workshop held in Istanbul*. Ministry of Transport and Infrastructure – Istanbul 2040 Mobility Scenarios Workshop.

[25] Pan, M., Wong, S., Tainter, F., Woelfel, S., & Ryan, A. (2024). Integrating equity in transportation scenario planning: A systematic review. *Transport Policy*, 145, 85–95. https://doi.org/10.1016/j.tranpol.2023.10.015

[26] Nazari Adli, S., & Chowdhury, S. (2021). A critical review of social justice theories in public transit planning. *Sustainability*, 13(8), 4289. https://doi.org/10.3390/su13084289