

AN ANALYSIS OF THE RELATIONSHIP BETWEEN TRANSPORT AND URBAN STRUCTURE IN ISTANBUL

Sirel Ayşe

İstanbul Aydın University (TURKEY)

aysesirel[at]aydin.edu.tr

Abstract

In the last thirty years of globalization, the world has seen comprehensive technological and economic change. In this new order, where geographic locations between countries are blurred or eliminated, new commercial relationships have been established with countries that were previously considered too remote. In turn, rapid global population growth, migration and urbanization have created new transport demands. Due to the symbiotic relationship between transport networks and urban structure, strategic planning that integrates the two factors has become increasingly important. In this context, this study aims to determine the interrelationship between transport and urban structure in Turkey at the national level, and in Istanbul at the city level. Following analysis, potential opportunities, threats and policy recommendations are presented.

Keywords: Urbanization; urban development; land use; transport system; Istanbul.

1.INTRODUCTION

Transport can be simply defined as a method of moving people, goods and services quickly, safely and cost-effectively. Considered an indispensable part of daily life, transport significantly affects society both socially and economically. As transport constitutes a key phase of the production process, transport and its required investments play a considerable role in determining societies' economic structure. To efficiently and effectively make and use such investments, it is therefore important to make sound transport decisions [1, 2].

Moreover, transport improves accessibility to the regions it serves, thereby affecting regional land use and socioeconomic structure. In this respect, it plays a significant role in the formation of the urban macroform [3, 2]. Indeed, various studies from the 1960s to the present have asserted that transport and urban planning are indispensable prerequisites for 'sustainable economic growth'. As such, issues such as establishing a balanced distribution between modes of transport, eliminating traffic congestion and giving users a central role in transport policies and global transport management in line with 'sustainable transport policies' have gained prominence in developed European countries.

Since the 1950s, Turkey has experienced many transport problems caused by rapid urbanization, industrialization, migration and population growth. However, the country only began developing a balanced plan to establish a transport infrastructure relevant to the country's social and economic needs in the 2000s. Before that point, urban transport projects that were drawn up without determining macro-level transport policies failed to yield the expected outcomes

due to political issues and illicit profit motives.

In the early 2000s, spurred by the blurring of borders under globalization, Pan-European Transport Network was prepared with the long-term aim of connecting European countries with the Caucasus and Central Asia. Meanwhile, in 2005, Turkey (as part of the process of acceding to the European Union) began developing its own domestic multi-modal transport network in order to connect to the European Union's larger network. This activity provided Turkey the opportunity to develop solutions to its transport infrastructure problems while enhancing its integration and competitiveness in the global marketplace.

As part of this effort, Turkey began to accelerate transport projects with significant developmental potential; these private and public sector mega-transport projects include airports, high speed trains, metros, the Marmaray tube tunnel, highways and bridges. However, such mega-transport projects (the majority of which are in Istanbul) initiated after 2000 have not always complied with cities' land use regulations (urban zoning plans), exclude large masses of society from decision-making mechanisms and are largely implemented through hegemonic discourse.

1.1. Conceptual background: transport and urbanization

Urbanization refers to the transition from rural to urban society. According to the United Nations' World Population data: the world population in 2019 is 7.7 billion, and the estimated population in 2050 is 10.9 billion [4]. Current global tendencies suggest that the urban population is expected to increase by approximately 50 million per year. Indeed, according to the same United Nations projections, the urban population is expected to increase from 3.6 billion (52% of the world population) to 6.3 billion people (67%) between 2013 and 2050 (Figure 1). In light of these projected increases, particularly in urban spaces, transport issues will gain increasing importance [2].

Due to their numerous and complex mobility needs, cities essentially form their own transport systems. These needs relate not only to human mobility, but also to issues of production, consumption and distribution [5]. Further complexity is added by the quantity and diversity of transport methods, the high number of starting and arrival points and, in some cases, incrementally increasing mobility demands. The demand caused by increasing population in particular is the source of numerous transport problems.

Researchers first addressed the issue of transport problems; travel demands and urban growth in the late 1940s. Then, in the 1950s, social scientists began investigating modern transport planning techniques. Among these were leading American planning experts Mitchell and Rapkin, who first mathematically analysed the connection between land use and transport in their groundbreaking work, *Urban Traffic: A Function of Land Use* [6]. Their methods were applied to transport planning for the cities of Detroit (The Detroit Metropolitan Area Traffic Study (DMATS) and Chicago (The Chicago Area Transportation Study (CATS) in 1955 and 1956, respectively [7]. Around the same time, Hansen [8] found, after studying the city of Washington, D.C. in 1948 and 1955, that easily accessible locations were more likely to be developed than satellite settlements.

Building on these key early works, systematic studies have been conducted to solve transport problems for more than half a century. These theoretical and empirical studies have largely investigated the relationship between urban transport and land use from two different dimensions [9, 10,11];

1. The effect of urban structure on transport systems, travel demand and urban travel behaviour; and

2. The effect of transport systems and investments on urban structure

These two analyses express the two-way relationship between transport, which is the principle element of accessibility in cities, and land use, which forms the urban structure [12]. The structure of land use (population, employment, industry, commerce, accommodations, education, etc.) affects transport system formation and modalities, while the transport system and its available options guide the formation of land use patterns, and therefore urban structure [13]. Therefore, effective and successful urban transport planning must occur in concert with urban planning efforts [14].

Further, a sustainable urban development process should take into account the effects of technological developments on transport system and urban structure, as these factors can affect human and goods accessibility relationships, transport modes and distances, vehicle intensity, carrying capacities and energy efficiency. With this in mind, recent conventional transport planning efforts with regard to traffic connections and human patterns should be reconsidered in detail on both a global and local scale.

1.2. A global history of transport systems and planning

Over the last several decades, transport planning has gained increasing prominence as various cities and nations worldwide seek to move more passengers and goods more quickly, comfortably and reliably. During this time, scientific and technological advances, societal developments, changes in economic needs, modification of human habits, cultural accumulation and (perhaps most importantly) political events have all contributed to directing and developing transport [15].

The inception of modern transport is generally regarded as having occurred after World War II, when the automotive industry became an influential and authoritative presence. While steam-driven rail and maritime travel played important roles before the creation of effective highways, automobiles quickly overtook them in popularity due to advantages such as mobility, comfort, speed and convenience. This major shift completely changed transport development and the structure of the transport system. As railway development fell out of favour, highway-based transport systems rapidly pushed to the foreground, due to their facilitation of door-to-door mobility, adaptability to rapidly changing transport needs and the strengthening of the automotive industry.

This transition accelerated proportionally to post-World War II automotive assembly line production, as well as to increases in income and quality of life. To address transport problems caused by this rapid increase in automobile users, separate, un-integrated remedies were adopted to facilitate vehicle mobility and resolve traffic congestion, including opening new roads, expanding existing roads, constructing interchanges, etc. In this context, the unit of scale for planning purposes was automobiles rather than humans. Although this increased capacity certainly improved traffic speed for a time, congestion problems soon re-emerged due to changes in land use, emergence of new centres and increased settlement density (Figure 2) [16].

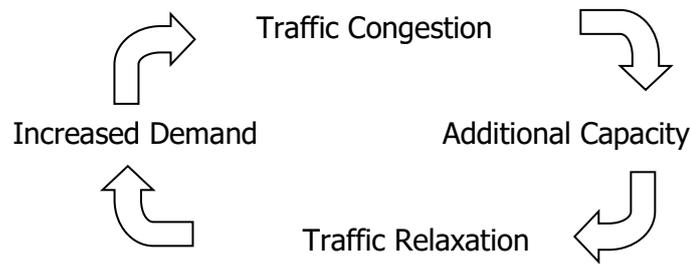


Figure 2. The insolvability of a conventional transport approach [17]

Serious debates on transport planning began in the 1960s and 1970s as automobiles and roads continued to increase, appearing on various countries' agendas through radical legal arrangements [18]. In the 1960s, transport planning mainly concentrated on long-term projects, with planners focusing most of their attention on estimating future transport demands as accurately as possible. Accordingly, mathematical models explaining the relationship between travel behaviours and other urban elements (population, regional social structure, type and intensity of land use, etc.) were developed [17].

In the 1970s, the global oil crisis shifted focus to a search for alternative transport model; planning approaches also had to consider increasing social awareness of the environmental problems caused by vehicle traffic [3]. In attempting to tailor planning methods to load and passenger transport demands within certain frameworks, the 'travel demand management' model gained prominence. Many developed countries devised modern approaches to balance transport problems with societal concerns, such as prioritization of passengers, efficient use of the existing infrastructure, land use and urban planning decisions, viable investments, economic solutions and developing public transit systems by shifting travellers to higher-capacity vehicles.

Until the 1970s, transport planning was primarily based on attempting to predict future transport needs and setting appropriate objectives; in other words, identifying goals to be reached and working toward them accordingly [19]. After realizing the inadequacy of this approach, developed countries moved to a more realistic strategy of determining objectives to be achieved and drawing a 'roadmap' to achieve them. This marked the beginning of the 'strategic planning' period, marked by more efficient use of infrastructure and vehicles, energy efficiency, environmental awareness, etc. During this period, many cities adopted policies restricting the use of private vehicles in intercity travel, supporting public transit and encouraging bicycle or pedestrian travel.

After the 1980s, the world experienced a period of rapid integration known as globalization. This new evolutionary process ushered in a period of rapid technological developments, liberalization in international trade and capital flow, and comprehensive economic restructuring. As geographical boundaries between countries blurred or disappeared entirely, free-market economic principles and free trade spread widely. As such, countries that were previously considered too remote for far-reaching international trade developed new commercial relationships, and in turn began developing new transport networks.

The ideal of a strong and single Europe, as first proposed at the 1992 Maastricht Summit, increased the importance of transport for the purposes of economic and social integrity. This required reviewing EU transport policies for sustainability.

Following this review, newly developed policies emphasized the following subjects [20]:

- Integrated use of all transport systems: prioritization of railway, interior waterway, short maritime transport, combined transport and public transit; and
- Improvement of transport system construction and operation (infrastructure, vehicles and equipment, services and operations).

The first concrete steps toward developing EU transport policies were taken in the 1993 Maastricht Agreement, which specified objectives for improving EU transport networks. Most prominent among these was the introduction of the Tran-European Transport Network (TEN) to support economic and social integration throughout Europe [15].

In 2001, the EU issued the whitepaper 'European transport policy for 2010: time to decide' to assess the future development of the transport policies issued in 1992. Specifically, this new policy aimed to establish a sustainable transport system by balancing economic development with member societies' quality and security demands. These objectives aligned under four themes [21]:

- Establishing a balanced distribution between modes of transport
- Eliminating traffic congestion
- Giving passengers a central role in transport policies
- Managing global transport

During the same period, important exchanges of finances, goods and information were concentrated in a triangle between the US, the EU, and Asia. In order to include Central and Eastern European countries in these relationships, the concept of Pan-European Transport was introduced. In support of this concept, and as new relationships emerged parallel to the development of the global economy, studies were commissioned to develop new transport corridors and to establish a multimodal transport network within the affected countries [22]. Thus, the Pan-European Transport Network Project was introduced to establish long-term connections between EU and candidate countries and the Caucasus and Central Asia via the Trans-European Motorway (TEM) and Trans-European Railway (TER) (Figure 3) [23]. United Nations Economic Commission for Europe, 2011). In so doing, the project aims to integrate balanced and sustainable modes of transport that are more economical, don't cause traffic congestion, and are environmentally friendly, safe and comfortable into the transport plans of countries within these corridors.

In support of this project, the EU began to develop the project Transport Corridor Europe-Caucasus-Asia (TRACECA, European Commission) in 1993 (Figure 4). TRACECA, which is supported by the US, is an East-West transport corridor established by the EU to connect the Commonwealth of Independent States to Europe over the Caucasus and the Black Sea. This project, also called the 'Silk Road of the New Era', relies on a multimodal transport model. However, some believe the project was produced based on certain far-fetched ideas [24].

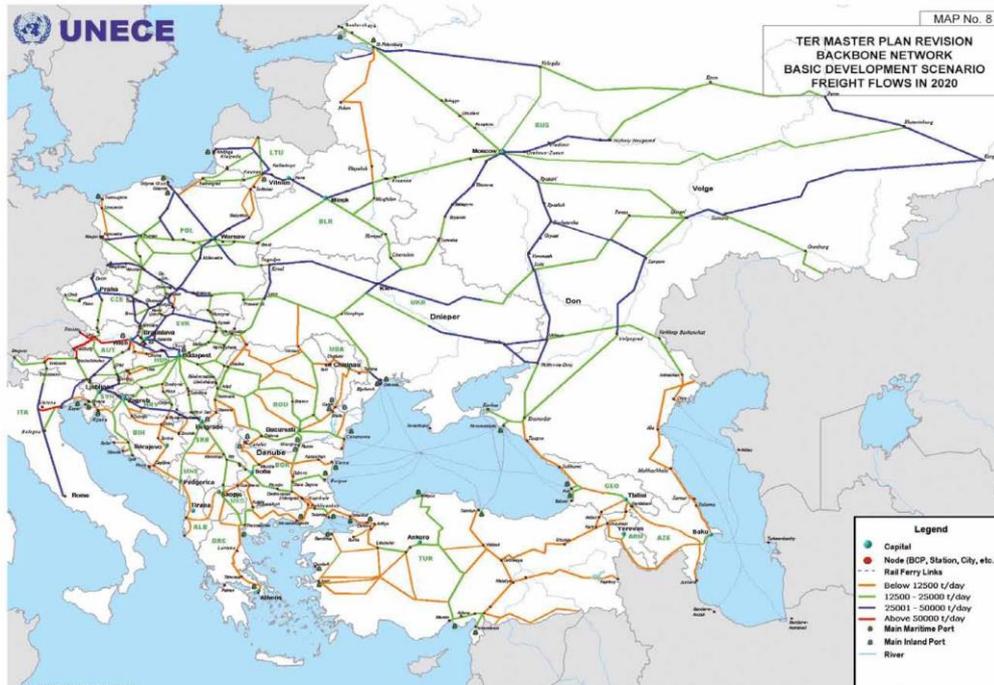


Figure 3. TEM and TER Transport corridors [25]



Figure 4. TRACECA [26]

Ultimately, despite the technological advancements in transport in the last 60 years, it is clear that most countries are still occupied with problems related to

more economic, congestion-free, environmentally friendly, safe, comfortable, balanced, and sustainable transport and urbanization”.

1.3. Transport problems and planning in Turkey

Located at the intersection of three continents (Asia, Europe and Africa) and corresponding highway, railway and maritime transport corridors, Turkey has long held historical, geographic and strategic importance. While Turkey’s population was low in the early years of the republic (1923), it has increased rapidly since the 1940s (Figure 5). The sharp population increase during this period (1923-1950) reflects a national policy focus on maritime and railway travel, particularly in connecting important settlements and production centres via railway network; at the time, highways were considered as a mere complement to railways (Figures 6 and 7).

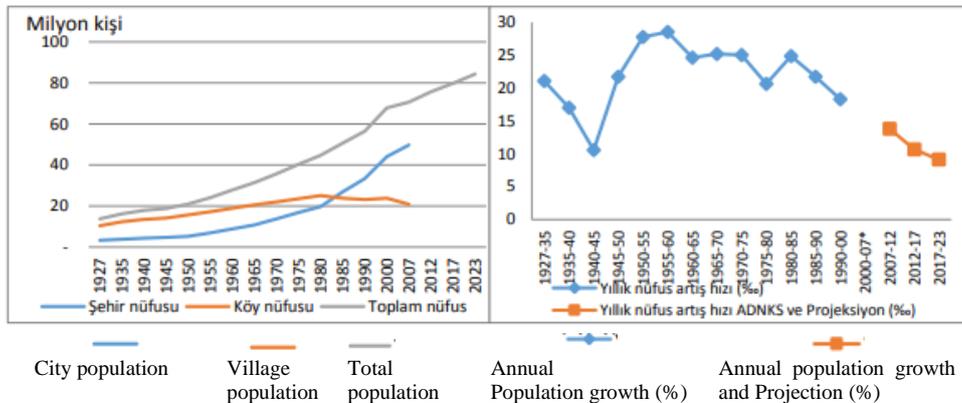


Figure 5. Population growth rates and projections in Turkey by year [27]

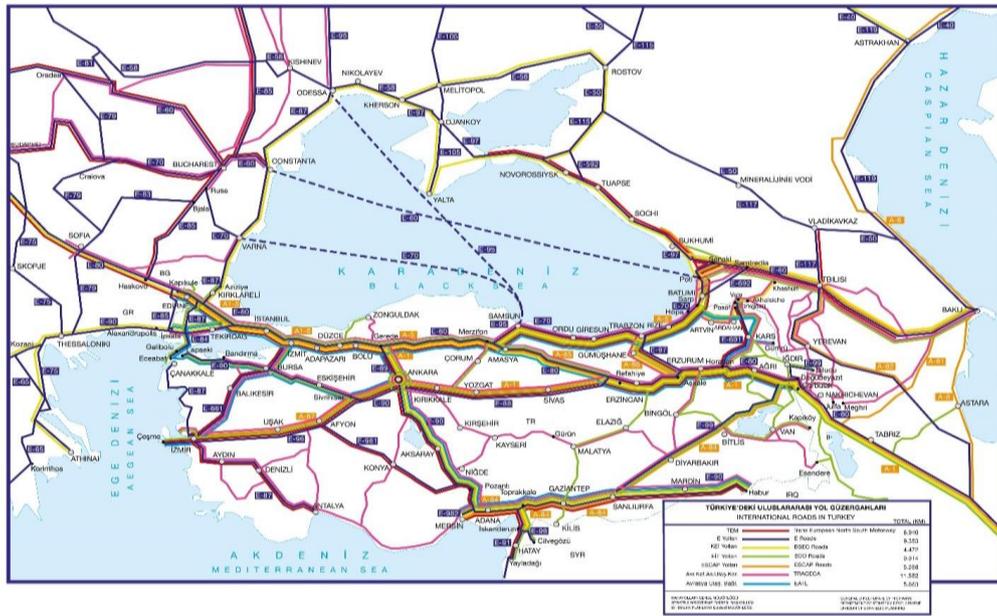


Figure 6. International highways passing through Turkey [28]

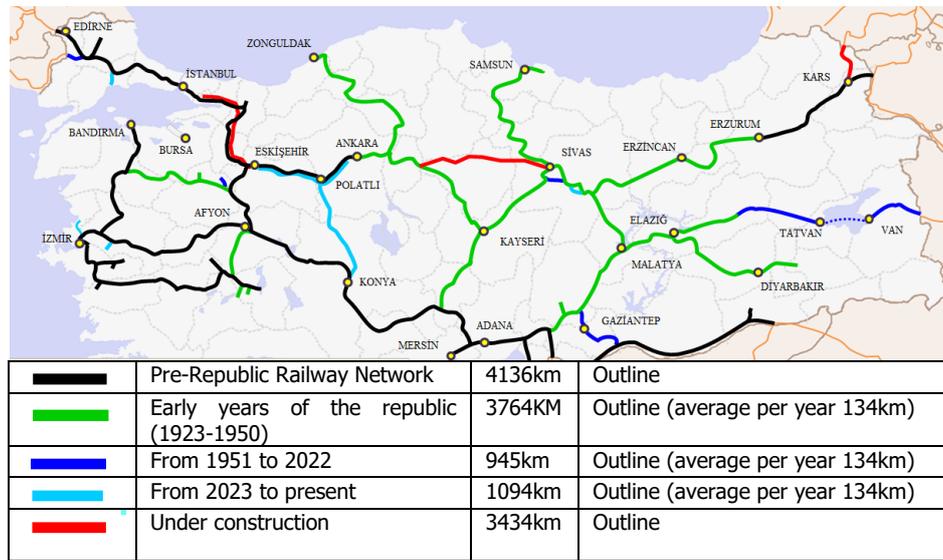


Figure 7. Historical railway development in Turkey [29]

In the 1950s, highways in Turkey developed rapidly, aided by the US Marshall Plan and the establishment of the General Directorate for Highways [30]. However, as no other modes of transport received such support, railway and maritime transport began to lose their significance (Table 1), resulting in an increase in motor vehicle ownership, and growing dependence on foreign automotive manufacturers [31].

Table 1. Passenger transport in Turkey by decade (passenger-km) (TUIK Information was used) [32]

	1950	1960	1970	1980	1990	2000	2005
Railway	55.1%	24%	8.0%	7.0%	4.0%	3.0%	3.4%
Highway	17.1%	73%	91%	92%	94%	95.0%	95.0%
Maritime	27.8%	-	-	-	-	-	0.1%

In the 1960s, the period of Turkey's 'Five-Year Development Plans' began. In the first planned period (1963-1967), current transport needs and goals were determined. However, as the country was not prepared for rapid population increases and unplanned urbanization and growth in terms of infrastructure and operation, these goals were not achieved. Additionally, transport and urban planning studies were not consulted, and short-term, narrow solutions were selected to save money. In this period, the share of public investment in highway transport increased to 80%, while investment in railway and maritime transport decreased to 6% and 4%, respectively [33].

In the 1970s, with certain exceptions (e.g. the Istanbul and Ankara metro systems), only short-term, narrowly focused transport projects were conducted [34]. These works were realized to identify and advocate for specific transport investments (e.g. the first Bosphorus Bridge) rather than to question the city's entire integrated transport structure [14]. In line with highway-focused policies, the first Bosphorus Bridge was constructed in the capital city of Istanbul in 1973, initiating a significant new transport connection between Europe and Asia. The construction of highways connected to both ends of the bridge further encouraged the use of motor vehicles (Table 2).

Table 2. Number of Motor Vehicles by Years [35]

Yil	Toplam	Otomobil	Minibüs	Otobüs	Kamyonet	Kamyon	Motorsiklet	Traktör
1970	369808	137771	20916	15980	52152	70730	60994	-
1980	1 696681	742252	64707	32783	165821	164893	137931	352247
1990	3750678	1649879	125399	63700	263407	257353	531941	769456
2000	8320449	4422180	235885	118454	794459	394283	1011284	1159070
2010	15095603	7544871	386973	208510	2399308	726359	2389488	1404872
2017	22218945	12035978	478618	221885	3642625	838718	3102800	1838222

In the 1980s, during the early years of globalization, the '1983-1993 Transport Master Plan' was prepared and put into effect. However, the plan's projections were not realized due to inadequate legal framework, lack of institutional coordination, budget problems and political pressures. Ultimately, in the process of developing infrastructure that integrated different modes of transport, it was impossible to develop transport projects in concert with urban planning and land use decisions in a way that involved and accounted for the entire city. The 1985 revision of the Transport Master Plan (TMP) deviated considerably from the transport sector's original goals [36, 15].

During this period, expressways were also constructed to alleviate traffic congestion caused by increased private automobile use. For the same reason, the second Bosphorus Bridge (also known as the Fatih Sultan Mehmet Bridge) was constructed in 1988. However, at the same time, intercity public transit was given secondary importance, with the exception of the development of certain aboveground metro and rail systems to meet intercity passenger and freight demands in large cities such as Istanbul and Ankara.

In the 1990s, despite increased government interest in railway and maritime transport, investments in these areas remained below the desired level (Figure 8), as reflected by Turkey's low transport network ratios relative to the rest of Europe (Table 3). Proposals to enable more effective use of the existing highway infrastructure were prioritized to improve passenger and goods transport (Table 4).

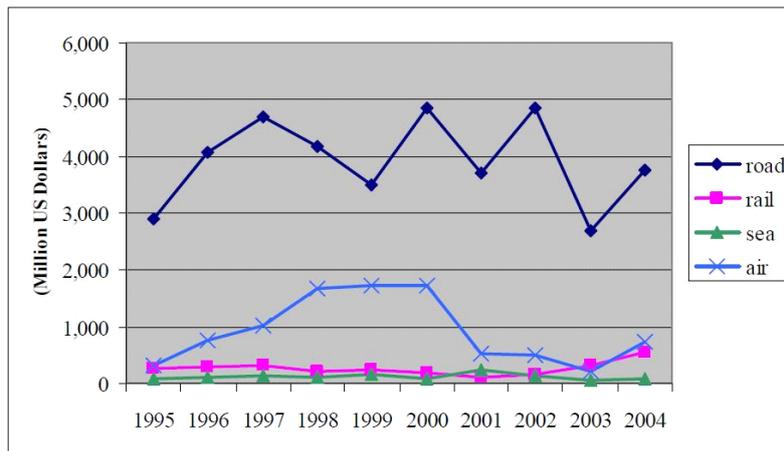


Figure 8. Turkey's investments in different modes of transport (1995-2004) [37]

Table 3. Transport network size [38]

Country	Highway density km/km ²	Motorway density km/km ²	Railway density km/1000 km ²	Annual air transport (x 1000 passengers)
Czech Republic	0.737	0.006	121	7.788
France	0.715	0.017	58	96.296
Germany	0.675	0.032	101	121.136
Belgium	0.571	0.056	113	15.087
Austria	0.444	0.019	71	15.799
EU-25	0.454	0.014	51	32.408
Turkey	0.196	0.002	11	34.267

Table 4. Passenger and freight transport by mode, 2002 [38]

Turkey	Passenger (%)	Freight (%)
Road	95.21	90.47
Rail	3.15	4.52
Maritime	0.02	4.84
Air	1.62	0.17

In the 2000s, after the introduction of transport corridors parallel to international trade development, studies were conducted on the development of a multimodal transport network. From these studies, the Pan-European Transport Network Project was proposed to connect Central and European countries with the EU via the Trans-European Motorway (TEM) and European Railway (TER), thereby promoting balanced and sustainable development for all parties [39].

In 2005, the Transport Infrastructure Needs Assessment (TINA) was launched to advocate for the inclusion of several Central and Eastern European states, including Turkey, in the Trans-European Transport Network (TEN). In support of this effort, Turkey’s Ministry of Transport, Maritime Affairs and Communications submitted a document to the European Commission that proposed prioritized projects for the benefit of Turkey and the EU within the framework of the TEN-T Network. Subsequently, a collaborative study between TINA-Turkey (TINA-T) and the EU (2008) defined and evaluated a multimodal transport network consisting of highways, railways, ports and an airport within Turkey’s borders and connected to the EU’s TEN-T system (Figures 9, 10, 11) [40] from there, Turkey was included in TRACECA.



Figure 9. TRACECA project [41]



Figure 10. TINA-T highway system [42]



Figure 10. TINA-T railway system [42]

Building on the economic and transport opportunities proposed by the TINA-T and TRACECA projects, 'Transport Master Plan Strategy Result Report' was collaboratively prepared in 2005 by the Republic of Turkey Ministry of Transport and Istanbul Technical University [15, 33]. The report, citing the Transport Master Plan Strategy as an important step toward Turkey's accession to the EU [43], evaluated the country's strengths and weaknesses, and cited the need for technologically advanced, high-quality, uninterrupted, safe, environmentally friendly and user-friendly transport services.

This analysis of Turkey's transport planning over the last 50 years reveals that transport principles and policies that were intended to establish a balance between modes of transport and develop an economically and societally appropriate

transport infrastructure were not implemented until the 2000s. Highways were prioritized over railways and maritime transport due to high economic and social costs [44]. However, the limited transport projects developed during this time failed to improve the country's transport situation due to political pressures and illicit profit motives. In summary, the weaknesses of Turkey's transport sector can be regarded as follows:

- Uneven investment in different modes of transport.
- Lack of Transport Master Plan to facilitate consideration of transport system as a balanced whole.
- Inconsistency between physical transport project plans and land use decisions.
- Railway networks in main corridors are old and largely single-lined; few lines comply with high-speed requirements between large cities.
- Gradually decreased budget despite steady increase in transport needs.
- Inefficient operation of transport system due to poor coordination between the many public institutions involved in the system.
- Rapid development of highway transport has failed to adequately reduce traffic accidents, environmental pollution and traffic congestion.
- Lack of fast, safe, comfortable, and economical public transit facilities.
- Difficulty of acquiring private sector transport investments due to bureaucratic obstacles.
- Generally low vocational educational level of transport employees.
- Inadequate data collection system, leading to difficulties retrieving private sector transport data.
- Inability to adequately ascertain start and end points of passenger and freight transport [15].

However, Turkey's transport system also exhibits the following strengths:

- Strategic location between Europe-Asia and Europe-Middle East axes, facilitated by convenient and expandable railway networks and maritime ports.
- In addition to the first and second Bosphorus Bridges, the Marmaray Project will provide uninterrupted rail transport between Europe and Asia.
- Increasing freight transport between the EU, the Middle East and Asia.
- High-capacity vehicle fleet for international highway transport.
- Considerable transport sector knowledge, particularly through institutionalized and organized international transport firms.
- Improvements in investment, operation and legislation within the framework of EU accession [15].

Ultimately, it is clear that the TINA-T and TRACECA projects offer Turkey promising transport solutions. Supported by funding from public and private sectors and the EU's Instrument for Pre-Accession Assistance, mega-transport projects such as airports, high-speed trains, metros, the Marmaray Tube Tunnel, highways and bridges are already under development. At the micro level, intercity rail public transport projects have been implemented to connect large cities like İstanbul, Ankara and İzmir. However, many mega-transport projects proposed after 2000 have remained in development limbo due to noncompliance with urban zoning plans, exclusion of most citizens from decision-making mechanisms and attempted implementation by hegemonic discourse.

This paper investigates the role of transport decisions in the development of

Istanbul's urban structure. In this context, the terms 'transportation' and 'urbanization' are defined, and the relation between urban transport systems and land use is analysed. Transport problems caused by rapid urbanization since the 1950s are examined at global and national levels, and corresponding solutions are indicated.

2. METHODOLOGY

In the method of this study, primarily a literature review was made, reports and maps related to the subject were examined. The same analysis is then applied to a case study of the relationship between transportation and land use in Istanbul, both at the macro level (with respect to Turkey's transportation policies) and the micro level (with respect to the observed relationship between transport planning and urban structure in Istanbul). Various city and national data are used to illustrate the city's explosive growth and urbanization since the 1950s, and the factors affecting transportation and urban structure over every decade of growth. The findings of this analysis are then used to highlight the negative role of transportation decisions and policies on Istanbul's historical development. Finally, corresponding policy recommendations are made for the development of a sustainable transport plan that integrates both transport and urban structure concerns.

3. ISTANBUL'S URBAN DEVELOPMENT AND TRANSPORT SYSTEM

Istanbul, which has served as the capital of two empires (Byzantine and Ottoman) is the only transcontinental city in the world located in both Europe and Asia. The city is strategically located between the Black Sea and the Sea of Marmara, with the highway and railway corridors extending to and from Europe, Asia and the Middle East. Due to its special geographic location, deep-rooted historical relationships with neighbouring countries, cultural diversity, dynamic population and economic potential, Istanbul is not only one of the most important cities in Turkey, but in the world. This importance is underscored in modern international transport policies; the fourth Pan-European Corridor (one of the 10 primary transport axes comprising the Pan-European Transport Project) ends in Istanbul. In TRACECA, Istanbul also serves as a bridge between Europe and Asia (Figures 9 and 12).

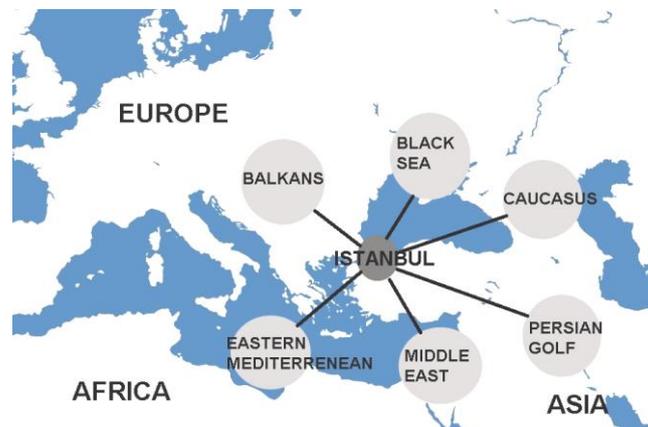


Figure 12. Istanbul's global position [45]

The E-80 and E-90 highways, Trans-European Motorway (TEM) and railways passing through Istanbul are the most important corridors connecting Turkey to Europe. The city also houses Haydarpaşa Port (the most important import centre in Turkey) and Atatürk Airport (an international air transport centre). Therefore, Istanbul is, in all respects, Turkey's socioeconomic and cultural centre and its most important gate to the world [46] (Figures 13 and 14).

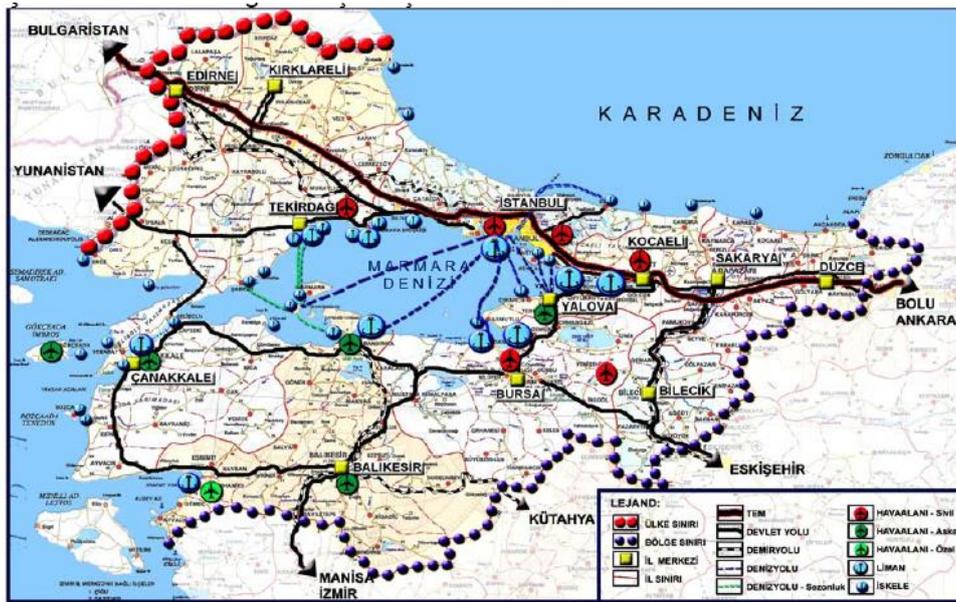


Figure 13. Istanbul's transport connection lines [47]

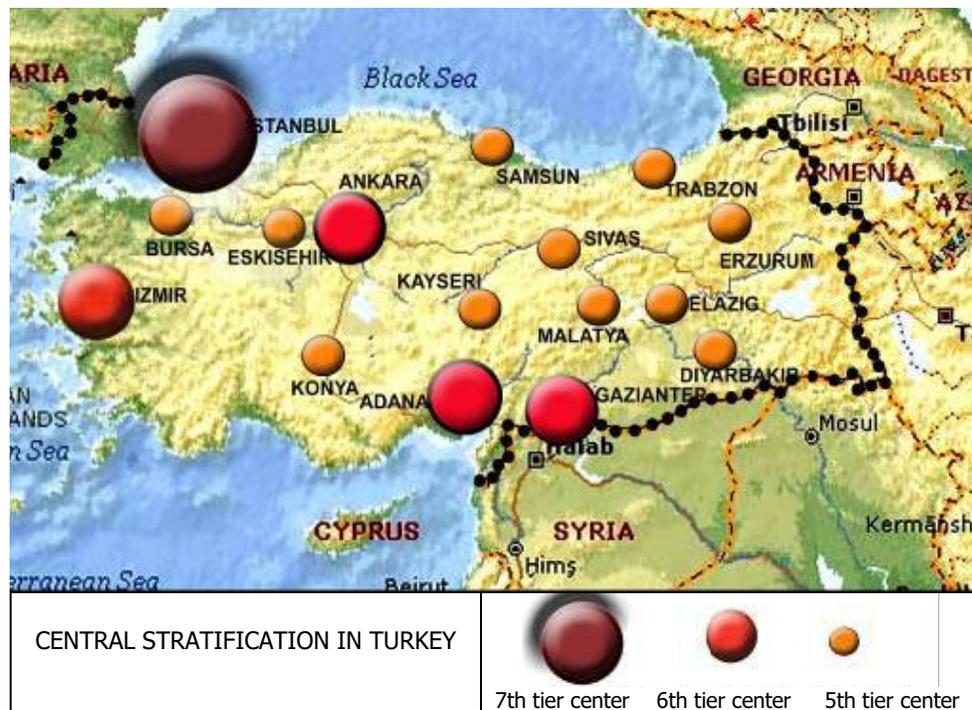


Figure 14. Central Hierarchy in Turkey [47]

Urban location, development and transport connections

As a seaside city, transport relationships have significantly determined Istanbul's history, urban development and structure. Until the 1950s, Istanbul functioned as a compact settlement with a single centre (the Historic Peninsula, bounded by the Galata and the Golden Horn) that developed in an east-west trajectory along the southern coast of the Marmara Sea (Figure 15). During this period, the distance from the city's boundaries to its centre did not exceed 30 km.

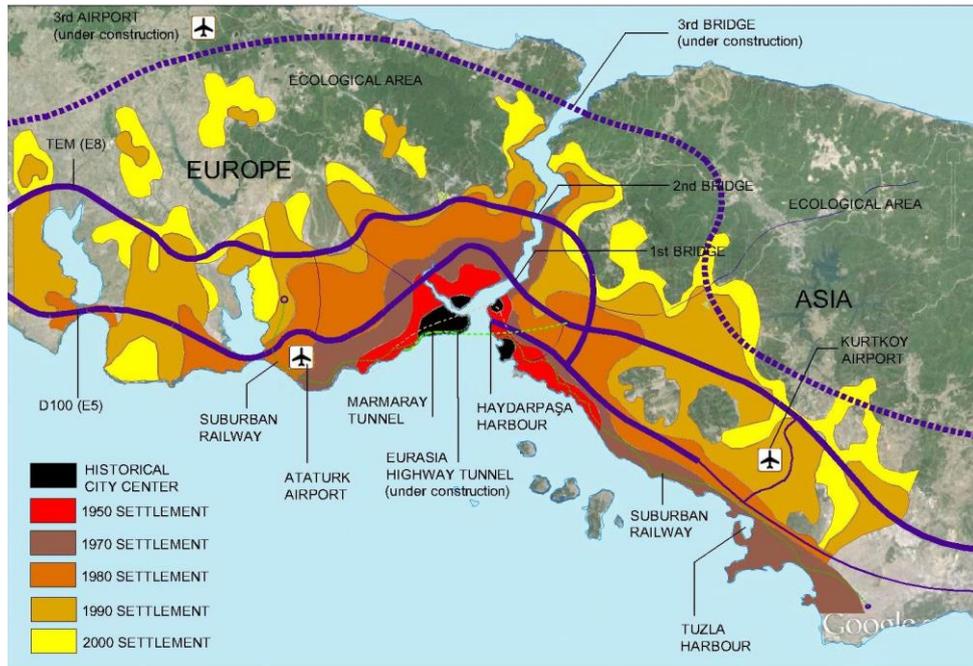


Figure 15. Changes in Istanbul's urban structure from 1950-2010 [48]

In the 1950s, the process of industrialization that radically transformed 19th century Europe eventually reached Turkey. While this industrialization and accompanying rapid urbanization can be regarded as a breaking point for Turkey and Istanbul, it also brought important changes to the city's working and residential areas (Table 5). In particular, the aforementioned highway-based transport policies implemented during this period stimulated Istanbul's further development in a northeast-west direction along both coasts of the Bosphorus (Figure 15).

Table 5. Istanbul's population growth by decade/period [49]

	1950	1960	1970	1980	1990	2000	2009	2013
Population	1166477	1882097	3019032	4741890	7309190	10018478	12915158	13000000
Increase (%)			8.5	10.6	13.0	14.8	17.7	18.3

Since the 1960s, Istanbul has mainly developed through illegal settlements, although planned settlements were also implemented. In this period, the city began to develop linearly along the southern coast of the Sea of Marmara (in the direction of industrial settlement) [50]. The distance between the city's borders and its centre expanded to 40 km in the 1970s and 50 km by the 1980s. In the

1990s, expansion and urban sprawl began to occur in response to rising property values [51]; this outward expansion continued through the 2000s (Table 6). The most important agents of this change have been the first and second Bosphorus Bridges, constructed in 1973 and 1988, respectively. The new motorways and interchanges connecting both bridges to surrounding regions created new long-term settlement areas, which in turn created new transport demands.

Table 6. The relationship between transport and Istanbul’s urban structure by decade [52]

Year	Urban Structure	Cause of Change	Distance from Centre (km)
Pre-1950	Compact, single-centred	Historic nucleus (Historic Peninsula, Galata, Golden Horn region)	30
1960-1970	Linear	Industrialization, migration, population growth, rapid urbanization	40
1970-1980	Large linear	Industrialization, migration, population growth, rapid urbanization, first Bosphorus Bridge	50
1980-1990	Expansion/sprawl	Changed land use demands, industrial decentralization, population growth, new cities, second Bosphorus Bridge (and associated motorways and interchanges)	60
2000-Present	Large linear, northward sprawl (pressure on forests, agriculture and water basins)	Functional land use changes, rapid urbanization, new settlement areas, TOKI projects, urban transformation projects, mega-transport projects (Marmaray Tube Tunnel, third Bosphorus Bridge, Istanbul Channel, Eurasia Highway Tube Tunnel, Eastern Marmara Highway, new airport, new motorways)	60

After development of the two Bosphorus Bridges and associated transport routes, Istanbul’s total area expanded to 19 times its 1950s-era size, extending along both coasts of the Bosphorus in a northeast-west direction (Table 7). Inability to prevent unplanned settlement in the face of rapid population growth has exposed the city’s forests, water basins and agricultural areas (which are northern part of the city’s primary living resources) to increasing settlement pressure [53] (Figure 16 and 17).

Table 7. Size of settlement area by decade and proportion [54]

Year	Settlement Area (m ²)	Settlement/Total Area (%)
1955	7132	1
1965	11392	2
1975	17156	3
1987	384666	7
1997	73707	14
2007	105028	19

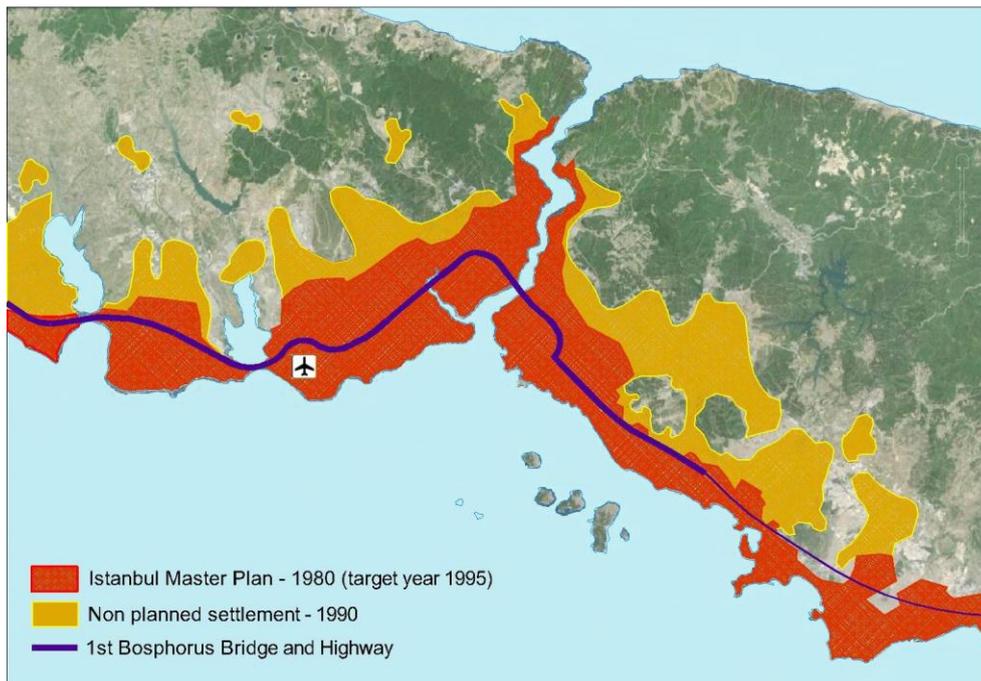


Figure 16. First Bosphorus Bridge (1973) and settlement pattern [55]

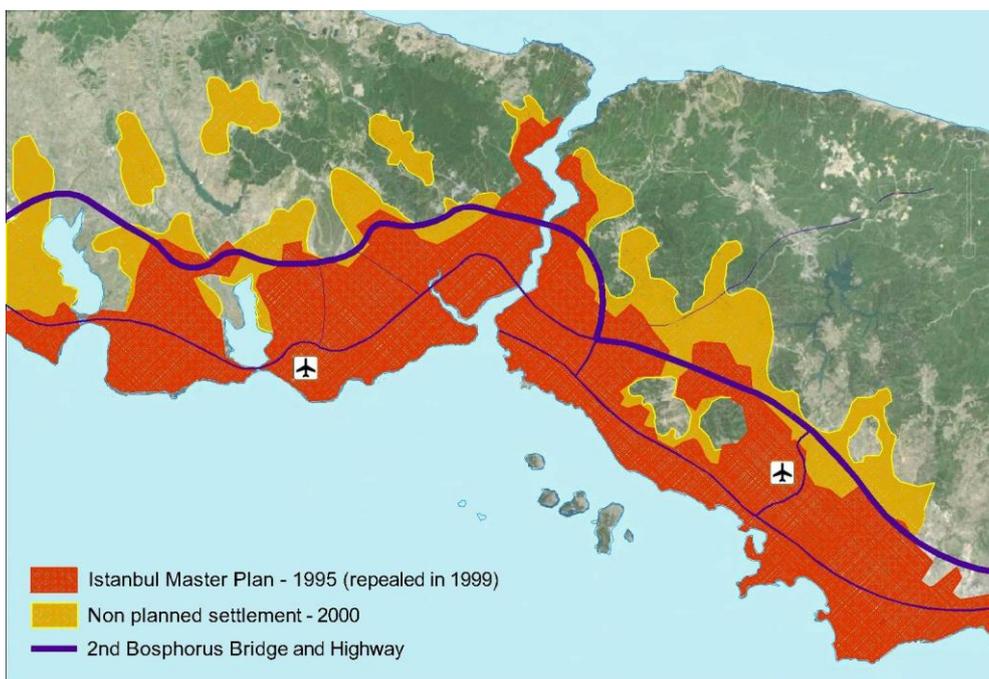


Figure 17. Second Bosphorus Bridge (1988) and settlement pattern [56]

Despite its historic reliance on maritime and rail travel, highways currently dominate intercity passenger transport with a share of 89% (Table 8), with passengers traveling by bus, metrobus, minibus, shared taxi and shuttle bus (Table

9). Of private automobiles in Turkey, 18.3% are found in Istanbul. In 2013, with 600 new vehicles joining traffic daily, Istanbul became the second most congested city in Europe [57].

Table 8. Intercity travel distribution according to mode of transport [58]

Transport Mode	1987 (%)	1996 (%)	2006 (%)
Private Automobile	19.3	19.2	26.24
Taxi/Shared Taxi	10.2	9.4	4.75
Shuttle Bus	10.4	11.5	21.48
Bus (İETT-ÖHO)	35.2	34.1	24.12
Minibus	19.0	19.6	16.71
Rail System	3.8	3.6	4.6
Maritime Transport	2.1	2.6	2.0

Table 9. Highway passenger transport distribution [59]

Transport Mode	Proportion (%)
Bus	39
Minibus	24
Metrobus	10
Shared Taxi	1
Shuttle Bus (Registered)	26
Total	100

As an indispensable element of urban planning, the estimation of future transport demands should primarily depend on the urban structure that will inform future land use decisions [60, 61]. While various urban and transport planning studies have been conducted in Turkey, none have been developed from an interactive standpoint between the two perspectives, and most were politically motivated. The most recent of these, 'Istanbul Metropolitan Transport Master Plan Study', was approved in 2006. The most recent study to determine the city's land use, 'Istanbul Provincial Environment Master Plan' was approved in 2009. Based on data of from this plan, a revised Master Transport Plan was approved in 2011 (after the cancellation of a previous, independently implemented transport plan) [62].

In light of this explosive growth, the latest 'Istanbul Provincial Environment Master Plan' that determines all guiding principles of the Istanbul metropolitan area has the stated aim of: '... giving Istanbul the status of a strengthened city at global scale'. In many respects, Istanbul already qualifies as a 'global city', as its high-density settlement decisions support communication, finance, commercial functions and the gradual enlargement of its urban structure (Figure 18). However, in the last decade, Istanbul has failed to adequately satisfy the key areas that define globalization: technology, finance, media, thought, and especially transports [63].

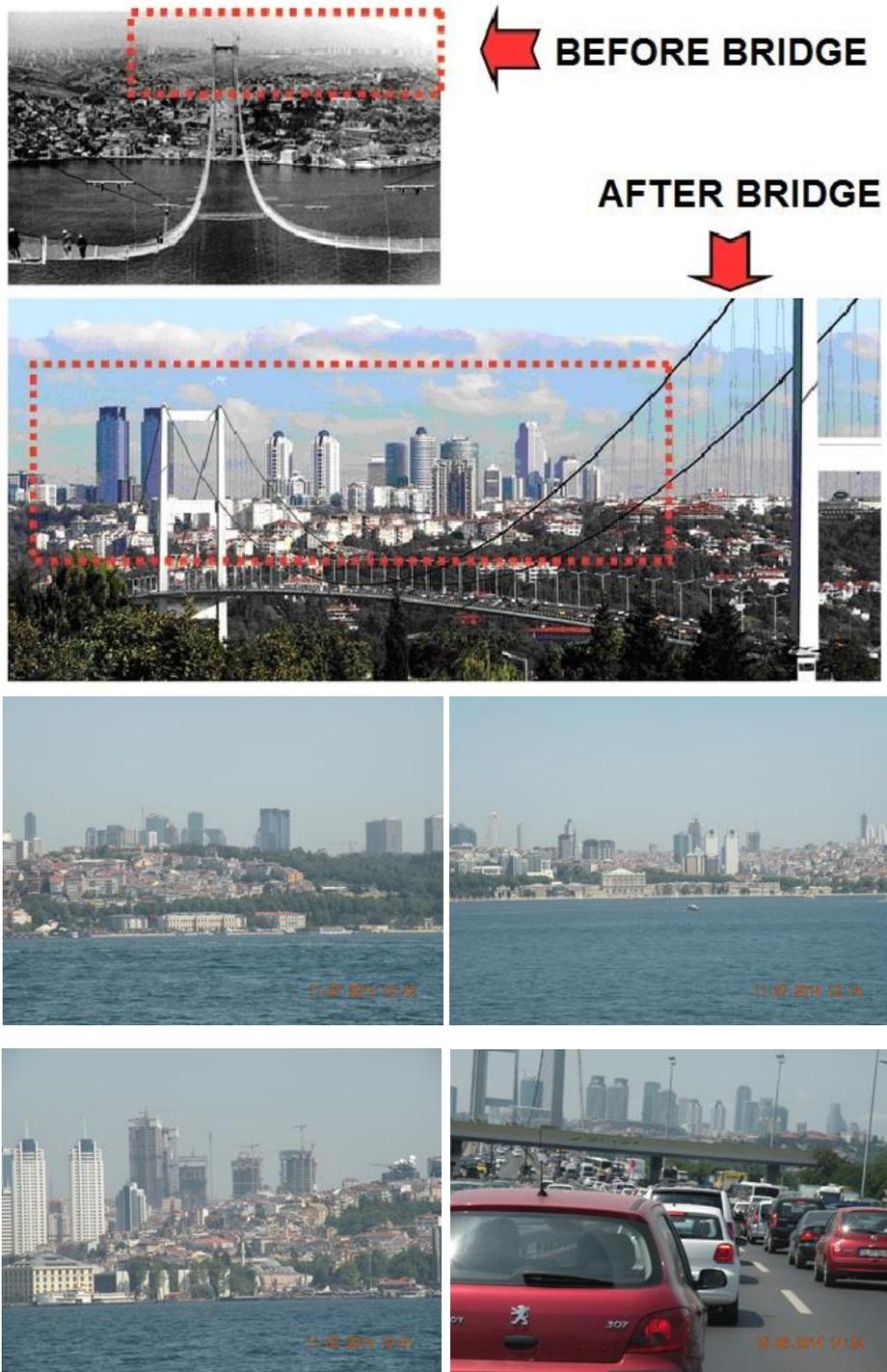


Figure 18. The new high-density face of Istanbul [64]

In the last 10 years, various high-capacity public transit system projects and investments have been developed in Turkey to solve transport problems, including metros, high-speed tramways, metrobuses, sea buses, new highways and the

Marmaray Tube Tunnel. However, the following transport problems persist [65, 66, 67];

- Rapid growth in automobile ownership
- Uncontrolled urban growth
- Geographic characteristics (the strait connecting the two continents and the Historic Peninsula)
- Lack of coordination between modes of transport
- Inadequate public transit
- Loss of time due to long-distance commute between houses and workplaces
- Environmental pollution and noise
- Lack of coordination between multiple public institutions (Istanbul Electricity, Tram and Tunnel, Istanbul Sea Buses, Transport Co., Turkish State Railways and lack of coordination)
- Ambiguous and conflicting administrative and legal frameworks
- Inadequate parking lots
- Traffic accidents and safety issues
- Psychological problems
- Deteriorated quality of life
- Loss of public space (including roads)
- Environmental effects and energy consumption,
- Difficulties with non-motorized transport (pedestrian and bicycle travel)

In summary, Istanbul has not realized sustainable transport decisions in its last 50 years of growth [59, 68]. Politically motivated mega-transport projects continue to stimulate uncontrolled growth of Istanbul's urban structure. The fact that urban space continues to be used as a playground for the implementation of unscientific strategies could cause new problems in Istanbul's urban structure, which is formed by a network of highways in the medium and long term [69]. While Istanbul's historical and cultural values should be protected, the abovementioned transport problems could be sustainably solved with technological support. Accordingly, a new, sustainable Transport Master Plan that balances ecological, historical and cultural values should be reviewed based on scientific studies of the interaction of urban and transport planning in Istanbul. As such, the following macro- and micro-level actions are recommended:

Macro:

- All modes of transport should be used to integrate both sides of Istanbul (using the results of the TINA-T study).
- Combined transport should be used, including railway and maritime transport.
- Public transit should be prioritized as the main method of passenger transport.

Micro:

- **Improving public transit:** Improving bus use by increasing comfort levels of transit vehicles and stations; diffusion of light and heavy rail and maritime systems.
- **Priority lanes for busses and high-occupancy vehicles** to minimize the use of private car.
- Discouraging automobile use in central regions by not constructing new

parking lots; facilitating automobile drivers' transition to rail travel by establishing **park and ride** facilities outside central areas, especially near rail systems.

- **Parking management:** Restriction of on-street parking; higher parking fees.
- Building more bicycle lanes and introducing policies to **promote bicycle use.**
- **Enhancing pedestrian areas,** especially in historical city centres.
- **Alternating work schedules** to prevent traffic congestion.
- **Encouraging car sharing** with neighbours and colleagues.
- **Traffic reduction:** placing speed bumps in certain streets; narrowing avenues.

4. CONCLUSION

Under the last thirty years of globalization, the world has seen rapid and comprehensive rapid technological and economic developments. Corresponding rapid global population growth, migration and urbanization have created new transport demands, especially in metropolitan cities [70, 71, 72]. As such, the importance of sustainable transport to economic and social integration has increased significantly, demanding reconsideration of conventional transport planning projects on global and local scales [73]. Additionally, given the symbiotic relationship between transport and urban structure, transport planning and urban planning should be conducted simultaneously and interdependently to best meet a city's social and economic needs [74, 75, 76].

This study, which examined these issues in the city of Istanbul, reached two main findings. First, it was found that none of Turkey's transport principles and policies were compliant with the country's economic and social conditions until the 2000s; any plans implemented before that time were inconsistent with its cities' physical plans and land use. Second, Istanbul's transport policies in particular were found to be inconsistent with national, regional and local transport concerns. Indeed, Istanbul's explosive growth in the last 40 years has both affected and been affected by transport decisions made independently from land use concerns, leading to increased settlement pressure on ecologically important areas.

To address these issues while facilitating larger-scale integration, Turkey should take the EU's transport policies into account when conducting future transport planning efforts. In this context, sustainable transport decisions and practices should be realized at the national level, aiming to achieve a whole and balanced distribution between modes of transport. At the city level, Istanbul should develop a new sustainable Transport Master Plan that integrates urban planning concerns, uses scientific data, and facilitates citizens' democratic participation in decision-making mechanisms. Finally, public transit methods (particularly railway travel) that use modern technologies are high quality, uninterrupted, safe, environmental and user friendly should be promoted and prioritized.

REFERENCES

- [1] Çelik, Murat. Sürdürülebilir Ulaşım ve Türkiye Kentleri Ulaştırma Sorunları. *Tmmob 1. İzmir Kent Sepozyumu Bildiriler Kitabı*, 2009, 08-10.
- [2] Ducluet, César; Rodrigue, Jean-Paul. Graph Theory: Measures And

- Indices. *The Geography Of Transport Systems*, 2013.
- [3] Gerçek, H. Ulaştırma Yatırımları Üzerinden İstanbul'un Geleceği. *Mimarist Dergisi*, 2012.
- [4] Nations, U. World Population Ageing 2019 Highlights; United Nations, Department of Economic and Social Affairs. *Population Division: New York, NY, USA*, 2019.
https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf, Accessed May 25, 2016.
- [5] Banister, David; Lichfield, Nathaniel. *The key issues in transport and urban development*. Routledge, 2003.
- [6] Mitchell, Robert B.; Rapkin, Chester. *Urban traffic*. Columbia University Press, 1954.
- [7] Mees, P. What Happened To The Systems Approach? Evaluation Of Alternatives İn Planning For Major Transport Projects. In: *Australasian Transport Research Forum (Atrf), 26th, 2003, Wellington, New Zealand*. 2003.
- [8] Hansen, Walter G. How accessibility shapes land use. *Journal of the American Institute of planners*, 1959, 25.2: 73-76.
- [9] Krizek, Kevin J. Perspectives on accessibility and travel. In: *Access to destinations*. Emerald Group Publishing Limited, 2005. [10] Giuliano, G., (1989) New Directions for Understanding Transportation and Land Use. *Environment and Planning A* 21: 145-159.
- [11] Gerçek, H. İstanbul Ulaşım Nazım Planı Çerçevesinde Arazi Kullanım Senaryolarına Bağlı Olarak Boğaz Geçişleri. *Birinci Ulusal Ulaşım Sempozyumu*, 1996, 27-41.
- [12] Babalık-Sutcliffe, E. Kentsel Sorunların Çözümünde Ulaşım Politikaları; Ulaşım Sorunlarının Çözümünde Kent Planlama Politikaları, Ankara'da Uygulanan Ulaşım Politikaları ve Kente Etkileri Sempozyumu, Ankara; 2005, 57-71.
- [13] Litman, Todd; Steele, Rowan. *Land use impacts on transport*. Canada: Victoria Transport Policy Institute, 2017.
- [14] Öncü, Erhan. Ülkemiz Kentlerinin Ulaşım Yapısı ve Kentlilerin Yolculuk Özellikleri, 5. *Toplutaşım Kongresi*, 1993.
- [15] Transport Master Plan Strategy Final Report (Ulaştırma Ana Planı Stratejisi Sonuç Raporu), T.C. Ulaştırma Bakanlığı ve İstanbul Teknik Üniversitesi, Ulaştırma ve Ulaşım Araçları Merkezi, İstanbul, 2005.
- [16] Meadows, D., et al. *The Limits to Growth*. New York: Universe book. *Cerca con Google*, 1972.
- [17] Elker, C. Çağdaş Ulaşım Politikaları, II. Ulaşım ve Trafik Kongresi Bildiriler Kitabı. *TMMOB Makine Mühendisleri Odası Yayını, Ankara*, 1999.
- [18] Black, Alan. *Urban mass transportation planning*. 1995.
- [19] Rodrigue, Jean-Paul; Comtois, Claude; Slack, Brian. *The Geography Of Transport Systems*. Routledge, 2016.
- [20] Kuşçu, Sinan, et al. Avrupa Birliği Ulaştırma Politikası ve Türkiye'ye Yansımaları. *Gazi Akademik Bakış*, 2011, 09: 77-92.
- [21] To, Having Regard; Barker, Mrs Muriel. White Paper European Transport Policy For 2010: Time To Decide. *Commission Of The European Communities Brussels*, 2001.
- [22] Tutar, Erdinç; Tutar, Filiz; Eren, Mehmet Vahit. Uluslararası Ulaşım Koridorunda Yeni Bir Açılım: Traceca Projesi Ve Türkiye. *Mevzuat Dergisi*, 2009, 12.139: 1306-0767.

- [23] United Nations Economic Commission for Europe. Trans-European Motorway (TEM) Project, Trans-European Railway (TER) Project, TEM and TER Revised Master Plan Final Report, Volume I: Main text, 2011
- [24] Kuşcu, S. European Union, Eurasian Transportation Policies and Prospective Effects on Regional Economies, In: *International Conference On Eurasian Economies*, 11-13 October, Kazakhstan, 2012, pp. 452-459.
- [25] United Nations, TEM and TER revised Master Plan, 2011, https://unece.org/DAM/trans/main/temtemp/docs/TEM_and_TER_Vol_I.pdf
- [26] European Commission. TRACECA. 2014. <http://www.traceca.org.org/en/home/> Accessed 11 January 2020.
- [27] Republic of Turkey Ministry of Development. Regional Development National Strategy (2014-2023), Population growth rates and projections (‰) in Turkey by year, T.C. Ministry of Development, 2014, [https://www.sbb.gov.tr/wp-content/uploads/2018/11/2014-2023 Bölgesel Gelişme Ulusal Stratejisi.pdf](https://www.sbb.gov.tr/wp-content/uploads/2018/11/2014-2023_Bölgesel_Gelişme_Ulusal_Stratejisi.pdf), Accessed 20, January 2016
- [28] Turkish Ministry of Transport and Infrastructure, International highways passing through Turkey, www.kgm.gov.tr, Accessed 20, January 2020.
- [29] Republic of Ministry of Transport, Maritime Affairs and Communications, Historical railway development in Turkey. 2012. <https://www.raillynews.com/2019/11/historical-development-to-this-very-day-the-turkey-railways/>
- [30] Yıldız, A. Ulaşım ve Trafik Politikalarında. *Planlama” Zorunlu”, Mühendis ve Makine Dergisi*, 2008, 580: 38-51.
- [31] Vural, K. V. II. Dünya Savaşı Sonunda Türkiye'nin Dış Siyasetinde Yaşananların Ulaşım Politikalarına Etkileri ve Karayolları. *İzmir Ulaşım Sempozyumu*, 2009, 8-9.
- [32] Data Portal For Statistics, Passenger transport in Turkey by decade (passenger-km), (TUIK Information was used-2005)
- [33] Operational Transportation Programme. CCI No: 2007 TR 16 I PO 002. T.C. Ministry of Transportation, Ankara, 2007.
- [34] Özalp, Musa; Öcalır Akünal, Ebru Vesile. Türkiye'deki Kentiçi Ulaşım Planlaması Çalışmalarının Değerlendirilmesi (1). *Orta Doğu Teknik Üniversitesi Mimarlık Fakültesi Dergisi*, 2008, 25.2: 71-97.
- [35] Aydın, Fatih; Muhammed, O. R. A. L. Türkiye'de Karayolu Ulaşımının Tarihsel Gelişimi. *Journal Of Awareness*, 2018, 3.5: 257-266.
- [36] Teşkilatı, Devlet Planlama; Komisyonu, Ulaştırma Özel İhtisas. *Ulaştırma Özel İhtisas Komisyonu, Genel Ulaştırma Alt Komisyonu Raporu*. Tc Başbakanlık Devlet Planlama Teşkilatı, 1995.
- [37] Kartal, Kazım. Extension of ten-t into accession countries and Turkey. *Ministry Of Transport, Ankara And Transport Studies Unit, University Of Oxford Working Paper*, 2007, 1021.
- [38] Transport network size, Sectoral Operational Program for Transport, Draft, prepared by the Ministry of Transport for IPA programming.
- [39] Secretariat, T. I. N. A. Status of the Pan-European Transport Corridors and Transport Areas. Developments and Activities in 2000 and 2001. 2002.
- [40] Yaman, Sevinç. Trans Avrupa Ulaşım Şebekelerinin (TEN-T) gelişimi kapsamında Türkiye'de yürütülen çalışmalar. *Uluslararası Ekonomik Sorunlar*

Dergisi, 2009, 24-48.

[41] TRACECA Turkey. "TRACECA project". 2012.

[42] TINA and the European Commission. *Status of The Pan-European Transport Corridors and Transport Areas, Developments and Activities In 2000 And 2001, Final Report, 2002.*

[43] Onur, Emrah Yazar; Fırat, Melek Tez Danışmanı. *Avrupa Topluluğu'nun ortak ulaştırma politikası ve Türkiye için ulaştırma faslında katılım müzakereleri süreci.* 2006. PhD Thesis. Ankara Üniversitesi Sosyal Bilimler Enstitüsü Uluslararası İlişkiler Anabilim Dalı.

[44] Gerçek, H., 2003. İstanbul Ulaştırma Ana Planı Ve Mevcut Uygulamalar (Istanbul Transportation Master Plan and Current Applications). *Istanbul Bulteni* , 65.

[45] İstanbul's global position. (Search Produced by the author, Ayşe Sirel, 2016)

[46] Gezici, F., & Kerimoglu, E. (2010). Culture, tourism and regeneration process in Istanbul. *International Journal of Culture, Tourism and Hospitality Research.*

[47] Belediyesi, İstanbul Büyükşehir; Müdürlüğü, Şehir Planlama. 1/100.000 Ölçekli İstanbul Çevre Düzeni Planı. 2009.

[48] Changes in İstanbul's urban structure from 1950-2010 (Produced by the author, Ayşe Sirel, 2013).

[49] İstanbul's population growth by decade/period, www.tuik.gov.tr, Accessed May 20,2020

[50] Uysal, Y. (2006) İstanbul ve Ulaşım (Istanbul and Transportation). *mimar.ist* 2: 57-60.

[51] Akın, O. İstanbul kentinin değişim öyküsü. *Mimarist*, 2012, 12.45: 46-59.

[52] The relationship between transport and İstanbul's urban structure by decade. (Produced by the author from text information)

[53] Köktürk, Erol; Çelik, Rahmi Nurhan; Köktürk, Erdal. The Natural Resources Of İstanbul, European Capital Of Culture 2010.

[54] Taşdemir, İ.; Batuk, F. Boğaz Geçişlerinin İstanbul Üzerinde Oluşturduğu Sosyoekonomik Değişimlerin CBS Ortamında İncelenmesi.

[55] First Bosphorus Bridge (1973) and settlement pattern (Produced by the author, Ayşe Sirel, 2016)

[56] Second Bosphorus Bridge (1988) and settlement pattern (Produced by the author, Ayşe Sirel, 2016)

[57] Tomtom Traffic Index, http://www.tomtom.com/en_gb/trafficindex/. Accessed November 25, 2021.

[58] The İstanbul Metropolitan Municipality, Intercity travel distribution according to mode of transport, <http://www.iett.gov.tr/metin.php?no=38>, Accessed April 20, 2020.

[59] İstanbul Electricity, Tram and Tunnel and Directorate of Public Transit Services, Highway passenger transport distribution, (2010).

[60] Gerçek, Haluk. Is there a road ahead. *Istanbul: City of intersections*, 2009, 47.

[61] Curtis, Carey. Integrating land use with public transport: The use of a discursive accessibility tool to inform metropolitan spatial planning in Perth. *Transport reviews*, 2011, 31.2: 179-197.

[62] IUAP. İstanbul Metropolitan Area Transport Master Plan, İstanbul Büyükşehir

- Belediyesi Ulaşım Daire Başkanlığı, Ulaşım Planlama Müdürlüğü, İstanbul., 2011.
- [63] Appadurai, Arjun. Disjuncture and difference in the global cultural economy. *Theory, culture & society*, 1990, 7.2-3: 295-310.
- [64] Çalışkan, Çare Olgun. 3. Köprü Projesi Değerlendirme Raporu. *TMMOB Şehir Plancıları Odası İstanbul Şubesi*, 2010.
- [65] Wioletta, Szymanska. *Sustainable Transport Policies in South Eastern Europe: Needs, Priorities and Lessons Learnt from EU Countries*. REC, 2008.
- [66] Saatçioğlu, C.; Yaşarlar, Y. Kentiçi ulaşımda toplu taşımacılık sistemleri: İstanbul örneği. *Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 2012, 3.3: 117-144.
- [67] Evren, Güngör. Kentsel ulaşımda raylı sistemler. *Türkiye Mühendislik Haberleri*, 1996, 384: 63-72.
- [68] Canitez, Fatih; Alpkokın, Pelin; Kiremitçi, Sabahat Topuz. Sustainable Urban Mobility İn İstanbul: Challenges And Prospects. *Case Studies On Transport Policy*, 2020, 8.4: 1148-1157.
- [69] Karabey, H. Yeni İstanbul planı aslında ne söylüyor. *Mimarlık Dergisi*, 2010, 356: 17-22.
- [70] Darin-Drabkin, Haim. *Land Policy And Urban Growth*. Oxford: Pergamon Press, 1977.
- [71] Rahman, Md, Et Al. Future Mass Rapid Transit İn Dhaka City: Options, İssues And Realities. *Jahangirnagar Planning Review*, 2008, 6: 69-81.
- [72] Sinha, Kumares C. Sustainability And Urban Public Transportation. *Journal Of Transportation Engineering*, 2003, 129.4: 331-341.
- [73] Litman, todd; burwell, david. issues in sustainable transportation. *international Journal Of Global Environmental Issues*, 2006, 6.4: 331-347.
- [74] Ballantyne, Erica Ef; Lindholm, Maria; Whiteing, Anthony. A Comparative Study Of Urban Freight Transport Planning: Addressing Stakeholder Needs. *Journal Of Transport Geography*, 2013, 32: 93-101.
- [75] Kwakye, E. A.; Fouracre, P. R.; Ofosu-Dorte, D. Developing Strategies To Meet The Transport Needs Of The Urban Poor İn Ghana. *World Transport Policy And Practice*, 1997, 3: 8-14.
- [76] Stanley, Janet; Stanley, John; Gleeson, Brendan. Planning Transport To Meet The Needs Of Children And Young People. In: *A Companion To Transport, Space And Equity*. Edward Elgar Publishing, 2019.

Article distributed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND).

Received: August 2, 2021

Accepted: August 9, 2021, revision September 13, 2021