Vizyoner Dergisi

Süleyman Demirel Üniversitesi Vizyoner Dergisi, Yıl: 2023, Cilt: 14, Sayı: 100. Yıl Özel Sayısı, 254-279.
Süleyman Demirel University Visionary Journal, Year: 2023, Vol: 14, No: 100th Anniversary Special Issue, 254-279.

ISSN: 1308-9552

ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

INTELLIGENT TRANSPORTATION SYSTEMS AND POLICIES IN THE WORLD AND IN TÜRKİYE: ASSESSMENT FROM A SUSTAINABLE TRANSPORTATION PERSPECTIVE

DÜNYADA VE TÜRKİYE'DE AKILLI ULAŞIM SİSTEMLERİ VE POLİTİKALARI: SÜRDÜRÜLEBİLİR ULAŞIM AÇISINDAN BİR DEĞERLENDİRME

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ABSTRACT

As people have to change their places in order to meet their needs, there has been an increase in the demand for mobility and transport. It has become more important to correctly plan the time spent on roads and traffic according to criteria such as safety, security, comfort, and environmental impacts for the seamless mobility of people and goods. One of the prominent concepts in the studies and search for solutions in this direction is intelligent transport systems. The purpose of the study is to find out the importance of Intelligent Transport Systems (ITS) and policies in the world and in Türkiye in terms of sustainable transportation. In this context, firstly, the importance of ITS and its regional development in the historical process is mentioned. Then, ITS activities and policies in Türkiye and their place in strategy documents is analysed. Finally, the National ITS Strategy and Action Plans related to intelligent transport systems, which have developed as a new transport solution within the framework of sustainability in the world, are evaluated in terms of their contribution to transport, economy and climate change, and technical, administrative, and social focus areas to increase ITS deployments in Türkiye are presented.

Keywords: Intelligent Transportation Systems, Intelligent Transportation Policies, Intelligent Transportation Strategies, Sustainable Transportation, Transportation Economics.

JEL Classification Codes: R41, R42, R49, N7.

ÖZ

İnsanların ihtiyaçlarını karşılamak amacıyla yer değiştirmek zorunda kalmasıyla birlikte hareketlilik ve ulaşım alanlarındaki taleplerinde artışlar ortaya çıkmıştır. İnsan ve yüklerin hareketliliğinde emniyet, güvenlik, konfor, çevresel etkiler gibi kriterlere göre yollarda ve trafikte geçen zamanın doğru planlanması daha önemli hale getirmiştir. Bu doğrultuda yapılan çalışmalar ve çözüm arayışlarında akıllı ulaşım sistemleri kavramının öne çıktığı görülmektedir. Bu çalışmanın amacı, Akıllı Ulaşım Sistemleri (AUS) ve politikalarının sürdürülebilir ulaştırma açısından önemini ortaya koymaktır. Bu kapsamda çalışmada öncelikle Akıllı Ulaşım Sistemlerinin önemine; tarihsel süreçte bölgesel gelişimine değinilecektir. Sonrasında, Türkiye'de Akıllı Ulaşım Sistemleri faaliyet ve politikaları ile bunların Strateji Belgelerindeki yeri irdelenecektir. Nihayetinde dünyada sürdürülebilirlik çerçevesinde yeni bir ulaşım çözümü olarak gelişen akıllı ulaşım sistemlerine ilişkin Ulusal AUS Stratejisi ve Eylem Planları, ulaşıma, ekonomiye ve iklim değişikliğine katkısı bakımından değerlendirilecektir ve Türkiye'de AUS'un yaygınlaştırılmasına yönelik teknik, idari ve sosyal başlıklar sunulacaktır.

Anahtar Kelimeler: Akıllı Ulaşım Sistemleri, Akıllı Ulaşım Politikaları, Akıllı Ulaşım Stratejileri, Sürdürülebilir Ulaşım, Ulaştırma Ekonomisi.

JEL Sınıflandırma Kodları: R41, R42, R49, N7.

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Makale Geliş Tarihi / Received : 13.04.2023
Makale Kabul Tarihi / Accepted : 04.10.2023

https://doi.org/10.21076/vizyoner.1281444

Süleyman Demirel Üniversitesi Vizyoner Dergisi, Yıl: 2023, Cilt: 14, Sayı: 100. Yıl Özel Sayısı, 254-279.
Süleyman Demirel University Visionary Journal, Year: 2023, Vol: 14, No: 100th Anniversary Special Issue, 254-279.
ISSN: 1308-9552

GENİŞLETİLMİŞ ÖZET

Amaç ve Kapsam:

Son yıllarda ülkemizde ve dünyada özellikle salgın hastalık, deprem, sel baskını, yangın gibi olağan dışı olumsuz doğa olaylarının da etkisiyle endüstride yer alan pek çok sektör hızlı bir dijitalleşme hatta ticari dijitalleşme sürecine girmiştir. Yeni dijital çağ; teknolojik değişimlerden değil, teknolojinin mümkün hale getirdiği aynı zamanda sebep olduğu alışkanlıklar, yaşam tarzı, ihtiyaçlar gibi toplumsal değişimlerden oluşmaktadır. Kent merkezlerine göçlerin çoğalması, dünya çapında kentleşme oranlarının artmasına ve ulaşımın da dahil olduğu birçok alanda acil çözüm gerektiren ciddi sorunlara neden olmuştur. Bu çözümlerden biri, sürdürülebilir ulaşımı sağlamak için trafiği daha etkin bir şekilde planlamayı ve yönetmeyi amaçlayan Akıllı Ulaşım Sistemlerinin geliştirilmesidir. Ulaşım sektöründe büyük ölçüde karbon içeriği yoğun ve çevreye olumsuz etkisi fazla olan geleneksel yakıtların kullanımının doğal sonucu olarak ortaya çıkan zararlı gaz emisyonu konusu sürdürülebilirlik çözümlerine ilişkin tartışmalarda önemli bir yer işgal etmektedir. Özellikle ulaşımın olumsuz çevresel etkilerinin azaltılması ile enerji verimliliği ve ulaşım güvenliğinin sağlanması çerçevesinde ulaşım kaynaklı ekonomik sorunların çözülmesine ilişkin süreçler sürdürülebilirlik kavramıyla ifade edilmektedir. Aynı zamanda insan ve yüklerin hareketliliğinde emniyet, güvenlik, konfor, çevresel etkiler gibi kriterlere göre yollarda ve trafikte geçen zamanın doğru planlanması daha da önemli hale getirmiştir. Bu doğrultuda yapılan çalışmalar ve çözüm arayışlarında sürdürülebilir bir dünya ve içinde bir unsur olan ulaşım için öne çıkan kavramlardan biri de akıllı ulaşım sistemleri olmaktadır. Bu çalışma AUS'un sürdürülebilir ulaşım bağlamında önemini ortaya çıkarmayı amaçlamaktadır. Bu doğrultuda, öncelikle AUS kavramı, ulaşım politikaları kapsamında yenilikler ve dijitalleşme girişimleri konularına değinilerek paydaşları ile birlikte açıklanmıştır. Sonrasında AUS'un dünyadaki ve ülkemizdeki durumu incelenerek AUS'un Türkiye'deki durumu ile ekonomi ve sürdürülebilir ulaşım üzerindeki etkisine odaklanılmıştır. Nihayetinde, Türkiye'de AUS'un yaygınlaşması doğrultusunda gerekli olan teknik, idari ve sosyal politika alanları kapsamında önerilerilere yer verilmiştir.

Yöntem:

Bu çalışmada Türkiye'de ve dünyada AUS'un sürdürülebilir ulaşım kapsamında önemini ortaya koymak amaçlandığından, belgesel kaynak taraması yoluyla ABD, Avrupa, Asya-Pasifik ve Türkiye'deki bölgesel/ulusal AUS politika ve uygulamaları incelenerek değerlendirmeler yapılmıştır. Bu inceleme ve değerlendirmeler ulusal ve uluslararası literatür çalışmaları, raporlar ve mevzuat dokümanları ile desteklenmiştir. Öncelikli olarak kavramsal yapı üzerinde durularak AUS'un dünya ve Türkiye'deki dönüşümüne odaklanılmış, çıkarım ve yorumlarda bulunulmuştur. Türkiye açısından ulaşıma, ekonomiye ve iklim değişikliğine katkısı bakımından Ulusal AUS Strateji Belgesi ve 2020-2023 Strateji Belgesi bu konuda incelenmesi gereken temel belge olarak karşımıza çıkmaktadır.

Bulgular:

Dünyanın pek çok yerinde bilgi ve sistem kontrol teknolojisi ile yapay zekâ gibi ileri teknolojilerin entegre bir uygulaması olan akıllı ulaşım sistemleri hareketlilik, dijitalleşme, ulaşım, altyapı, yol güvenliği ve bölgesel uyum alanlarında uygulanan kamu politikaları zorluklarına ve ulaşım sorunlarına etkili bir çözüm olarak kabul edilmektedir. AUS'un sürdürülebilirlik, bilinçli toplum ve yaşanabilir çevre hedeflerine katkısı kapsamında yakıt tüketimini ve emisyonları azaltarak bu alanda ciddi çalışmalar yürüten iyi uygulama örneklerine sahip birçok ülke tarafından, 2030-2035'li yıllara kadar elektrikli araç kullanım miktarını kademeli olarak artırılması ve fosil yakıt tüketen araçların üretiminin durdurulması gibi kararlar alınmıştır. Kaynakların sonsuz olmadığını, dünyayı ve toplumsal ihtiyaçları dikkate alarak ortaya çıkan uygulanabilecek politikaların, ulaşım sektörü üzerindeki etkilerinin sonuçları diğer sektörlere göre daha hızlı görülebilmektedir. Bilgi ve iletişim teknolojileriyle birlikte yıkıcı yenilikçi teknolojileri kullanarak geliştirilen sistem, hizmet, uygulama gibi akıllı ulaşım çözümleri, birçok faydalı amaç için kullanılmasının yanında iklim değişikliğinin en önemli unsurları olan enerji verimliliği ile çevre ve hava kalitesinin iyileştirilmesine de katkıda bulunmaktadır. Türkiye'de de AUS'un farkındalığı artarak birçok iyi uygulamayı ortaya çıkartmaktadır. Bu uygulama ve projeler ise şehir içi ve şehirlerarası ulaşımda değişim ile dönüşümü ortaya çıkartmaktadır. Bu değişim ve dönüşüm süreçlerinin düzenli ve standart bir yapıda olması için üst politika belgelerine ihtiyaç duyulmaktadır. Bu belgeler sektör için yol gösterici bazen da gelişmelerin önünü açan dokümanlar olarak karşımıza çıkmaktadır.

Sonuç ve Tartışma:

Türkiye'de AUS'un yaygınlaşmasının önündeki engellerin en önemlileri mevzuat, politika, strateji ve düzenleyici çerçevelerdeki eksiklikler ile yetki karmaşalarının ortaya çıkardığı sorunlardır. AUS geliştirilmesinde kısa vadeli hedef acil olarak görülen sorunların belirlenerek ele alınması ve altyapının iyileştirilmesi çabaları olmalıdır. Uzun vadeli hedef ise AUS'un ülke geneline yaygınlaştırılmasının sağlanmasıdır. Bu doğrultuda Ulusal Akıllı Ulaşım Sistemleri Strateji Belgesi ve 2020-2023 Eylem Planı, dünyadaki iyi örnekler dikkate alınarak hazırlanmış mevcut durum ve geleceği öngörerek planlanmış bir yol haritasıdır. Eylem planının 2023 yılı sonunda uygulama süresi dolacak ve bu doğrultusunda yeni bir güncelleme ihtiyacı ortaya çıkacaktır. Güncellemenin ise bu alanda öncü ülke örneklerinde olduğu üzere otonom ve bağlantılı hareketlilik, ekonomik sürüş, paylaşımlı, adil ve erişilebilir ulaşım modellerini içeren bütünsel bir bakış açısıyla yapılmalıdır. Bu noktada, bu çalışmanın "*AUS'un Sürdürülebilir Ulaşıma ve Ekonomiye Katkısı* bölümünde", AUS'un Türkiye'de yaygınlaştırılmasına yönelik olarak teknik, idari ve sosyal öneri başlıkları sunulmuştur. Bu başlıklar dikkate alınarak yapılacak faaliyetlerde, kurumsal yapılar da göz önünde bulundurulmak suretiyle kamu kaynaklarının verimli kullanımında mükerrerliğin önüne geçecek önlemler ile çalışmalar sürdürülmelidir.

1. INTRODUCTION

Within the framework of the increasing demands and needs of human beings, migration towards urban centres continues at an increasing pace in the world and in Türkiye. The data in the World Urbanisation Prospects report prepared by the United Nations clearly shows that people no longer prefer rural areas for living and settling in cities. According to this report, in 1950, 30 percent of the population lived in urban areas, which increased to 54 percent in 2014. Thus, it is projected that the proportion of the total population living in urban areas will reach 66 percent in 2050. (United Nations, 2022). This means that 2.5 billion people will be added to the urban population in the next thirty years. With this population increase, the need for efficient and effective resource management to ensure environmental, social and economic sustainability increases in importance.

In Türkiye, as in the whole world, many sectors in the industry have felt the need to enter a rapid digitalization and even commercial digitalization process in recent years, especially with the effect of epidemics, earthquakes, floods, fires and similar extraordinary negative natural events. The new digital age does not consist of technological changes; it consists of social changes such as habits, lifestyle and needs made possible by technology. Therefore, it will be possible for innovations and digitalization initiatives within the scope of transport policies to benefit all stakeholders by analysing the possibilities of technology correctly in social terms and using them to create efficient and effective solutions. In this direction, governments have very important duties and responsibilities, and it is necessary to take into account many factors in determining strategies and policies.

Traffic congestion, air pollution, carbon emissions and similar environmentally negative issues are directly related to sustainability in developed and developing countries. Sustainable transport is a concept that refers to the efficiency of energy consumption and the reduction of air pollution, ensuring transport safety as well as solving economic problems arising from transport, especially in terms of decreasing the environmental impacts of transport.

It is clear that transportation infrastructure is the main element for the economic development of a country. In this study, first of all, the situation of ITS in the world and developments in Türkiye will be discussed. Afterwards, the National Intelligent Transportation Systems Strategy Document and 2020-2023 Action Plan will be discussed from the perspectives of climate change and transportation economics. Finally, policy heading recommendations will be presented so as to help increase ITS deployments for the next ten-year period.

2. INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

Transportation is a crucial area that requires adaptation, advancement, and rejuvenation to keep pace with the ever-evolving technological landscape in our rapidly changing world. The fundamental objective of transportation is to efficiently and securely transfer individuals, commodities, and provisions from one location to another while minimizing costs and maximizing speed. In other words, transportation is the movement of good and people with the organisation of this movement. Transport, which is an economic activity field, includes all the mechanisms and tools that try to ensure the transportation of people, goods and services and mobilise different sectors and segments by covering all the developments in communication, industry, internet and information technology together with transport modes (Saatçioğlu, 2016, p. 10). According to Gutiérrez (2020), mobility is a manner of expressing the act of displacement and defines the universe of study that refers to perfected, feasible and designed journeys, expanding traditional boundaries for transportation services and practices. Looking at it from this perspective, transportation is cantered around the methods that facilitate the action of transitioning between locations, that is, movement. The provision of transport activity is carried out by land, airways, railway and maritime transport types, each of which has different functional characteristics.

Since the dawn of civilization, transportation has been a significant aspect of human existence. While pedestrian transport was the primary mode of transport for shorter distances within cities, urban expansion and population growth have led to accessibility challenges for essential locations such as workplaces, residences, and markets. Transportation is an essential component of meeting the fundamental needs of citizens throughout their life cycle (Bilgiç, 2022, p. 1).

ITS can be defined as the utilisation of information and communication technologies (ICT), including monitoring, measurement, analysis and control mechanisms to ensure interoperability in the applications and solutions developed by all horizontal and vertical sectors related to transportation. ITS therefore involves various interdisciplinary intersections, including computer science and informatics, telecommunications, communications,

transport engineering, sensors and control, finance, electronic commerce and automobile manufacturing. ITS can be thought of as a tool to provide innovative mobility solutions in all modes of transport. Various technologies, such as sensors, wireless, infrared communication, data analytics, artificial intelligence, and machine learning are among the tools used in ITS applications.

Intelligent transportation uses modern technologies such as new generation communications and cloud computing, location-based systems, artificial intelligence, and the Internet of Things to make travelling more convenient and safer, to provide cost-effective options for cities and users, and to create rapid visibility and notification of potential problems (Mazur, 2020; Peak, 2020). In addition, effective governance, efficiency, and safety concepts and, beyond these, security, environmental considerations and supply chain flexibility are the main benefits of intelligent transport (Mazur, 2020). It is evident from this perspective that cellular communication technologies play a crucial role in delivering the anticipated advantages of ITS. After the introduction of 5G, autonomous vehicles, which are noted for their reliability in communication, high transmission quality and speed, and low latency, are expected to be used and become widespread. Developments in deep learning and artificial intelligence will come to the agenda with this process. In addition, advanced driver support systems will be developed to prevent accidents and ensure safe travel for passengers. In addition, vehicle-to-passenger (V2P), vehicle-to-infrastructure (V2I), vehicle-to-home (V2H), vehicle-to-vehicle (V2V) and in-vehicle mobility (In-V) will provide the ground for connected, cooperative and autonomous mobility (CCAM) (Gajewska, 2017, p. 155-166).

ITS refers to a set of technologies and practices that aim to provide safe, efficient and sustainable transportation and mobility, as well as to increase people's productivity and reduce the negative impacts of traffic (Meneguette et al., 2018, p. 3). At the same time, ITS aims to collect, monitor, measure, analyse, control and improve data from equipment and sensors placed in infrastructure and vehicles by integrating ICT (Alam et al., 2016, p. 3).

Republic of Türkiye Ministry of Transport and Infrastructure (2020) defines ITS as information communication-based systems that include monitoring, measurement, analysis and control mechanisms as well as multi-directional data exchange between users, infrastructure, vehicles and centres developed to achieve objectives such as optimum utilisation of existing road capacities, reducing travel times, increasing traffic safety and mobility, efficient use of energy and reducing environmental degradation. From this point, three important basic application areas of ITS consisting of mobility, safety and environment (Khan et al., 2017, p.4) draw attention. The research conducted in the realm of intelligent transportation is a cutting-edge problem-solving approach that encompasses all forms of transportation and addresses numerous transport-related issues, including those in the three foundational areas, and is gaining widespread attention both nationally and globally. Thanks to the solutions using ITS technologies, which continue to be deployed and developed today, human errors can be minimised in all modes of transport, while at the same time, traffic-related time loss, accidents causing fatalities and injuries, material losses, air pollution and many similar negative situations can be prevented. Thanks to this controlled change and continuous development in ITS, it is possible to provide generally accepted optimum features in transport services and applications.

Activities related to traffic management and control in the national road network and urban areas can be achieved through the increasing deployment, implementation and monitoring of ITS components such as travel information, ticketing, integration between transport modes, logistics and fleet management, smart city logistics, road safety, emission reduction, vehicles that is connected and autonomous, Cooperative Intelligent Transport System (C-ITS), electric vehicles, data management, communication technologies, smart city, mobility and accessibility (Kocalar, 2023). C-ITS, which focuses on interoperability between systems by sharing and integrating data generated by factors such as pedestrians, drivers, vehicles, passengers, vehicles and infrastructure, which are the main components of transportation, is an important intelligent transportation technology based on the processing and examination of the gathered data (Çapalı, 2022, p. 1250-1251).

ITS includes market dynamics for users of any ITS application or service, road transport infrastructure users and operators, including passengers, vulnerable road users, emergency services operators and fleet managers. Some of these dynamics include government initiatives to ensure road and public safety and effective traffic management, the need to reduce increasing traffic congestion, high-level adoption of environmentally friendly car technology, and the rapid development of smart cities globally. In addition, constraints such as high installation costs of smart systems for this ecosystem, stagnation or slow growth in the infrastructure sector, and the need for a globally interoperable and standardised ITS architecture are seen as challenges. The increasing interest of automobile companies in designing, improving and developing ITS-compatible smart vehicles and the increasing number of

economically and technologically advanced countries are seen as the most important opportunities for the sector (Businesswire, 2022).

The development of a technically and economically compatible and efficient transportation system is important for the rational use of the country's resources. Integration of road, maritime, railway and airways are important for freight and passenger mobility by ensuring harmony between all modes of transportation. ITS is a good method to provide hybrid and effective solutions to innovative approaches such as autonomous, connected, co-operative and shared mobility together with the existing modes of transport. At the same time, ITS is a multidisciplinary sector where all stakeholders demonstrate their expertise in their own field and adopt a collaborative approach adhering to a standardised framework and policies. The ITS ecosystem is composed of central and local governments, universities, non-governmental organisations (NGOs) and private sector stakeholders, especially citizens. Meeting the expectations and needs of these stakeholders regarding transportation will contribute to the increase in ITS related studies and the benefits that will be reflected in society.

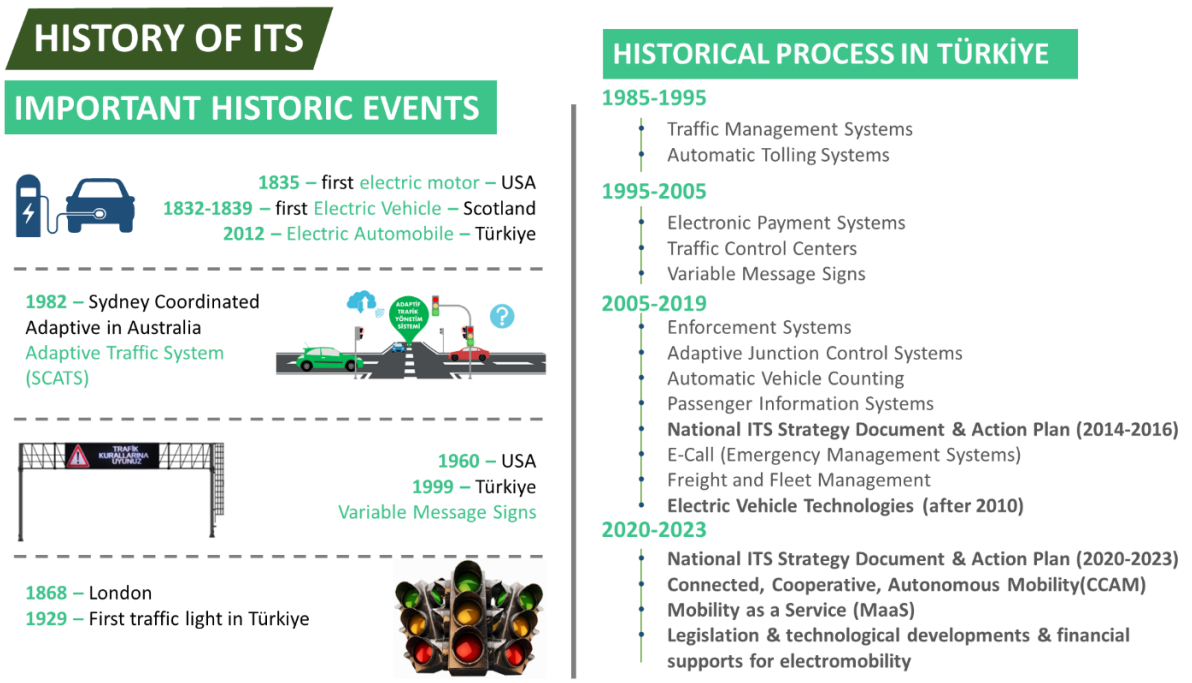
By definition, intelligent transportation is an approach that incorporates modern technologies such as location-based services, wireless communication, cloud computing and other means to improve mobility into transport systems. The main idea behind ITS is to build a network that connects people, vehicles and city infrastructure. The main benefits of intelligent transportation are sustainable transport, increased safety, and better accessibility (Peak, 2020).

3. STATUS OF ITS IN THE WORLD

The roots of Intelligent Transportation Systems date back to the late 19th century, with the invention of the electric motor in the United States and the first traffic signs in London. The early 1900s marked the beginning of the development of ITS, as the first traffic signal systems were introduced in the United States of America (USA). In Türkiye, ITS were introduced with traffic signalling systems in İstanbul in 1929. Figure 1.

Although the initial application of ITS is credited to the deployment of electric traffic lights in 1928, the introduction of computerised traffic signal systems in the 1960s also holds significant importance in the chronicles of ITS (Berdiyorova, 2022, p. 78).

Figure 1. Historical Process of ITS and Key



Source: (Republic of Türkiye Ministry of Transport and Infrastructure, 2022b).

3.1. ITS in the United States

The ITS Joint Program Office (ITS JPO) under the Office of the Undersecretary for Research and Technology (OST-R) of the United States Department of Transportation (U.S. DOT) carries out activities within the scope of improving the safety and mobility of road transport and contributing to the economic growth of the country with ICT. The ITS JPO spearheads the development of cooperative and inventive intelligent transportation systems, aimed at enhancing the safety and efficiency of transporting individuals and goods, while also conducting research and development activities in this domain. The ITS JPO collaborates with other sub-administrations (6 land/marine operator agencies) to plan and coordinate the U.S. DOT's multimodal ITS technology research programme aim to improve transportation safety, efficiency, and mobility by integrating innovative technologies into the nation's transportation system. The tasks of the ITS JPO include preparing ITS Action Plan, conducting research and development (R&D) and pilot studies, coordinating innovative ITS applications and organising programmes such as training, webinars and capacity building in the field of ITS. It also carries out all studies on national ITS architecture and standards. The work of the ITS JPO has enabled the integration of intelligent transport technology into infrastructure and vehicles and planned and accelerated existing ITS projects by private and government organisations (U.S. DOT, n.d.). Collaborating with state and local administrations as well as private entities, the ITS JPO continues to collaborate with all stakeholders in research on the implementation, evaluation and interoperability of emerging technologies.

In the USA, the National Highway Traffic Safety Administration (NHTSA) was created with the Highway Safety Act enacted in 1970, and the concepts for the use of innovative technologies in transportation emerged in this period. The first studies on ITS in this period can be observed in the research and development initiatives carried out by regions, academic institutions, states and automotive industry. The basic research and development studies related to ITS in the USA until today and future plans are given in Table 1.

Table 1. ITS Developments in the USA

Before 1980
- The U.S. DOT was established in 1966 to create a transportation system that meets the needs of the American people.
- In the mid-1960s in the USA, research on navigation was initiated by General Motors in line with the Driver Assisted Information and Routing System (DAIR) studies.
- In the 1970s the first algorithms related to map matching were developed and were complementary to the first navigation systems. Autonomous Vehicle Positioning (AVL) systems were implemented in North America in the 1970s, and the first map matching model, the Automatic Route Control System (ARCS), was developed by Robert L. French in 1971.
- The prevalence of loop detectors in event detection systems has made them the favoured sensor among all available options. Dynamic Message Signs (DMS) were first used in the 1960s and continue to be used on motorways today.
- For the preventive solution to highway safety ramps, management techniques were investigated in the 1950s. Ramp counters were first installed and manually tracked along Chicago's Eisenhower Highway in 1963.
- The first known ramp closure was implemented in Los Angeles in 1967. Today, ramp counting solutions are widely implemented in all common jurisdictions in the U.S. and have been found to have many benefits, including mobility, safety, security and environmental.
- The first Traffic Management Centres (TMCs) were established in North America in the late 1960s to collect and process highway-related data on weather, speed, congestion, incidents requiring emergency response, such as accidents, and special situations.
- Global Positioning Systems (GPS) were first designed in the 1960s for the military to receive information and news. GPS began to be used in civilian applications in the 1980s, and it was not until the 1990s that civilian use became accessible, widespread and feasible. GPS is an important component for the current implementation and future projection of ITS, as it contributes to more efficient, safe and secure urban and intercity mobility.
- In late 1960, the Defense Advanced Research Projects Agency (DARPA) financed the Early Mobile Robotics project to develop the first mobilised robot capable of sensing and reasoning about its own movements. This project was carried out at the Stanford Research Institute. This and similar robotic research has formed the basis for the developed of many ITS services and applications. Sensor, exploration and navigation functions developed for mobile robots are reflected in connected and autonomous vehicle technologies. In the same year, the Stanford Artificial Intelligence Laboratory Vehicle was developed.
- In the 1970s, Shakey, described as "the first electronic man", was developed to perform exploration and navigation tasks. For this purpose, a TV camera, sensors and distance metres were used in its design, laying the foundations of functionality and performance for mobile robots.
- In 1979 Stanford Artificial Intelligence Laboratory Vehicle successfully completed an autonomous driving trial with a travel time of 5 hours.

1980s
- Established in 1984 in Los Angeles, the Automated Traffic Surveillance and Control System was the first one to integrate closed-circuit television, coordinated signal timing and vehicle detectors. - Operation Greenlight began in 1989 as a joint initiative to reduce demand and congestion and increase capacity on the existing road network. - In 1983, the California Fuel Efficient Traffic Signal Management (FETSIM) programme emerged as a solution to reduce fuel consumption and emissions by adjusting traffic signal timing, improving traffic operations, and making signal systems more efficient. The programme has been active for 11 years, during which time 12,245 signal timing updates were made in more than 160 cities and counties. The interventions, which included re-timing these signals, resulted in a 13% reduction in vehicle stops, a 14% reduction in traffic delays, a 7% reduction in total travel time and an 8% reduction in fuel consumption. - The introduction of DARPA-supported artificial intelligence applications began with Shakey in the 1960s and continued with the DARPA Autonomous Ground Vehicle (ALV) in the early 1980s. The ALV was a terrain vehicle equipped with various components and sensors such as a laser scanner and video camera. Consisting of six computer racks using images from an overhead camera, the vehicle could safely navigate along the road unmanned, that is, autonomously. - In 1986, TRANSCOM was established in Connecticut, New Jersey and New York states as the Transportation Coordinating Committee, which was formed by a coalition of 16 institutions related to transportation.TRANSCOM has been involved in technology development since its inception and has evolved to include a multilateral testbed for the deployment of ITS applications and services. - In 1987, the project Evaluation of Advanced Technologies for Urban Congestion Relief/03-38(1) was initiated under the National Cooperative Highway Research Program (NCHRP). Within the framework of the project, the requirements for establishing a National Intelligent Vehicle-Highway System (IVHS) and applications such as travel information systems, traffic and autonomous vehicle control systems were examined and evaluated. - Heavy Vehicle Electronic License Plate Program (HELP) programme involved weighing commercial vehicles on the move and research into the application of Autonomous Vehicle Identification (AVI). This programme was initiated in 1984 by the Arizona and Oregon Departments of Transportation (DOT). This programme led to the development of PrePass, North America's most important vehicle-to-infrastructure (V2I) application and the largest service for truck transit permits.
1990s
- Under the leadership of the Road Users Federation (HUF), IVHS America, now ITS America, was established in late 1990 and early 1991. Parallel to this, the Intermodal Road Transport Efficiency Act (ISTEA) came into force in 1991. - In 1992, the Strategic Plan for Intelligent Vehicle-Highway Systems prepared under the leadership of IVHS America was presented to the sector. - In 1994, the U.S. DOT officially began using "ITS" instead of IVHS, reducing the focus on vehicle navigation technologies and recognising the multimodal nature of transportation and mobility. - In 1996, the U.S. DOT organised the "ITS Standards Program" to ensure the dissemination of technologies and systems related to ITS applications and services in surface transportation. - The Transportation Equity Act for the 21st Century (TEA-21), approved in 1997, increased investment in highway construction while preserving key features of the ISTEA. - Launched in 1992 as a major ITS operational programme and designed as a testbed for a small-scale traffic control system, the FAST-TRAC project has expanded over the years. As part of the project, efforts were made to integrate Advanced Traffic Management Systems (ATMS) and advanced passenger information systems. - Developed specifically for the IVHS operational field trial in Orlando, Florida between 1992 and 1993, TravTek's main purpose was to achieve driver acceptance as a navigation device and in-vehicle passenger information system and to collect the necessary field data for efficient use. - In 1990, research was conducted on the Pathfinder In-Vehicle Information System project on the Santa Monica Freeway Corridor (I-10) in Southern California. The main objective of this project was to evaluate communication technologies for route guidance and in-vehicle navigation to be used as a solution to road incidents and traffic congestion. - The Guidestar programme was initiated in 1992, initially in the Twin Cities and then statewide, to research and implement IVHS technologies. One of the first activities and unique projects within the IVHS operational testing programme was the Genesis project, supported by the Federal Highway Administration (FHWA). - Advantage I-75 was established as a public and private partnership to reduce congestion, increase efficiency and improve road safety along the Interstate 75 (I-75) corridor. - New York's INFORM traffic management system was effective in managing Long Island's traffic flow by providing alternative route information to drivers and using variable message signs. - The Denver Smart Bus Project showed the importance of using GPS technologies to enhance transportation management, coordinate emergency incidents, and provide transportation services in a timely manner. - Dedicated Short Range Communications (DSRC) technology is directly related to the work for connected vehicles and was developed primarily and specifically in the context of vehicular communications. In 1997, ITS America's request for 75 MHz spectrum allocation in the 5.9 GHz band was answered by the allocation of spectrum for DSRC use in 1999.

- A Report and Instruction was published in 2004 setting out standard licencing and service rules for DSRC within the ITS Radio Service in the 5.850-5.925 GHz band to ensure the safety of travel.
- Free passage was tested in the 1960s and 1970s, with readers placed just below the highway surface and transponders mounted underneath vehicles. In 1986, the Electronic Toll Collection (ETC) system was introduced in Europe and was soon adopted in the U.S. The Oklahoma Turnpike Authority's Pikepass system was introduced in 1991 and was the first ETC system in the U.S. ETC systems have led to reduced emissions and lower equipment maintenance and operating costs.
- E-ZPass Interagency Group (IAG) was formed on the initiative of seven independently owned toll agencies in New Jersey, New York and Pennsylvania to develop a product that would enable toll system interoperability, in 1991. E-ZPass was first used on the New York State Thruway in 1993.

2000s

- In 2003, the Vehicle-Infrastructure-Integration-VII Program was launched by the U.S. DOT.
- In 2005, the U.S. DOT established the "Research and Innovative Technology Administration" to conduct and implement scientific research and development related to the transportation sector.
- In 2006, it became involved with the U.S. DOT and the Crash Prevention Metrics Partnership (CAMP) to develop and test prototype safety applications as part of V2V.
- In 2005, the Mobility Services for All Americans (MSAA) initiative was launched by the ITS JPO.
- In 1998, the Intelligent Vehicle Initiative (IVI) Program was launched by the U.S. DOT because driver errors are one of the leading causes of crashes. This programme aimed to help reduce traffic accidents and their potential adverse effects through the improvement and commercialization of Driver Assistance System products with the ability to take partial control of vehicles developed to warn drivers of hazardous situations, provide suggestions and prevent accidents. In addition, the Integrated Vehicle-Based Safety Systems (IVBSS) initiative was created by the U.S. DOT to test and improve integrated safety systems for commercial trucks and light vehicles.
- The only traffic information telephone number used by state and local governments across the country is "National Passenger Information Telephone Number 511".
- Clarus was founded in 2004 as a U.S. DOT initiative to create a weather observation and forecast management system for roads across the country, reducing the negative impact of weather on transportation services.
- The first of its kind, the DARPA Grand Challenge race, was held on March 13, 2004 to support the research and development of driverless and autonomous vehicles. The long-term goal of the project was to develop autonomous vehicle technology to replace humans in military service and operations.
- The first 911 system was installed in 1968 and rapidly deployed across the country. In 2005, the National 911 Programme Office was established. The programme office published the Next Generation 911 (NG911) system architecture design. Within the framework of the NG911 system, the public can send images, video, data, text and other information about an emergency situation to the 911 center.
- The U.S. DOT launched the Integrated Corridor Management (ICM) initiative in 2006, which will increase the power of decision support systems and offer many benefits.
- In 2006, U.S. DOT announced its National Strategy to Reduce Congestion on America's Transport Network as a congestion initiative. Solutions such as telecommuting, transit, tolling, and ITS have aimed to reduce traffic congestion for many years, and the Congestion Initiative was established to ensure the visibility of the effectiveness of the strategies developed within the scope of these solutions.
- In the race to invest in autonomous technologies, traditional car companies are being joined by big technology companies like Apple and Google, as well as innovative car companies like Tesla Motors. Google's Driverless Car project started in 2009.

2010s

- In August 2010, the Washington State Department of Transportation (WSDOT) implemented Active Traffic and Demand Management (ATDM) to decrease accidents and congestion. WSDOT is the first state in the U.S. to use this type of application in its transportation operations.
- Within the U.S. DOT's environmental research framework, the Real-Time Information Synthesis (AERIS) implementation, conducted research on advanced vehicle applications to decrease the negative impact of transportation activities on the environment. A successful application within the AERIS research programme is GlidePath. AERIS collects real-time environmental transport data to support and facilitate solutions for "green" transport activity options.
- The Moving Ahead for Progress in the 21st Century (MAP-21) law was passed on July 6, 2012. MAP-21 continued its support for the ITS programme by establishing a Technology and Innovation Deployment Programe of $62.5 million annually as well as an updated ITS research and development budget of $100 million annually.
- In 2012-2013, a Connected Vehicle Safety Pilot Model Installation was conducted in Ann Arbor, Michigan in relation to connected vehicle technologies. This is the largest of the real-world tests, where more than 2,700 drivers and vehicles used wireless safety technologies while travelling their normal daily routes to assist them in preventing accidents. Drivers were alerted by safety applications to the possibility of red light violations, braking by the vehicle in front, vehicles in the blind spot, etc.

- In 2013, NHTSA defined autonomy levels as non-autonomous (level 0), function-specific autonomy (level 1), combined function autonomy (level 2), limited driverless autonomy (level 3), and fully driverless autonomy (level 4). - In August 2014, NHTSA published a proposed rulemaking on V2V communication technology an Advance Notice of Proposed Rulemaking on Single Unit Truck Crash Protection (ANPRM) and a comprehensive supporting research report. - U.S. Congress delegated all Research and Innovative Technology Administration (RITA) programs to the Office of the Secretary of Transportation (OST) in 2014.The ITS JPO was incorporated into RITA, structured within the Office of the Assistant Secretary for Research and Technology. The ITS JPO was incorporated into RITA and structured within the Office of the Assistant Secretary for Research and Technology. - U.S. DOT announced in September 2015 that three connected vehicle distribution sites were selected to be included in the Connected Vehicle Pilot Installation installation.
Between 2015-2020
- In 2015, U.S. Congress directed the Federal Highway Administration to manage the ITS JPO in consultation with the relevant administrations of other modes of transportation. - The U.S. DOT is working on advanced technologies such as accessibility and inclusive design, data exchange and access solutions, on-demand mobility, and connected and autonomous mobility as part of future transportation system activities. - In 2016, the Fixing America's Surface Transportation (FAST) Act was instrumental in the creation of the Advanced Transportation and Congestion Management Technology Deployment (ATCMTD) Grants to support innovative transportation technologies. - In 2017, the U.S. DOT published A Vision for Safety 2.0 (AV 2.0) guidance on Autonomous Driving Systems. The following year, Autonomous Vehicles 3.0 (AV 3.0) was prepared. In early 2021, work on autonomous vehicles progressed further, including the publication of the Autonomous Vehicles Comprehensive (ADS) Plan, which promotes collaboration and transparency in accordance with the tenets of AV 4.0, modernises the regulatory environment and provides rules for preparing the transportation system. - An Executive Order on Sustaining American Leadership in Artificial Intelligence (AI) was issued on February 11, 2019. U.S. DOT focused on ensuring the safe integration of AI into transportation operations and the application of AI-based tools to internal operations, research and citizen services. - The 2015-2019 ITS Strategic Plan, prepared by the ITS JPO in 2015, emphasised two key strategic priorities for the development of connected vehicles and autonomous technologies. It also included goals to increase emerging capabilities, enterprise data, interoperability and deployment. - In 2016, U.S. DOT launched the "Smart City Challenge" to create an innovative transportation network based on data and technology to shape the mobility of people and freight in mid-sized cities. - In 2020, the Covid-19 pandemic severely impacted the country's entire transportation ecosystem. - In 2020, ITS JPO Strategic Plan 2020-2025 was published, focusing on ITS standards and architecture, evaluation, professional capacity building and communication within ITS, and related technology transfer programs. - ITS JPO's Strategic Plan for 2020-2025 has been published, which is based on four main objectives focused on technology transfer. i) Assessment of the country's situation in ITS, ii) Development of professional capacity in ITS, iii) ITS standards and architecture, iv) Communication methods and technologies used in ITS.
2021 and Future Plans
- Increasing the deployment of ITS - Development of autonomous technologies - Complete (Full) journey-ITS4US plans - Data access and exchange activities - Cybersecurity efforts for ITS - Investigation of emerging and enabling technologies - Security tape, communication technologies. - The Way Forward: Working within the framework of the Putting People First vision. Putting People First: Smart Cities and Communities report was published in 2021 by ITS JPO.

Source: (Intelligent Transportation Systems Joint Program Office [ITS JPO], 2021).

3.2. ITS in Europe

In the Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the use of ITS in the field of road transport and on the framework for interfaces with other modes of transport; the optimum use of road, traffic and travel data, traffic and load management and continuity of ITS services, road safety and security practices, and communication of vehicles with transport infrastructure are identified as priority areas and various actions are defined in this direction (Directive 2010/40/EU of the European Parliament and of the Council of the EU, 2010). In all activities in line with this Directive, the European Union (EU) focuses on the effective and efficient implementation of ITS-related activities by the connected and neighbouring countries. Optimal use of transport data, continuity of traffic and transport management, communication of vehicles with infrastructure,

ensuring road safety and security, protection and responsibility of data, and ITS coordination in Europe have been identified as priority areas to be studied in (Directive 2010/40/EU of the European Parliament and of the Council of the EU, 2010). In addition, the Official Journal of the EU (2010) emphasised the adoption of the principles of efficiency, cost-effectiveness, proportionality, continuity, interoperability, compatibility, accessibility on equal terms, consistency within the scope of working with existing infrastructure and ensuring coordination between modes in the implementation of activities and provision of services.

As a requirement of the common transport policy, the EU aims to ensure the creation of a safe, secure, modern and sustainable transportation system, as well as finding solutions to problems such as congestion, negative environmental impacts and accident rates that arise in the Union and neighbouring countries in the field of transportation. The EU Transport Network and corridors are an important tool in developing relations with member and neighbouring countries and gaining competitive advantage in many areas (Çaylan & Kişi, 2011, p. 83-84).

ITS-related studies in EU countries are progressing in line with the European Commission Directives and in compliance with the recommended solutions developed by each country on the condition of adhering to them. ITS activities for EU countries and other countries around them may include many differences in terms of social, administrative and technical aspects. Although generally coordinated by ministries of transportation, it is considered normal to have different practices due to its multi-stakeholder structure. In Germany, work on innovative transport technologies such as digitalization in transport, 5G, autonomous vehicles, the use of artificial intelligence in transport, and the digitalization of infrastructure is handled by the Directorate General for Digital Society of the Federal Ministry of Transport and Digital Infrastructure. Austria, on the other hand, carries out its activities in the field of ITS in cooperation with AustriaTech, a 100% subsidiary of the Ministry of Transport and Housing.

In addition, the Commission adopted and put into effect the EU Sustainable and Smart Mobility Strategy and Action Plan in 2020. Accordingly, mobility policies for uninterrupted, safe, secure and efficiently connected travel are set out as follows (European Commission, 2020):

- The EU to take full advantage of the full benefits of smart digital solutions and ITS,
- Activities to make connected, cooperative and autonomous multimodal mobility a reality,
- Further support for safe, smart and sustainable road transport operations,
- Increased accessibility through multimodality and adjustability of trips,
- Update of the technical specifications for interoperability (TSI-Technical Specifications for Interoperability),
- Increasing the use of innovation, artificial intelligence and big data about more intelligent mobility.

3.3. ITS in Asia and the Pacific

Many cities in Europe and the United States, as well as in Asia and the Pacific, are making use of ITS as part of their efforts to improve transportation. In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) leads ITS efforts. ITS-related activities are carried out under the coordination of ITS Japan and the ITS Standardization Committee together with 4 different ministries. In South Korea, under the Ministry of Land, Infrastructure and Transport (MOLIT), there is the Road Bureau department under the deputy minister and the ITS Korea Association plays a very active role in coordinating ITS activities. ITS Korea is the national competent organisation designated by law that is responsible for the coordination and management of ITS (road, maritime and air transport) by the Ministry. Australia has a history in ITS dating back to the 1970s and has pioneered many innovative practices in this field. Many organisations and universities in the country play an active role in ITS research. The federal government sets national policies, which are implemented by road authorities operating under state ministries of transportation. The Transport and Infrastructure Council is composed of the deputy minister, state transport ministers, regional and local authorities, and representatives of associations, and transport action plans are prepared by these authorised institutions and organisations.

The Asia-Pacific region's countries vary in their progress in ITS. Some countries are world leaders in testing and implementing innovative transportation technologies, some are in the early stages of ITS adoption, and the rest have not even started. There are four milestones in the development of ITS: initiation, progress, acceleration and maturity. The historical development chart of ITS in Asia-Pacific shows two distinct groups of countries that have

progressed from inception to maturity and two different groups of countries that have not yet reached this stage (Escape 75, 2019).

In 2013, with the Declaration to Become the World's Most Advanced IT Nation, Japan focused on Public-Private ITS Initiatives/Roadmap focusing on the implementation of driving safety support systems and traffic data to achieve the goal of establishing and maintaining the world's most advanced ITS. In April 2018, it established the Improving the Legal System and Environment for Autonomous Driving Systems Act to allow the commercialization of Level 3 and above autonomous driving systems and the provision of services. In September 2018, MLIT issued Guidelines on Safety Technology for Autonomous Vehicles, which clearly set out the safety requirements that autonomous vehicles must meet. In May 2019, the Road Transport Vehicle was revised for autonomous vehicles and MLIT was authorised to set the conditions for the use of autonomously operated devices. The Road Traffic Law was also updated in May 2019 for autonomous vehicles and driving. Japan's ITS-related trend studies are presented in Table 2.

Table 2. Developments in Japan

Vehicle Information and Communication System (VICS)		
Advanced Safety Vehicle (ASV)		
Universal Traffic Management System (UTMS)		- Advanced Mobile Information Systems (AMIS), - Fast Emergency Vehicle Prevention Systems (FAST), - Public Transport Priority Systems (PTPS), - Traffic Signal Prediction Systems (TSPS), - Pedestrian Information and Communication Systems (PICS), - Driver Safety Support Systems (DSSS)
Smart Roads	Advancing ITS Deployment	- Comprehensive provision of road traffic data - Expansion and effectiveness of electronic toll collection (ETC)
	Nationwide Rollout of ETC 2.0 Services	- Launch of ETC 2.0 services - Transportation initiatives and logistics
Autonomous Driving		- ITS Initiatives in the Strategic Innovation Incentive Program (Cabinet Office) - Evaluation of the Legal System and Other Issues (National Police Organization) - Roadmap for the Deployment of Autonomous Systems - Driving Services by the Autonomous Driving Technologies Business Negotiations Subcommittee (Ministry of Economy, Trade and Industry-METI) - Autonomous Driving Services in Semi-Mountainous Areas Using Michi no Eki Roadside Stations as Hubs and Support from Road Administration Authorities (Road Bureau, MLIT) - Evaluating New Communication Technologies for Autonomous Driving Systems (Ministry of Internal Affairs and Communications MIC)
Introduction of ITS Using Radio Signals		- 700 MHz Deployment and Development Initiatives - Belt Intelligent Transportation Systems - Initiatives to Build a Connected Car Community - Attempts to Utilize Fifth Generation Mobile Communication Systems (5G)
Improving International Standardization		- International Standardization Activities for Intelligent Mobility Systems (METI) - International Standardization Activities for Autonomous Driving and Advanced Driving Assistance Systems (METI) - International Standardization Activities in the Field of Information and Communication (MIC)

Source: (The Society of Automotive Engineers of Japan [JSAE], 2020).

The first plan for ITS was prepared by South Korea MOLIT in 2000 with the title "Intelligent Transportation System 21" and the second plan was prepared in 2011 with the title "Intelligent Transportation System 2020". The third plan was prepared under the title of "Intelligent Transportation System Master Plan 2030" to cover all modes of transportation in line with the National Integrated Transportation System Efficiency Act and published on

October 19, 2021, with the vision of "providing environmentally friendly, safe and uninterrupted people-centred transportation services". The plan, which aims to build a communicating intelligent transportation system infrastructure beyond the expansion of new transportation vehicles such as autonomous vehicles by using the most advanced technologies of the 4th industrial revolution era, such as artificial intelligence and big data, includes medium- and long-term ITS activities (Smart City Korea, 2021). The main headings of the strategy are given in Table 3.

Table 3. ITS Developments in South Korea

Strategy	Objective
Preparing the infrastructure for innovative vehicle technologies	Creating infrastructure for the smooth introduction and activation of new means of transportation such as autonomous vehicles and UAM (Urban Air Mobility)
Solving blind spots in traffic safety with advanced technologies such as artificial intelligence	Intelligent CCTV surveillance system that detects unexpected situations such as reverse driving with artificial intelligence, and Intelligent level crossings
Laying the foundations for the provision of user-specific services	Comfortable and efficient mobility support reflecting users' demand characteristics
Support for expansion of domestic intelligent transportation system abroad	Building the ITS export ecosystem

Source: (Smart City Korea, 2021).

4. ITS IN TÜRKİYE

In Türkiye, many activities and studies on ITS and mobility issues are carried out with the contributions of institutions and organisations such as the Ministry of Transport and Infrastructure (MoTI), the Ministry of Industry and Technology, the Ministry of Environment, Urbanization and Climate Change, the Ministry of Interior, the Ministry of Energy and Natural Resources, the Ministry of Trade. Similarly, there are many studies carried out by local governments within the scope of ITS. In addition, many projects, papers, articles and thesis studies are carried out in higher education institutions within the scope of intelligent transportation systems, and doctoral scholarships are provided by the Council of Higher Education (CoHE) to develop qualitative and quantitative measures of qualified human resources. In addition, some universities have research and application centres to carry out studies on ITS. Mobile network operators, service providers, suppliers, automotive manufacturers, and transportation and traffic industries are some of the categories in which private sector enterprises acting as ITS stakeholders can be grouped. In Türkiye, there are also many non-governmental organisations such as ITS Türkiye, Union of Municipalities of Türkiye, Automotive Industry Association that are directly or indirectly active in the fields of ITS and its applications (Republic of Türkiye Ministry of Transport and Infrastructure, 2020, p. 33-40).

Many institutions and organisations in Türkiye carry out different studies on ITS and mobility. In order to ensure coordination in these activities, MoTI determines the policies, strategies, targets and execution principles within the scope of ITS and monitors their implementation. At the same time, it also works on ensuring the use of the determined standards throughout the country, deploying the communication infrastructures related to these systems and conducting international relations in this context.

Since September 2012, MoTI has been a member of the European Road Transport Telematics Implementation Coordination (ERTICO), the common civil platform of ITS stakeholders in European countries, and closely follows the work carried out by ERTICO. Since the end of 2019, MoTI has been an "Associated Member" of the C-Roads Platform, which coordinates pilot studies for C-ITS with financial support from the European Commission.

Currently, certain responsibilities in the field of intelligent transportation systems are assigned to the Republic of Türkiye. MoTI has been given specific responsibilities in the field of intelligent transportation systems by the Presidential Decree and is responsible for *''Determining national strategies, targets, architectures, technical criteria to be complied with on a national scale for intelligent transportation systems, preparing and monitoring action plans, developing innovative intelligent transportation systems projects, public institutions and organisations, municipalities, to establish, lead to establish, operate and lead to operate a data management centre in order to ensure the use and evaluation of data produced by special provincial administrations, nature and legal persons within the scope of intelligent transportation systems, and to set out the implementation*

procedures and principles related to these duties'' (Presidential Decree on the Organization of the Presidency, 2018).

4.1. ITS in Policy and Strategy Documents in Türkiye

Some of the legislation, policy and strategy documents and short, medium and long-term plans in which the Türkiye ITS approach is directly or indirectly involved are given in Table 4.

Table 4. Türkiye's ITS Policies and Strategies

Year	Document	Description
2002	e-Türkiye Initiative Action Plan	Intelligent Transportation Services were addressed first. In this study, the objective of "increasing the performance and efficiency of resource utilisation in transportation systems by utilising electronic technology" was set, and actions related to the ITS development plan, architecture and the work of municipalities were defined.
2006	Information Society Strategy and Action Plan	The significance of e-payment in transportation systems, national transportation portal, transportation demand management and similar actions and proposed studies on intelligent transportation have been disclosed.
2006	Ninth Development Plan (2007-2013)	Under the heading of "Transportation", it is envisaged to give importance and priority to increasing traffic safety in all modes of transportation, especially on highways, protecting the existing infrastructure, ensuring efficient use, and making maximum usage of ICT regarding ITS.
2010	National Climate Change Strategy Document (2010-2023)	The enhancement of ITS applications is included under the heading of "Transportation" as a medium-term target.
2011	Türkiye Transport and Communication Strategy Document	Intelligent transportation systems are discussed in detail, including smart roads and smart vehicles.
2011	Regulation on Duty, Authority and Responsibility of the General Directorate of Highways	Provisions on ensuring the installation of ITS and their supervision are included.
2011- 2012	Medium Term Program (2012-2014) and (2013-2015)	Under the heading "Transportation", it is stated that the use of ITS will be expanded in the highway network and urban transportation in order to expand the use of intelligent transportation systems. In the 2013-2015 Medium Term Program, within the scope of ITS, it is targeted to expand the use of automated transit systems and to establish driver information and traffic management systems. The programme also envisages strengthening the management and coordination capacity of central and local administrations by making use of intelligent transportation systems.
2013	2014-2018 Tenth Development Plan	In many issues affecting transportation, transport, mobility, liveable environment and similar issues affecting intelligent transportation, targets such as the following have been set: - The Road Traffic Safety Strategy and Action Plan has set the target of extending the use of Traffic Electronic Control Systems in an integrated manner with ITS in line with the target of reducing deaths due to traffic accidents by 50 percent. - Intelligent transportation and traffic management models such as the Electronic Monitoring System, as well as important rail system projects in urban transportation, practices to increase the share of maritime transport and expand the use of bicycles were mentioned. - Among the objectives are the expansion of public transportation, the use of small engine volume, electric and hybrid vehicles, the establishment of smart bicycle networks in appropriate settlements and the creation of pedestrian paths closed to traffic. - Ensuring integration between transportation modes, the need for more efficient, faster and safer transportation and logistics infrastructure in freight transport, as there is a need to further improve the transportation connectivity of underdeveloped regions, are discussed.

Year	Document	Description
		- Emphasis will be placed on transport systems that prioritise energy efficiency, clean fuel usage, and environmentally sustainable vehicles. - Investments and practices for alternative modes of transportation such as pedestrian and bicycle transportation will be encouraged.
2013	Republic of Türkiye Ministry of Transport and Infrastructure Strategic Plan (2014-2018)	The strategic objective of "To formulate and plan policies in accordance with balanced and technological innovations in order to realise and expand transportation, maritime and communication infrastructure and services in a way to meet commercial, economic and social needs" has been set. The target of "implementing and monitoring the actions in the Action Plan (2013-2015) prepared as an annex to the National ITS Strategy Document (2023)" is included here.
2014	National ITS Strategy Document and Action Plan (2014-2016)	The first strategic plan on ITS was prepared by MoTI and became official after the publication of the Official Gazette dated 25.10.2014 and numbered 29156.
2015	2015-2018 Information Society Strategy and Action Plan	The adaptation of ICT to intelligent transportation and communication networks, especially intelligent transportation, smart applications and many other issues in this field were discussed.
2016	Republic of Türkiye Ministry of Transport and Infrastructure Strategic Plan (2017-2021)	In order to achieve, environmentally sustainable, uninterrupted transportation and communication systems where the safety of individuals and assets is upheld to the utmost level, the strategic objectives of implementing effective regulations, practices and inspections have been adopted.
2016	Türkiye Automotive Sector Strategy Document and Action Plan (2016-2019)	Türkiye has the vision to have a say in the world market with its domestic automotive brands. The document focuses on the application of international standards in the development of smart systems like emergency braking systems, driver assistance systems, active cruise control systems, e-Call, lane-keeping systems and the testing of non-driverless vehicles.
2017	2018-2020 Medium Term Program	It aims to accelerate the transition to ICT-enabled smart applications (intelligent transportation systems, buildings, urban and energy infrastructures, etc.) and to encourage R&D and innovation activities.
2017	National Broadband Strategy and Action Plan (2017-2020)	Under the strategic objective of "Creating both Broadband Supply and Demand", the action of "Developing Intelligent Transportation Systems" is included.
2019	Regulation on Procedures and Principles for Increasing Energy Efficiency in Transportation	It is aimed at establishing and expanding an integrated, effective, fast, smart, safe, and secure ITS according to the requirements of the era in transportation and communication services.
2019	Eleventh Development Plan 2019-2023	In addition to the individual efforts of different institutions and organisations, the following targets have been set across a wide range of fields including transportation, digitalization, domestic product development, sustainable transportation, mobility and intelligent transportation technologies, which need to be coordinated together: - The architecture related to ITS, which ensures energy and time savings, traffic safety and efficient use of road capacity on the road network, will be finalised and put into practice, including local administrations, - In order to use the existing infrastructure more efficiently, increase traffic safety, manage transportation demand correctly and plan more effectively, the following studies will be carried out on a national scale: • National ITS Strategy Document and Action Plan will be completed and put into practice, • The project for the development of ITS architecture will be completed, • Dynamic passenger, driver and pedestrian information systems will be established in the urban transportation network, especially in metropolitan areas.

Year	Document	Description
		- Smart products and systems required for the digitalization of priority sectors, including industry, will be developed and utilized, - Applications will be developed, and local standards will be established in sectors such as energy, agriculture, health, environment, including transportation, and in areas such as smart production facilities and disaster management, - In order to strengthen the competitiveness of the automotive industry, emphasis will be placed on the development of critical technologies such as connected and autonomous vehicles and smart mobility, taking into account global developments and changing customer demands, - The technical specifications, legislation and infrastructure requirements will be determined for autonomous and connected lines and for starting to operate actively, - Different solutions regarding mobility will be developed and implemented in accordance with the needs and demands of especially disadvantaged youth, - Industrialization Units to be established in relevant institutions and organisations together with the Ministry of Industry and Technology will prepare pioneering procurement programs within the scope of innovative and domestic production, and will work to ensure domestic product and legislative harmonization, - A demand management system will be adopted to ensure the sustainability of the transportation system and efficiency will be focused on in the realization of transportation investments.
2019	2020-2023 National Smart Cities Strategy and Action Plan	Development of critical technologies such as connected and autonomous vehicles and smart mobility is emphasized. ITS is treated as a component and targets are set under the action of increasing the level of maturity.
2020	Regulation (EU/2019/2144) on the Type Approval of Motor Vehicles and Their Trailers and Components, Systems and Separate Technical Units Designed for The General Safety and Protection of Vulnerable Road Users and Passengers	There are also issues concerning connected vehicles.
2020	National ITS Strategy Document and Action Plan (2020-2023)	It includes short, medium- and long-term targets, which are a roadmap within the framework of the digitalization of transportation and the promotion of mobility. (It will be discussed in detail in sub-heading 4.2 of our study).
2021	National Artificial Intelligence Strategy 2021-2025	The following issues are mentioned in the National ITS Strategy Document and 2020-2023 Action Plan, which are focused within the scope of optimisation of transport infrastructure: i) Establishing an Internet of Things (IoT) network that includes ITS elements; ii) storing the data gathered from these elements in a big data storage environment and making it suitable for analysis; iii) the using of innovative technologies in studies in areas like artificial intelligence, communication systems, deep learning.
2021	Electric Scooter Regulation	This Regulation includes regulations on shared electric scooter (e-scooter) operations.
2021	Green Deal Action Plan	In line with the goal of sustainable intelligent transportation, the Regulation on "Combined Transport" and the Regulation on "Logistics Centres" were put into force in order to support the balanced development of transportation modes and methods.
2021	National Youth Employment Strategy Document and Action Plan (2021-2023)	Activities to increase the awareness of young people in the field of intelligent transportation systems through activities such as information sharing, trainings to be provided, competitions to be organised and online sessions, etc. have been stated.
2022	Mobility Vehicles and Technologies Roadmap	Within the framework of this roadmap, the Autonomous Vehicles Working Group has been established to identify the needs of autonomous vehicle technologies and legislation. Connected, autonomous and shared vehicle technologies, advanced technologies in rail systems, autonomous vehicle traffic

Year	Document	Description
		management technologies and mobility development and test centres were addressed.
2022	National Transport Master Plan, Transport and Logistics Master Plan, Updated Transport Strategic Plan	Within the framework of the objective of "Ensuring Smart and Sustainable Mobility in Transportation and Logistics and Increasing Human Resources Competence", priority should be given to innovation, competition, technological development, digitalization, vocational training/qualification and economic competitiveness.
2022	Presidential Decree Amending Certain Presidential Decrees and Presidential Decree No. 1 2023-2025	Intelligent transportation has been added to the duties and responsibilities of the MoTI and the Directorate General of Communications (DGComms) has been assigned the following duties: "To determine national strategies, targets, architectures, technical criteria to be complied with on a national scale for intelligent transportation systems, to prepare and monitor action plans, to develop innovative intelligent transportation systems projects, to establish, lead to establish, operate and lead to operate a data management centre in order to ensure the use and evaluation of data produced by public institutions and organisations, municipalities, special provincial administrations, real and legal persons within the scope of intelligent transportation systems, and to determine the implementation procedures and principles related to these duties." provision has been added. Thus, the Ministry of Transport and Infrastructure Directorate General of Communications (MoTI-DGComms) has been designated as the country's authority in the field of ITS.
2022	2023-2025 Medium Term Program	Projects for technological transformations will be developed that will facilitate the transition to a low-carbon and sustainable transportation system. Especially railway transportation and urban transportation" policy measures are included.
2023	Presidential Annual Program	- The architecture related to ITS, which ensures energy and time savings, traffic safety and efficient use of road capacity on the road network, will be completed and put into practice, including local administrations. - A single card payment system will be put into practice to ensure widespread use of public transportation systems. - National ITS Strategy Document and Action Plan will be finalised and put into practice. - The project for the development of ITS architecture will be completed.

Source: (Republic of Türkiye Prime Ministry, 2002; Republic of Türkiye State Planning Organization of the Prime Ministry, 2006; Republic of Türkiye Ministry of Development, 2006; Republic of Türkiye Ministry of Environment and Urbanization, 2010; Republic of Türkiye Ministry of Transport, 2011; General Directorate of Highways Regulation on Duties, Authorities and Responsibilities, 2011; Republic of Türkiye Ministry of Development, 2011; Republic of Türkiye Ministry of Development, 2013; Republic of Türkiye Ministry of Transport, Maritime Affairs and Communications, 2013; Republic of Türkiye Ministry of Transport, Maritime Affairs and Communications, 2014; Republic of Türkiye Ministry of Development, 2015; Republic of Türkiye Ministry of Transport, Maritime Affairs and Communications, 2016; Republic of Türkiye Ministry of Science, Industry and Technology, 2016; Republic of Türkiye Ministry of Development, 2017; Republic of Türkiye Ministry of Transport, Maritime Affairs and Communications, 2017; Regulation on Principles and Procedures for Increasing Energy Efficiency in Transportation, 2019; Republic of Türkiye Presidency of Strategy and Budget, 2019; Republic of Türkiye Ministry of Environment and Urbanization, 2019; Type Approval Regulation on the General Safety of Motor Vehicles and Their Trailers and Components, Systems and Separate Technical Units Designed for Them and on the Protection of Unprotected Road Users and Passengers, 2020; Republic of Türkiye Ministry of Transport and Infrastructure, 2020; Republic of Türkiye Ministry of Industry and Technology, 2021; Electric Scooter Regulation, 2021; Republic of Türkiye Ministry of Commerce, 2021; Republic of Türkiye Ministry of Labor and Social Security, 2021; Republic of Türkiye Ministry of Industry and Technology, 2022; Republic of Türkiye Ministry of Transport and Infrastructure, 2022a; Presidential Decree Amending Certain Presidential Decrees, 2022; Republic of Türkiye Presidential Strategy and Budget Department, 2022; Republic of Türkiye Presidency Strategy and Budget Department, 2023).

Note: Table 4 was created by the authors using listed resources.

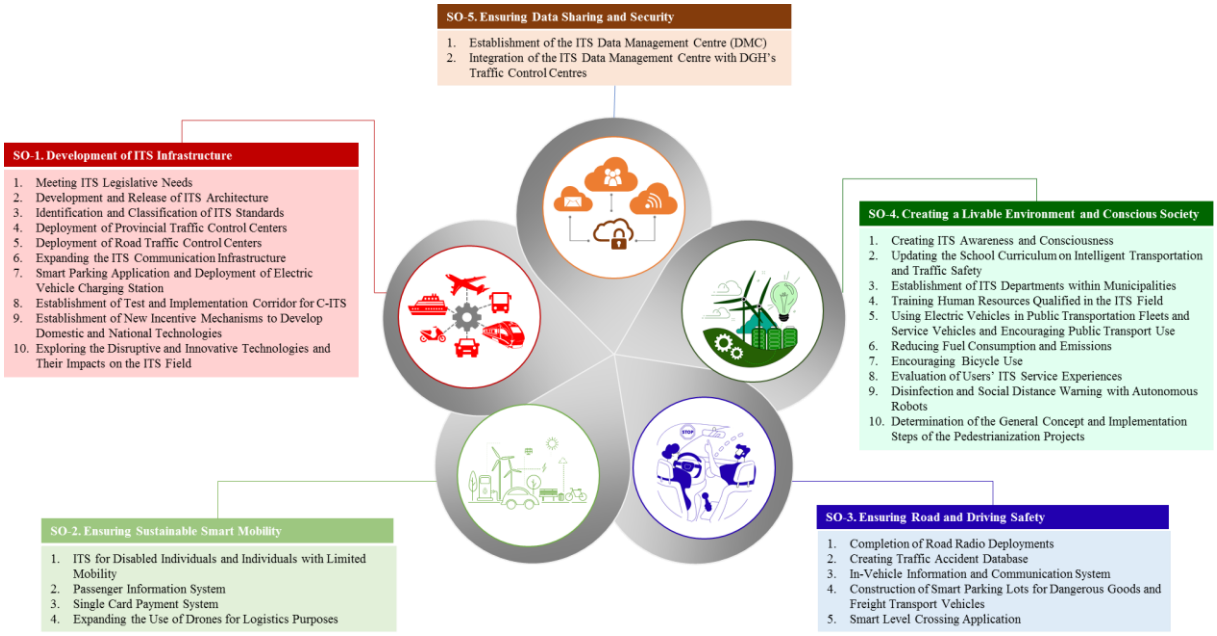
4.2. National ITS Strategy Document and 2020-2023 Action Plan

The National ITS Strategy Document and 2020-2023 Action Plan was published in the Official Gazette with the Presidential Circular dated 5 August 2020 in order to identify the needs of stakeholders and the obstacles to development in the field of ITS in line with the principles of more economical, environmentally friendly and

human-oriented sustainable transportation with digital transformation and smart applications in transportation planning due to the developments in ICT and to take appropriate measures.

ITS has become a very important concept in determining transportation and urban transportation policies with its opportunities such as using information by consuming less resources and ensuring economic growth and improvement in transportation. In the National ITS Strategy Document and 2020-2023 Action Plan, which was created within the framework of the mission "To create an efficient, safe, effective, innovative, dynamic, environmentally friendly, value-added and sustainable intelligent transportation network in our country that is integrated to all modes of transportation, uses up-to-date technologies, utilizes domestic and national resources, efficient, safe, effective, innovative, dynamic, environmentally friendly, and sustainable Intelligent Transportation Systems" and the vision "To achieve a human and environment-based transportation system in Türkiye with advanced information technologies", 5 strategic objectives, 31 actions and 54 implementation steps have been determined for a 3-year period, and long-term goals are also included, Figure 2 (Republic of Türkiye Ministry of Transport and Infrastructure, 2020).

Figure 2. ITS Strategic Objectives and Actions in Türkiye



Source: (Republic of Türkiye Ministry of Transport and Infrastructure, 2020, p. 44-94).

The long-term goals for the ten-year projection of intelligent transportation in Türkiye are listed as follows (Republic of Türkiye Ministry of Transport and Infrastructure, 2020, p. 44-94):

- Ensuring the integration of all modes of transportation in accordance with ITS architecture and set standards.
- Improving the existing ITS infrastructure, ensuring integration with ITS infrastructures and making it widespread throughout the country.
- Expanding the use of in-vehicle information and communication systems and conducting studies for the domestic and national production of these systems.
- Carrying out preparatory work to make the existing infrastructure suitable for autonomous driving, and developing fully autonomous vehicles, and making them widespread in transportation modes.
- Carrying out the necessary system and infrastructure studies to convert the motion energy of rail systems into green energy.
- Legislative work on alternative last-mile transportation applications such as car and ride sharing, micro mobility and similar alternative last-mile transportation applications.

- Expanding the use of blockchain technologies in Mobility as a Services (MaaS), data sharing, freight and logistics services and similar areas.
- Making legislative arrangements for air taxi (VTOL), drones and similar vehicles and expanding their use within the scope of ITS.
- Developing smart materials, surface coatings, nanotechnology and biotechnology products, recyclable and similar materials and expanding their use in the field of intelligent transportation for a sustainable environment.
- Establishing an IoT network including ITS components, storing the data collected from these components in a big data environment and optimizing the transportation infrastructure by using innovative technologies in artificial intelligence, deep learning, communication, and similar fields by making them suitable for analysis.
- Anonymizing the collected transportation data and using it for research and development of innovative applications.
- Developing congestion pricing, high occupancy lanes, low emission zones, and flexible working hours applications to reduce traffic congestion.
- Dissemination of smart energy solutions in the field of ITS.
- Dissemination of accessibility practices in transportation modes.
- Facilitating transportation activities by integrating logistics centres with transportation modes.
- Establishing and expanding Autonomous Driving Test and Certification Centres where functional and operational tests of autonomous vehicles are carried out and certification services are provided.
- Dissemination of sustainable urban mobility plans.

In addition to the responsibility of MoTI-DGComms for carrying out the studies and activities related to ITS, other units within the Ministry also have activities related to this field. In this direction, within the scope of ITS applications, the General Directorate of Highways has systems such as signalling, toll collection, weather and road observation, event detection, weight and size control, tunnel management, radio broadcasting, and activities like variable message signs and mobile applications in the road transportation network. In addition to these activities, traffic control and management centres are established, communication infrastructure and system installations are made, and transportation planning activities are carried out. The Directorate General for the Regulation of Transportation Services has the authority to coordinate the digital tachograph system utilised for the inspection of freight and passenger transportation vehicles and similar projects. In maritime transportation, the General Directorate of Maritime Affairs uses the Automatic Identification System (AIS) to track ships above a fixed tonnage for passenger and freight transportation. The Vessel Traffic Services System (VTSS) and Vessel Traffic Management System (VTSMS) provide traffic organisation and information services to vessels. With the Regular Voyage Information System, information on regular voyages (ship route information, ship capacities, etc.) for public transportation service is kept. Variable message signs are used at the piers where regular services are operated to inform passengers about the services. Turkish State Railways uses signalling and driver assistance systems to ensure driving security and rail safety. In addition, the railway network is constantly monitored with camera monitoring systems. The infrastructure necessary for citizens with mobility limitations to take advantage of transportation services in the best way is available in vehicles and stations. ITS applications are widely used in newly established or commissioned railway, metro, and tram vehicles, lines, and stations. General Directorate of Post and Telegraph Organization Inc: Within the scope of ITS, work is underway to develop a national e-payment system that can be used in all transportation vehicles across the country and to establish a Türkiye Card and Clearing Centre (automatic fare collection system) (Republic of Türkiye Ministry of Transport and Infrastructure, 2020, p. 33-42).

4.3. Contribution of ITS to Sustainable Transport and Economy

For medium, large and mega-sized cities around the world, the challenges of climate change, population growth, demographic change, urbanisation, and resource depletion are of great concern for survival, development and sustainability. A significant part of these concerns is the deterioration of environmental quality, climate change problems and losses in biodiversity, the consumption of renewable natural resources faster than the rate of renewal, the release of hazardous gases and greenhouse effect gases, in short, problems threatening the ecological and

natural balance and global warming Deloitte (2022) identifies five trends that address the challenges facing the transportation sector as follows:

1) Establish sustainable financing mechanisms for transportation,
2) Finding solutions to the problem of Electric Vehicles (EV) and charging infrastructure,
3) Modernize transport systems in an inclusive and equitable manner,
4) Making transportation networks more resilient,
5) Accelerating digital and technological innovation (Deloitte, 2022).

Together with these challenges, the Sustainable Development Goals, which address the issues of ending extreme poverty, increasing prosperity and well-being by overcoming the problems of injustice and inequality that the world faces today, have been put forward by 193-member countries, including our country, covering the years 2015-2030. These goals envisage making the fight against climate change an integral part of an economically and socially inclusive development model, a framework strengthened by the Paris Agreement.

The COVID-19 pandemic's effects on the social and economic crisis that started in 2020 have increased concerns for a sustainable world on a global scale. In the post-pandemic period, this situation has created the most important agenda of the whole world by making it a great need to put forward sustainable and inclusive solutions in all areas of social life, especially in the economy, transportation, health, education, agriculture, energy and similar social life.

In this process, the European Union (EU) published the European Green Deal on December 11, 2019 as part of the fight against climate change. The European Green Deal aims to increase the greenhouse gas emission reduction rate to 55% by 2030 and to become the first climate-neutral continent by 2050. The actions and activities set out in this agreement include issues and activities that will form the basis for the renewal and transformation of many sectors within the EU, including energy, transport, industry, finance, construction, agriculture.

In line with the EU's goal of becoming a climate-neutral continent by 2050, other leading actors in international trade, such as South Korea, Japan and China, started to announce their green transformation targets in 2020. In addition, countries such as Sweden, Norway, Canada, Chile and South Africa were among the countries that declared their net zero emission targets. In this direction, it is important for all sectors and work areas to take the necessary measures to ensure Türkiye's compliance with the European Green Deal.

The first Climate Law, which establishes the legal framework of the EU's 2030 and 2050 climate-neutral policies and climate targets, was published on July 9, 2021, and the obligation to take the necessary steps at the national level to achieve concrete targets was introduced. In order to achieve the targets enacted by the European Climate Law, the European Commission presented the draft "Fit for 55" green package on July 14, 2021, which includes a series of legal regulations. It is known that Fit-for-55 aims to pave the way for and develop a climate-neutral economy and encourage an even faster transition to a net-zero energy system, with a wide range of reforms covering key EU climate policies as well as various laws on transport, energy and taxation. Compliance with the goals of increasing the use of renewable energy, achieving higher energy efficiency, reducing greenhouse gas emissions, making low-emission transportation modes and the infrastructure and fuels to support them more rapidly available, and improving human health and well-being is seen as a necessity for the sustainability of the world and the countries of the world. The European Commission also published on December 14, 2021 a proposal for a new legislative package entitled "Efficient and Green Mobility", which is part of the European Green Deal and specific to the transport sector. This package aims to achieve the European Green Deal's target of reducing emissions from the transport sector by 90% by increasing connectivity in the transport sector, shifting transport to rail and inland waterways, making multimodal transport more efficient, introducing new charging points, introducing new digital technologies, giving more priority to sustainable urban mobility. In the new legislative proposal, which consists of four proposals in total, the Commission has presented new draft legislation in the areas of Trans-European Transport Networks (TEN-T) and Intelligent Transport Systems (ITS) in order to make the European transport sector greener and smarter. At the same time, the Commission is proposing new legislation amending the ITS legislation Official Journal of the EU (2010), which has been in force since 2010. The proposal aims to provide faster smart services, make certain traffic, road and travel data available in digital format across the TEN-T network and promote automation in transport. The package also adopts a new framework for urban mobility. In this context, it has been decided to implement sustainable urban mobility plans in a total of 424

European cities in order to promote zero-emission urban mobility (European Commission, 2022; European Commission, 2019).

In addition, the Ministry of Trade prepared the Green Deal Action Plan in 2021 in order to contribute to Türkiye's transition to a sustainable and resource-efficient economy and to ensure compliance with the comprehensive changes envisaged by the European Green Deal. The Action Plan includes actions to be implemented in order to achieve the targets set under the headings of carbon regulations at the border, a green and circular economy, green financing, clean, economical and secure energy supply, sustainable agriculture, sustainable intelligent transportation, combating climate change, diplomacy and European Green Deal information and awareness-raising activities. In this framework, the Action Plan includes a total of 32 targets and 81 actions under 9 main headings (Republic of Türkiye Ministry of Commerce, 2021).

In addition to preserving the current situation, it is seen that it is determined to take the necessary measures and carry out studies with all its stakeholders such as public, private, academia, local governments, NGOs on the basis of all sectors from transportation to agriculture, health to education with the aim of ensuring the sustainability required for change, development and progress and becoming a prosperous country.

The studies carried out in Türkiye in this direction are people-oriented, as in the whole world. They focus on the issues and areas that affect human life the most. These focus areas are generally related to the cities, which are the living spaces of the constructions. Developing and growing cities have to change and transform by using innovative technologies in the way they provide services in order to raise living standards and reduce carbon emissions by doing environmentally friendly work. The transformation of large cities with high levels of energy consumption into the low-carbon smart cities of the future will be possible thanks to the technological and scientific developments that are already available and will emerge in the future, especially ICT. This approach requires all stakeholders, including citizens, to use smart technologies to lead initiatives and manage assets and resources in a growing and evolving urban environment.

When determining urban transportation policies, it is expected to focus on the needs of society and individuals and to be accurate and in line with the requirements of the age. In order to realise these policies, it is important to put forward plans and programmes consisting of strategic goals, objectives and actions, projects and activities. By including disruptive and innovative technologies and developments in ITS in these plans and programmes, it is possible to achieve the desired results and reduce the negative effects of possible risks and problems.

In addition, the use of innovative approaches such as Industry 5.0, disruptive technologies, ITS applications and solutions in smart city logistics from a relational and holistic perspective can be useful at the micro level, especially in overcoming disaster and emergency logistics challenges while having an impact on many transportation-based problems (Kocalar, 2023).

More widespread use of electricity in transportation can significantly reduce sector emissions, especially in countries with high levels of renewable sources of electricity generation. Key opportunities for renewable energy sources in the transport sector include the use of biofuels blended with conventional fuels, biomethane-powered infrastructure, battery electric and plug-in hybrid vehicles, and the widespread use of electricity in transportation modes, including the use of renewable hydrogen and electro fuels.

All of the strategic objectives in the National ITS Strategy Paper aim for outcomes on par with the EU Green Deal. ITS is considered an important transportation policy in terms of sustainability as it consumes fewer resources and uses information while ensuring economic growth and improvement in transportation. When the National ITS Strategy Document and Action Plan are evaluated in this framework, the works to be carried out within the scope of the following actions will contribute significantly to environmental sustainability and the reduction of greenhouse gas emissions.

- Publishing the national-ITS architecture and setting ITS standards,
- Preparation of legislation on electric vehicle and charging station infrastructures,
- Conducting studies for the expansion of electric vehicle and charging station infrastructures,
- Expansion of charging stations for electric vehicles,
- Including electric vehicles in public transportation fleets and service vehicles,

- Expansion of public transportation,
- Creating the appropriate infrastructure to promote the use of bicycles,
- A general concept to include the basic framework for pedestrianisation projects and steps for implementation.

With the implementation of the actions and projects, the focus is on spatial planning decisions and the development of transportation systems through intelligent transportation planning, reducing dependence on non-environmentally friendly energy types commonly used in transportation and reducing greenhouse gas impacts. In this direction, this document, which aims to deploy intelligent transportation systems and is determined as a roadmap, aims to achieve common results with the EU Green Deal and Fit For 55, such as increasing the use of renewable energy, achieving higher energy efficiency, reducing greenhouse gas emissions, making low-emission transportation modes and the infrastructure and fuels to support them available faster, and improving human health and welfare.

Table 5 shows the proposed work topics for the roll-out of ITS for the next ten years period determined by this study:

Table 5. Suggested focus areas to accelerate ITS deployment in Türkiye.

Technical	Administrative and Social
- Improving infrastructure and making it resilient - Communication technologies (5G) - Active use of artificial intelligence in transportation and mobility solutions - Alternative energy (electricity and renewable energies) - Development of autonomous and connected vehicle (CAV) technologies - Internet of things - Electric vehicles and charging infrastructures - Cyber security studies - Fleet management and maintenance - Traffic management centres with traffic management solutions - Ticketing and payment systems - Interoperability - Big data, data access, exchange and integration studies - In-vehicle systems - Complete on-demand full journey planning solutions such as MaaS - Air quality monitoring and remediation solutions - Smart solutions for level crossings - Preparation of a guiding user guide on cyber security of intelligent transportation systems	- To put forward policies, strategies, legislation, frameworks and roadmaps related to ITS in a way to include all stakeholders - Improving transport and mobility services - Ensuring the integration of all modes of transportation (multimodality) and increasing their accessibility - Travel accessibility for transportation and mobility - Assessment of travel experience, travel and passenger information - Improvement and expansion of public transport - Identifying solutions to ensure safety and deterrence in transportation - Human resource development and capacity building - Coordination between stakeholders - Urban transport solutions and the division of cities into climate zones - Use of ITS in passenger and freight transport - Working especially on legislation to pave the way for the development of autonomous, connected and cooperative mobility - Developing roadmaps such as strategies and action plans for end-to-end travel solutions such as shared mobility and MaaS - Ensuring that the ITS strategy and action plan is a continuous, developing, updated and living road map as in international best practices - Establishing a mechanism to ensure cooperation and coordination in order to be competitive in ITS

5. CONCLUSION AND EVALUATION

While new technologies are constantly evolving, their diffusion and acceptance in social life vary depending on various factors in the social, economic and political framework. Discussing the strengths, weaknesses, opportunities and problems that will support the inclusion of intelligent transportation systems policies and developments in disruptive and innovative technologies in the processes while creating transportation plans is an important issue in terms of taking measures for uncertainties and risks.

In many parts of the world, intelligent transportation systems (ITS), an integrated application of advanced technologies like information and system control technology and artificial intelligence, are recognised as an effective solution to public policy challenges and transportation problems in the areas of mobility, digitalization, transportation, infrastructure, road safety and regional cohesion.

In order to reduce fuel consumption and emissions within the scope of ITS's contribution to a liveable environment and sustainability goals, many developed countries have taken decisions such as gradually increasing the amount of electric vehicles and stopping the production of fossil fuel-consuming vehicles by 2030-2035.

The transportation sector is a sector that can react faster than other sectors in terms of the effects of policies that can be implemented. Intelligent transportation systems, which are developed by using ICT for efficient use and better presentation of the transportation system, are also used to contribute to the improvement of the environment and air quality along with energy efficiency.

In Türkiye, ITS is increasing its awareness day by day. With many good practices, it brings change and transformation to urban and intercity transportation. In order to ensure that this change and transformation are organised and formalised, high policy documents are needed. These documents are sometimes guiding documents for the sector and sometimes pave the way for developments.

The most important obstacles to the widespread adoption of ITS in Türkiye are the deficiencies in legislation, policies, strategies and regulatory frameworks and the problems caused by confusion of authority. The short-term goal of ITS development should be to identify and address urgent problems and improve the infrastructure. The long-term goal is to ensure the spread of ITS throughout the country.

The National ITS Strategy Document and 2020-2023 Action Plan is a roadmap that is prepared by taking into account the best examples in the world and is planned by anticipating the current situation and the future. The enforcement period of the action plan will expire at the end of 2023 and a new update will be needed. The update should be made with a holistic perspective that includes autonomous and connected mobility, economic driving, shared, fair and accessible transportation models, as in the examples of leading countries in this field. At this point, while taking into account the technical, administrative and social focus areas for the deployment of ITS presented in Table 5, studies should continue with measures to prevent duplication by taking into account the efficient use of public resources and the institutional structures.

The strategic objective headings for the new period strategy document are proposed as follows: i) ITS infrastructure development; ii) ensuring sustainable intelligent transport and mobility; iii) ensuring transport safety and security; iv) developing and enabling ITS technologies; v) data access, sharing and management. In order to realise these strategic goals, strategic targets and actions need to be carefully defined. In addition, ensuring their realisation and implementation will be an approach that will pave the way for the spread of ITS.

DECLARATION OF THE AUTHORS

Declaration of Contribution Rate: The authors have equal contributions.

Declaration of Support and Thanksgiving: No support is taken from any institution or organization.

Declaration of Conflict: There is no potential conflict of interest in the study.

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