



Investigation of the Effects of Intelligent Transportation Systems on Urban Public Transport for the Province of Erzincan

Şeyma Sünbül and Ahmet Tortum

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Investigation of the Effects of Intelligent Transportation Systems on Urban Public Transport for the Province of Erzincan

Şeyma SÜN BÜL ¹[0000-0002-3333-7203] and Ahmet TORTUM ²[0000-0002-5770-766X]

¹seyma.sunbul@erzincan.edu.tr, Lecturer, Erzincan Binali Yıldırım University

²atortum@atauni.edu.tr, Assoc. Prof. Dr., Ataturk University

Abstract

Due to the rapid increase in population in the world, many problems arise in developing countries. The problem of dispersed settlement and therefore the problem of the urban transportation system comes to the fore among these problems. Thanks to the developing technology, concepts such as smart economy, smart governance, smart environment, smart life, smart transportation (mobility) and smart people (citizen) have emerged. It is very important to apply these tools to urban management. With the use of developing technologies, the communication of existing technological devices with each other and the perception of the environment have accelerated the studies on smart transportation. Intelligent transportation systems (ITS) applications, which play an important role in increase in safety in transportation, energy efficiency and protection the environment by making use of technological developments, stand out as an important component of the smart city concept. The concept of smart transportation has taken its place in various policy documents and local government practices in Turkey as well as in the world. Within the scope of this study, the application levels of Intelligent Transportation Systems in the field of urban public transportation in Erzincan Province were examined. In addition, suggestions were made for applications that will increase the use of Intelligent Transportation Systems in urban public transportation systems in Erzincan Province and for the development of existing applications.

Keywords: Barrier-Free Living, Intelligent Transportation Systems, Public Transportation.

1. Introduction

When the general distribution of the transportation system in our country is examined, it is seen that the highway has a higher share than other transportation systems. Route flexibility, passenger carrying capacity and direct transportation on the highway make this transportation system more preferable. As in other countries, road transport maintains its importance in our country and the ownership of motor vehicles is increasing day by day. The increase in the number of motor vehicles and the population causes many problems. Irregular traffic increases cause traffic jams and traffic accidents with death or injury. Therefore, it is almost impossible to talk about safe and comfortable journeys due to the high traffic load. In our country, it is important to direct people to the 'public transportation system' in order to bring functionality to the highways, which have a high usage share, and to ensure passenger safety and comfort. In order for the passengers to choose this route, the conditions of the public transport system should be improved. There are many technological developments that can be used to make public transportation more desirable. Smart transportation systems is the one of the solution at this point. One of the issues that Intelligent Transportation Systems (ITS) works on is making public transportation functional. For this aim, there are many options that can be use such as mobile applications, passenger information, city cards, and special applications for the disabled and smart stops.

1.1. Development of ITS in the World

The first intelligent transportation systems can be considered as red light cameras in the 1960s. Again in these years, the first ITS researches were started. Card Access System (CACS) in Japan, Electronic Route Guidance System (ERGS) in America, and ALI, a similar system in Germany, are the first ITS studies. All

these systems focused on the route/route guiding method in common and could not be applied in practice due to various restrictions (Öztürk, 2006).

In 1990, ERTICO-ITS Europe organization was established in order to set ITS standards and provide resources for R&D studies across Europe. In the same year, ITS America (Intelligent Transportation Society of America), the ITS association of the American continent, was established. Subsequently, ISO TC204 Intelligent Transportation Systems Technical Committee was established in 1992 and ITS started to work to set the worldwide standards. In 1994, annual international ITS meetings were initiated under the title of ITS World Congress on Intelligent Transport Systems. In the same year, VERTIS (The Vehicle, Road and Traffic Intelligence Society) was established as Japan's ITS association. With the increase in the effectiveness of technology in 1995, ITS applications are made from simple systems such as intersection signalization, radio broadcasts, electronic signage, smart pedestrian crossings, intersection control systems and attendance managements managed with real-time data use, 3G-WifiBluetooth-based data sharing and emergency management systems, infrastructure and emergency management systems. Its evolution into advanced applications such as autonomous vehicles that interact with other traffic elements took place in this period. In 1997, the American National Automation System Consortium (NAHSC-National Automated Highway System Consortium) presented the Demo'97 project with the aim of increasing highway efficiency and traffic safety (Roads, 1997). For this decade, the focus of ITS was moved from the solution of problems encountered only in road traffic to a wider framework and studies were carried out on the solution of inter-species problems.

VERTIS (The Vehicle, Road and Traffic Intelligence Society) was renamed “ITS Japan” in 2001 and subsequently became an international organization including other countries in the Asia Pacific region. ITS World Congress is now organized in cooperation with ERTICO, ITSA and ITS Japan. (Tektaş et al., 2016).

Today, ITS is on the way to become an extremely effective and important element in national and international platforms, and especially in recent years, the competitive environment between developed countries that want to have a share in the ITS market continues. In line with this competitive environment, ITS technologies have diversified and become widespread with the developments in information technologies (UDHB, 2014). The development processes of ITS in the world are summarized in Figure 1.

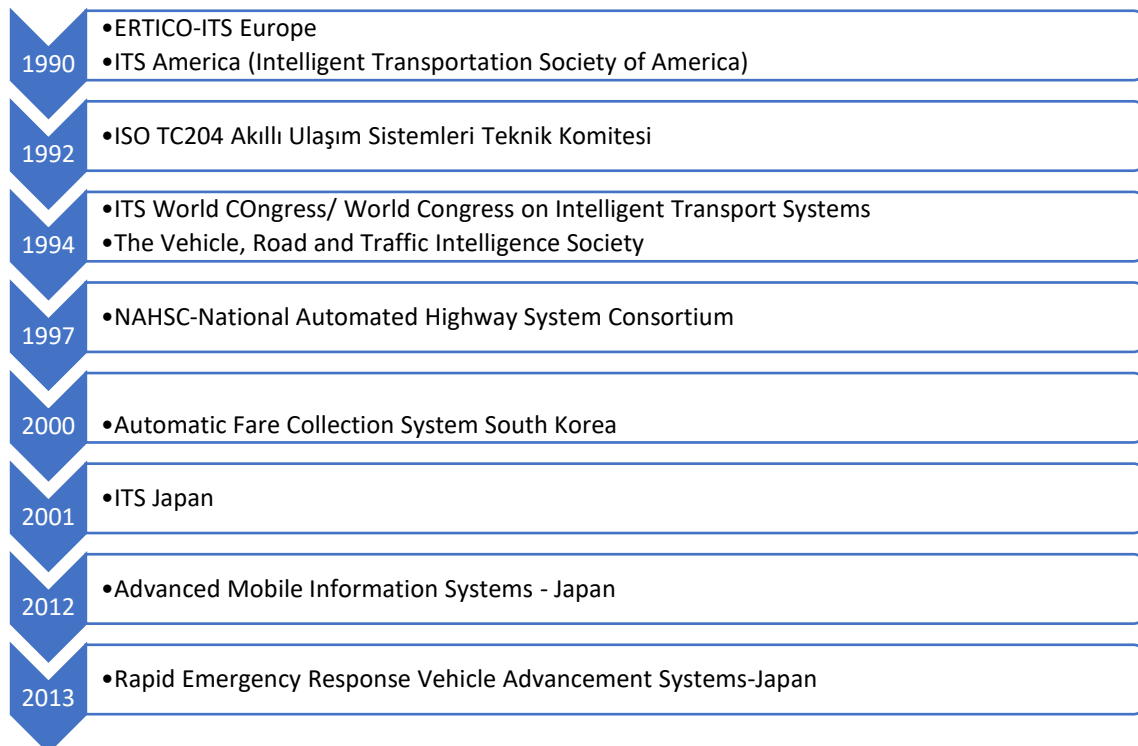


Figure 1. ITS Development Processes in the World

1.2. Development of ITS in the Turkey

Although it seems possible that the first breakthroughs on ITS in Turkey can be traced back to the Gebze-Izmit Expressway built in the 1980s, concrete studies begin with the Highway Toll Collection System, which was put into service in 1992. This system is an operator-based system developed to charge vehicles traveling on the highway according to the distance they travel and the vehicle class. Due to the rapid increase in population and vehicle ownership in our country in recent years, traffic problems are encountered especially in big cities. In this context, the Automatic Passing System (OGS) was put into practice on the Fatih Sultan Mehmet Bridge in 1999 in order to prevent time loss and to ensure rapid passage. As of the end of 2020, 198 OGS entries, 226 OGS exits; 205 HGS entrance and 251 HGS exit toll booths are open for operation. As of the end of 2020, a total of 387,639,267 vehicles using OGS and HGS crossed highways and bridges (KGM, 2020). Bolu Mountain Traffic Information System Project in 1999, Ankara Traffic Information System ITS Project and Aydın-İzmir Highway Selatin Tunnel Project in 1999, Istanbul Traffic Information System-ITS Project started to be implemented in 2001. In 2004, projects that are extensions of Ankara Traffic Information System were implemented. A large number of variable message signs, variable traffic signs, variable lane and speed limit signs, license plate detection equipment, radars, and various types of sensors are used in all these projects. Since 1995, by the Istanbul Metropolitan Municipality, to make the transition system modern and efficient; making it possible to apply different prices on passenger line distances and at different times; to be able to continuously monitor the demand level depending on the number and distribution of passengers, to make a demand forecast for the future by collecting data on a day/hour basis. Electronic ticketing system (AKBİL) has been started to be used in order to continuously subtract passenger distributions from incoming passengers according to ticket type, hours, stations and lines and give them to the relevant institutions. Today, AKBİL applications continue to develop, especially with interspecies integration (Yardımcı et al., 2005).

2. Literature Review

Yardımcı and Akyıldız (2005) mentioned ITS in their historical development process, and then focused on the technical infrastructure of the subject. The situation in Turkey with various applications in the world has been revealed. As a result, suggestions were made for the creation of the ITS architecture. The fact that the use of ITS will also highlight the need for a healthy, reliable and continuous transportation database and that the widespread use of these systems will come to the fore; presented the view that it will also create a driving force for studies on transportation data. Tufan (2014) mentioned the development of Intelligent Transportation Systems in the world and Turkey, and suggest a model for Intelligent Transportation Systems for Turkey in his study. With this model, it is expected to make a critical contribution to the dissemination of ITS in terms of keeping detailed information on current practices in Turkey in a central database and using this information in different geographical regions, and presenting it to researchers as an open source for different projects. In addition, in terms of administrative structure, he made a suggestion to establish a division only related to ITS under the Transport, Maritime and Communication Research Center Presidency established within the body of Ministry of Transport and Infrastructure. Tektaş, Korkmaz and Erdal (2016) suggested in their study short, medium and long term planning for ITS and interpreted the economic and environmental benefits in developed countries of ITS. After all these evaluations, it was stated that ITS applications will be one of the most important element of competition between cities and countries. They predicted that the world will be full of smart cities equipped with ITS in the next decade. Ilıcalı, Camkesen, Kızıldaş and Ergin (2016) stated in their studies that Intelligent Transportation Systems require a series of solutions in a wide area such as ensuring inter-species integration and balanced species distribution, directing consumption culture, and emphasizing environmental and sustainable approaches. They also made inferences about the benefits of EDS which is one of ITS's uses in Istanbul. Yalçın, Aydın and Kaygusuz (2017) made suggestions about "Trambus" used in Malatya to make the smart in their study. As a result, a system was designed that automatically sends a message to the system administrator for additional trambus/bus exit from intermediate stops when the occupancy reaches 85% by comparing the recommended in-vehicle occupancy rate. Thus, it has been stated that passengers will have the opportunity to provide more comfortable and timely transportation. Liu, Weng, Wan, Yue, Song and Vasilakos (2017) stated in their study that efficient urban transportation systems are widely accepted as basic infrastructure for smart cities and They noted that it greatly increases the vitality of a city and its comfort for its inhabitants. They also stated that in transportation systems, data-driven management can significantly

increase the operational efficiency of passengers' transportation behavior. In addition, they created an algorithmic framework to handle location data loss and time inconsistency. Finally, by analyzing the spatial distribution characteristics of location data loss events in their study, they found a strong and positive relationship with both high passenger volume and shadowing effects in urbanized areas, which could cause serious biases in passenger traffic analysis. Katanalp , Yıldırım , Eren and Uz (2018) examined the historical development of ITS in Turkey and the world, and evaluated the prevalence of ITS in our country. Compared to the leading countries in the world, it was stated that Turkey could not follow the developments in the world in the field of ITS simultaneously, but it was concluded that ITS studies have accelerated with the increase in ITS awareness in recent years and the tendency of ITS stakeholders to act together. In line with the views of ITS stakeholders and the objectives of the relevant ministries, it has been suggested that our country should make ITS planning in a safe, economic, environment-friendly, solution-oriented and user-friendly manner. In a study conducted for Erzurum province, the application levels of Intelligent Transportation Systems applications in the field of public transportation were examined. In addition to these, suggestions have been made for applications that will increase the use of Intelligent Transportation Systems in public transportation systems in Erzurum Province and for the development of existing applications. Within the scope of ITS, it has been suggested that the low diversity of public transportation in Erzurum and the desired comfort level has not yet been achieved, preventing the increase in the use of public transportation in this city, and it has been suggested by the local administrations in Erzurum that studies on ITS should become priority policies (Çodur and Topdağı, 2018). Kenanoğlu and Aydın (2018) conducted a survey for pedestrians and drivers for the traffic in the central district of Çanakkale, and aimed to improve the use of Intelligent Transportation Systems in order to eliminate negative externalities and increase positive externalities more. By evaluating the attitudes and behaviors of pedestrians and drivers in Çanakkale, solutions have been offered for the traffic problem in the context of smart transportation. As a result, sensitive signaling systems for emergency vehicles implemented in Australia, mobile applications that facilitate finding a taxi in Singapore, the use of electronic cards used in public transport in Hong Kong for parking meter payments (to encourage drivers to use public transport), in London, where congestion is high electronic pricing of zones are suggested for solutions for to the decrease of negative externalities caused by traffic and the increase of positive externalities in Çanakkale. In addition, they offered to establish an ITS application and research center within Çanakkale Onsekiz Mart University. Taç (2018) examined the impact of the development of ITS on highways at the national and international level. In this study, the changes in traffic accidents in developing countries in ITS technologies were evaluated using the relevant data. As a result, it has been stated that ITS applications have positive effects such as the effect of managing traffic, increasing traffic safety and reducing traffic congestion, and regulating the traffic flow. It has been determined that Turkey is one of the countries for more ITS information and applications, as it is a newly developing country in the field of ITS. It has been stated that ITS practices reduce traffic accidents and the rates of death and injury in traffic accidents. Güzel , Özdemir and Özdemir (2019) explained in detail the Smart Kasis Lighting Project, one of the domestic and national projects developed within the scope of the concept of smart transportation, depending on the importance given to smart urbanism in our country. With the analysis of the data obtained in the study, which carried out considering the needs of the city and the citizens, it has been determined that the Smart Kasis Lighting project supports the hypothesis that it will contribute to safe transportation in cities. Tektaş and Tektaş(2019) made the distribution and analysis of ITS applications according to the sectors in their studies. The benefits of ITS applications of some sectors are explained with data for the world and Turkey examples. As a result, strategies and action plans that should be made in order for ITS applications to become widespread in our country have been suggested. Uzun and Hakverdi (2019) suggestions were made by working on how to use smart transportation systems for the disabled. Thanks to this proposal, it is expected that the disabled people at the stops will be detected with various camera systems, the bus coordinating authority will be notified of the stop where the disabled person is located, and the appropriate buses will be directed for the next bus service. Uzun and Hakverdi (2019) made another study that suggested a different smart transportation system, which proposed a smart bus stop that will not make people with disabilities have to wait for buses with their own areas at bus stops via machine vision and the concept of the Internet of Things. It is stated that every understanding of advanced societies that attaches importance to the individual, human and life struggles to facilitate social life and to integrate the individual into society, and it has progressed quite rapidly in this regard. In Turkey, on the other hand, there are still insufficient, incomplete and meaningless applications though quite good advances. Özden, Akalın and Kara (2019) took into account the National Intelligent Transportation Systems Strategy Document prepared by the Ministry of Transport and Infrastructure in 2014, and evaluated the

services provided by the municipalities in Turkey in the field of public transportation within the scope of ITS. In many municipalities, traffic management, passenger information, accessibility and mobile applications were evaluated. As a result, it has been seen that the vast majority of municipalities have a serious infrastructure and provide services in terms of passenger information and electronic payment systems but it is also evaluated that there are issues that are open for development. Boukerche and Coutinho (2019) stated in their study that scientific and industrial initiatives have developed a new era of smart transportation that aims to overcome the limitations of existing transportation infrastructures. These initiatives are designed to collaborate for safer, efficient, environmentally friendly and enjoyable transportation for people and goods in major urban areas, he said. However, current research on intelligent transportation systems has also noted that a fundamental building block, intelligent crowd management, has also been neglected. In the study, the lack of current smart transportation system initiatives is discussed as they do not implement the smart crowd management component. In addition, the key steps towards the design of solutions for smart crowd management and the main challenges that need to be addressed are identified. Finally, future research directions for the design of intelligent crowd management solutions and infrastructures for intelligent transportation systems are presented. Yan, Liu and Tseng (2020) stated in their study that smart cities are developing aggressively around the world, especially in China. However, they stated that there is no uniform and clear understanding of the traffic operation systems of smart cities. As a result of this evaluation, they stated that wrong planning can lead to wrong construction. In addition, it was stated in the study that smart cities can be made practical with self-organizing systems and the design of self-organizing systems can be beneficial in such cities. Sun, Shi, Han, Wang and Shu (2020) stated in their study that traffic congestion in modern transportation has become an urgent problem in large and medium-sized cities. It has been stated that it is an effective solution to design load balancing road planning algorithms that can dynamically adapt to traffic conditions in order to avoid congestion in intelligent transportation systems. In the study, a traffic route planning algorithm based on data prediction, built on a prediction model based on historical traffic data and current traffic information, is proposed to find the road with the shortest travel time. A path planning algorithm based on load-balanced data prediction (TPPDP-LB) is also proposed, which combines the predicted information and the number of concurrent requests to obtain the path with the shortest travel time while maintaining global load balancing. Şengül ve Altıntaş (2020) mentioned how smart transportation systems affect smart city policies with the help of case studies in their study. The smart transportation policies implemented by the metropolitan municipality are discussed within the scope of smart city policies in Kocaeli, which is an industrial city and has various urban problems. As a result, it was concluded that the establishment of a control center for public transportation would help the traffic in the city to take place in a safer way. They also stated that the number of smart intersections, smart stops and variable message boards should be increased and there is a need for an upper control center to manage these systems in an integrated manner.

3. Material-Method

3.1. Material

Due to the geographical location, physical structure and climate of Erzincan, it is one of the areas where the first human societies settled in history. Erzincan is located in the Upper Euphrates section of the Eastern Anatolia Region. It is adjacent to Erzurum Bingöl in the east, Sivas Giresun in the west, Gümüşhane Bayburt in the north, Tunceli Elazığ and Malatya in the south and it is a city with a population of 234,431. Erzincan, with a surface area of 11,903 km²; It has 8 districts, namely Çayırılı, İliç, Kemah, Kemaliye, Otlukbeli, Refahiye, Tercan and Üzümlü. Erzincan province is an important transit point in terms of being on the E80 highway in Turkey's east-west transportation corridor. The traffic density at certain intersections is quite high. Public transportation is provided by 10 lines in total and minibuses serving at various points. Since it has a University that includes many faculties and colleges, public transportation is also used quite heavily by students. With the economic development of the city, vehicle ownership also increases over the years, and this causes congestion in traffic. The city center road structure is generally narrow and the parks on the side of the road make it difficult to pass. Private car parks in the city are not preferred much in terms of finance or because they are not a habit. Therefore, this situation increases the density on the roads. Congestion occurs at the intersections that are heavily used at peak hours.

3.2. Method

3.2.1. Intelligent Transportation Systems

Intelligent transportation systems have developed for the purposes of ensuring safety in traffic, reducing travel times, using the existing road more efficiently, increasing mobility, using energy efficiently and reducing the damage to the environment, multi-dimensional data exchange between user-vehicle-infrastructure-center and monitoring, measurement, analysis and control information communication based systems.

When it comes to Intelligent Transportation System, systems related to the use of electronic and computer systems to regulate transportation come to min (UBAK, 2017).

Classification and applications on intelligent transportation systems according to their usage areas can be given under the following titles:

1. Passenger Information Systems
2. Traffic Management Systems
3. Mass Transportation Systems
4. Electronic Payment Systems
5. Cargo and Fleet Management Systems
6. Driver Support and Safety Systems
7. Accident and Emergency Systems (Yalçın et al., 2021).

4. Findings and Discussion

Transportation services, which is one of the services that people use most frequently, is one of the most important factor that shows the country income level. The development of technology is effective in every field, as well as bringing very important innovations in transportation systems. Countries that can keep up with these innovations can take their transportation systems to advanced levels. In Figure 2, it is seen that the increasing population increases the number of vehicle ownership along with it (TUIK, 2020). However, despite the increase in vehicle ownership, the transportation systems remain at the same rate and it can cause serious congestion and traffic accidents. In order to reduce injury and death rates due to traffic accidents, technologies are needed to provide communication between the vehicle and fixed control centers, both inside and outside the vehicle. Therefore, ITS emerges as an inevitable development. With the use of ITSs, both the welfare level will increase and a safer and more comfortable transportation system will be created.

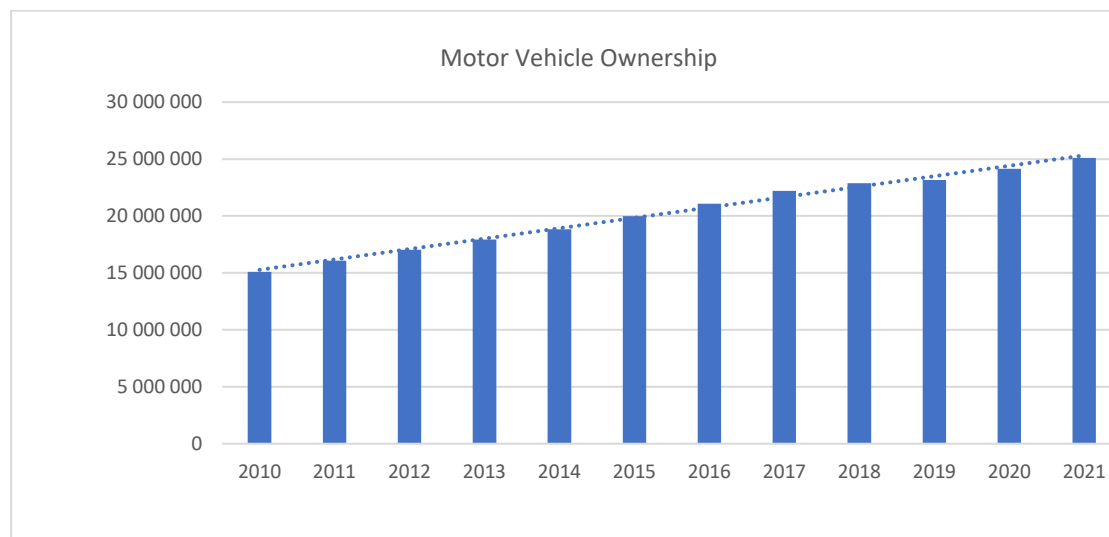


Figure 2. Motor Vechile Ownership

4.1. ITS Usage in Erzincan Mass Transportation Systems

As of the end of September, the number of registered vehicles in Erzincan was 63.018 units. The distribution of the vehicles is shown in Figure 3.

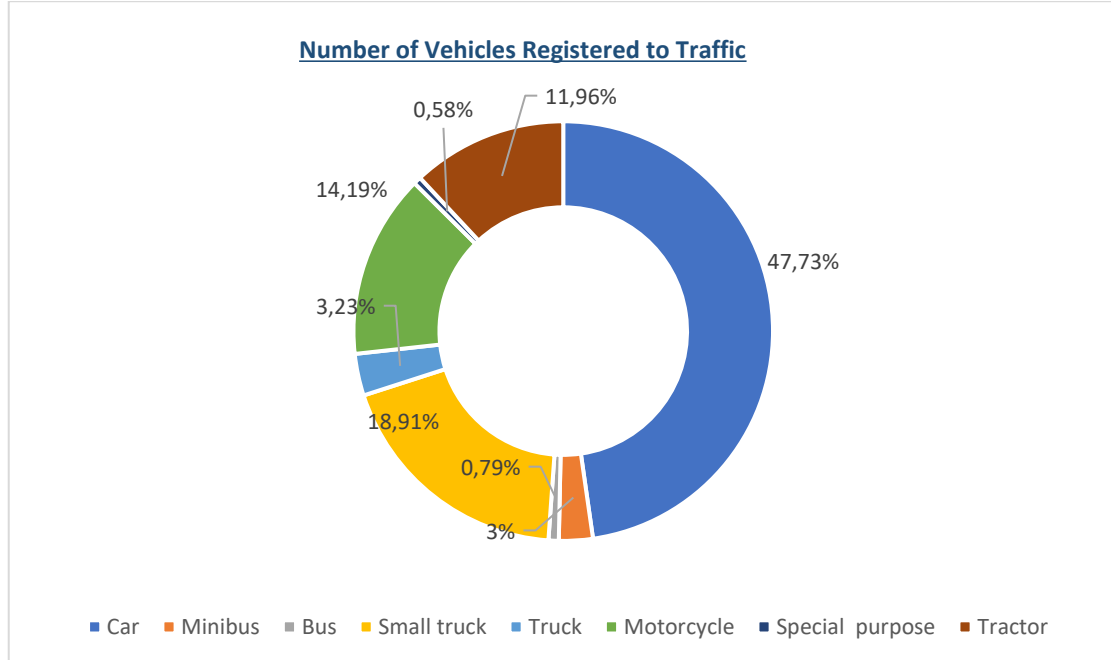


Figure 3. Number of Vehicles Registered to Traffic

Since Erzincan is still a developing city, the use of ITS is quite limited. Today, the system that is used prominently on behalf of ITS is the Cankart bus card system. With the the Cankart bus card system passengers pay the fee by having their card read by the electronic card reader system in the municipal buses. Thanks to this system, passengers get on the bus faster and prevent time loss. Cankarts can be obtained from various points in the city. In addition, although the existence of closed stops in and around the center of Dörtyol in the province throughout the province, it has been determined that the number of passengers is few and insufficient. In addition, it has been observed that the existing closed stops have disabled entrances, and there is a disabled access road in all of the closed and open stops.

5. Conclusion and Recommendations

The public transportation system is one of the important transportation elements used all over the world. Today, the use of ITS becomes mandatory in developing cities where the population growth rate is high. In the public transport services satisfaction survey, the Erzincan public transport system is ranked 28th in the country with a score of 64.5 (TUIK, 2013). Increasing the use of ITS will move this satisfaction to higher levels. In Erzincan, there is not enough construction in the name of ITS.

Within the scope of this study, a three-stage proposal plan was presented to increase the inadequate ITS applications in Erzincan.

The first of these is the development of a "mobile application" that can work on Android and iOS platforms in integration with the Cankart used to facilitate boarding the buses, and it will make the current system more accessible and systematic. With the mobile application to be designed, passengers will be able to inquire about the balance of their cards, access the locations of the buses, see which bus offers service on which route, and deposit balance their cards without going to the loading points. In this way, bus waiting times will be shorter and a more homogeneous passenger distribution will be achieved.

The second suggestion that can be used as an ITS is smart stops. In Erzincan Province, where winter conditions are severe and summer months are hot, the long bus waiting time makes it difficult to wait. Therefore, thanks to the smart stops to be designed as closed, heated and cooled, passengers will be able to

spend their bus waiting times more comfortably. In the current situation, the number of closed stops in the city center is very limited and not sufficient. By increasing the number of closed stops, digital screens to be placed inside the stops will enable passengers to share information such as which bus goes where, bus arrival times, which buses will stop at the current stop.

The third suggestion is warning systems that can be used for disabled individuals. With this system disabled person will use the button to inform transportation center to take actions to get personal for helping the disabled person and to send vehicles capable of carrying disabled passengers In Erzincan, the equipment for disabled people is not available in all public transportation vehicles in buses operating under current conditions. In this way, with the help of the additional system to be used for disabled individuals, the difficulties experienced by the disabled individual in transportation will be eliminated to some extent.

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