Araştırma makalesi

Digital dimension of urban transportation: Transportation 4.0

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Abstract: Today, changes occurring in many areas with the effect of industrial developments are frequently seen in the field of transportation. These changes, which are observed especially in urban transportation, emerge as various transportation modes and systems that have gained a different dimension with the developments in information-communication technologies and technological infrastructure. The products of the fourth industrial revolution, such as the internet of things, autonomous vehicles, sensor technologies, cloud storage, artificial intelligence, machine learning, are the most used elements of transportation modes and systems in smart cities under the heading of intelligent transportation. Within the scope of this study, the changes in urban transportation during the industrial revolutions are mentioned. Different modes of intelligent transportation systems that provide many advantages in urban transportation; individual transportation, mass transportation, and freight transportation are examined in terms. In this context, the latest in intelligent transportation literature accessible to the Transportation 4.0 concept is discussed developments in the world and Turkey. The changing dimensions of urban transportation from the past to the present, the transformation of technology, manpower, and today's conditions, and what kinds of opportunities this transformation will offer us in the future are discussed.

Key words: Smart city, intelligent transportation systems, industry 4.0, micro-mobility, transportation 4.0

Kentsel ulaşımın dijital boyutu: Ulaşım 4.0

Özet: Günümüzde, endüstriyel gelişmelerin etkisiyle birçok alanda meydana gelen değişimler, ulaştırma alanında da sıkça görülmektedir. Özellikle kentsel ulaşımda gözlenmekte olan bu değişimler, bilgi-iletişim teknolojileri ve teknolojik altyapıdaki gelişmelerle birlikte, farklı bir boyut kazanan çeşitli ulaşım tür ve sistemleri olarak ortaya çıkmaktadır. Nesnelerin interneti, otonom araç teknolojileri, sensor teknolojileri, bulut depolama, yapay zekâ, makine öğrenmesi gibi dördüncü endüstri devriminin ürünleri, ulaşım tür ve sistemlerinin akıllı kentlerde, akıllı ulaşım başlığı altında en fazla kullandığı unsurlar olmaktadır. Bu çalışma kapsamında, endüstriyel devrimler boyunca kentsel ulaşım alanında meydana gelen değişimlerden bahsedilmektedir. Kentsel ulaşımda birçok avantaj sağlayan farklı akıllı ulaşım sistemleri ve türleri; bireysel ulaşım, toplu taşıma ve yük taşımacılığı boyutlarıyla incelenmektedir. Bu bağlamda, akıllı ulaşım literatürünün erişebildiği en son nokta olan: Ulaşım 4.0 kavramında, Dünyada ve Türkiye'deki gelişmeler ele alınmaktadır. Kentsel ulaşımın geçmişten günümüze değişen boyutları, teknolojinin, insan gücünün, günümüz koşullarının da etkisiyle nasıl bir dönüşüm geçirdiği ve bu dönüşümün gelecekte bizlere ne tür imkânlar sunacağına değinilmektedir.

Anahtar kelimeler: Akıllı kent, akıllı ulaşım sistemleri, endüstri 4.0, mikro hareketlilik, ulaşım 4.0

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1. Introduction

Technological developments experienced today, as in every field, have also been seen both in the field of modes of transport and systems of it. Recent developments in transportation which is one of the most important areas that have undergone transformation with the emerging of industrial revolutions demonstrate that serious developments related to intelligent transportation systems which are a crucial part of smart cities have been experienced. A great part of these developments involve creating alternative fuel systems to fossil fuels, improving environment-friendly electric motors and hybrid motor technologies, manufacturing autonomous vehicles, integrating smart systems and applications which are directing from individual transport to mass transport into kinds of transport (Heremobility, 2020a). Furthermore, utilizing information-communication technologies, as well as producing systems telecommunicating with each other and with spatial elements, it also includes modes and systems of transport into which many structural features transform. When transport modes are taken into consideration, technological developments grounded in individual transport have been preceding, and after that, developments in mass transport systems and freight transportation have started to be the sine qua non of the 21st century smart cities.

The use of hybrid or electric automobiles called smart, whose samples we often come across in developed countries is still at a very low level (Özbay, Közkurt, Dalcalı, and Tektaş, 2020; Kocabey, 2018). These smart automobiles whose manufacturing capacity is very high in the world not only affect the mobility performance of drivers at a positive level but also intelligent transport systems embedded in these smart vehicles have many economic and environmental benefits and they can also be effective in preventing traffic accidents occurring on road network (Heremobility, 2020b; Taç, 2018).

Although there exists a similar case in mass transport systems, it can be stated that this system is more advanced than the systems used in automobiles and its usage area is more widespread, relatively. Smart technologies that are used especially in rail systems such as passenger information display system, automated ticket control system, smart management systems, GPS supported systems are beneficial for passengers in terms of time-energy-cost (Sarıkavak, 2018). These smart-systems can have a software infrastructure that can optimize the route information according to user density and can be self-updating through the data stored in a large database. In the study for a subway line in Ankara, developing smart systems called Decision Support System enhancing the efficiency in departure hours in mass transport systems has been recommended. With the support of these systems, the optimization of mobility time based on travel requests and usage levels can be provided during the day (Gençer, Alakaş, Eren, and Hamurcu, 2018). Besides the manufacturing of high tech vehicles, integrating transport infrastructure and web-based applications into this, it is also a necessity to edit an infrastructure where vehicles equipped with the Internet of Things, wireless sensor networks and sensors can communicate among each other and with spatial elements (Koşunalp and Arucu, 2018). Only this way, intelligent transport and the digital dimension of transport can be put forth truly.

While the case is like this in individual transport and mass transport systems, reflections of the digital dimension of transportation under the impact of Industry 4.0 are inevitable for freight transport. In the world, freight transport services that are taking productivity as a basis in transportation and where advanced technologies are used in highway, railway and water transport, and where GPS supported information-communication and communication is provided have been operating (Huang, Blazquez, Huang, Paredes-Belmar, and Latorre-Nuñez, 2019; Li, Soleimani, and Zohal, 2019; Wang, Wang, Peng, Chen, Cai and Xing, 2019). Electric and hybrid freight vehicles, drones, autonomous carrier robots, and autonomous vehicles are the prominent means of transport of urban freight transport in the context of intelligent transport (Heremobility, 2020b). While the realizations are like this in freight transport, for increasing productivity, different studies aiming at determining a productive route of firms which distribute cargo and product have also been done (Özalp and Alp, 2020; Yazgan and Büyükyılmaz, 2018).

It is necessary not to limit intelligent transport and the digital dimension of transport within this scope. When looked at in this context, it will be inevitable for transport modes and systems that are under the impact of Industry 4.0 to get affected by all areas of technology. It is an expected case that especially the digital context of transport modes and systems which are supported by information technology and internet-based applications, programs, and systems will transform in many different sizes. Planning this case in an efficient, effective, and environmentally sensitive context with the proper infrastructure will be more beneficial for the future of cities and countries.

2. Material and methodology

This study is based on an analytical evaluation of changes in urban transportation during industrial revolutions. The advantages of today's transportation structure and the vision of possible future transportation are presented. Intelligent transport is the latest point reached by the literature: Transportation 4.0 concepts are discussed developments in the world and Turkey. These developments are the future; It focuses on its examination in the context of individual transportation, mass transportation, and freight transport.

3. Theoretical background

The theoretical background of this study is based on the demonstration of the impact of industrial revolutions on different transportation types and systems with examples from national and international literature. It also covers the theoretical background for the evaluation of smart transportation, which is the most important component of smart cities, including the vision of future transportation in the context of transportation 4.0.

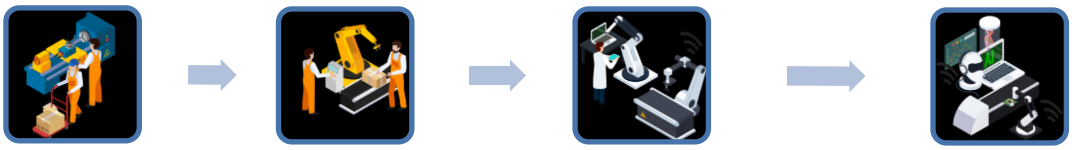
3.1. The fourth wave in industry and its effect on transportation systems

The process of the emergence of Industrial Revolutions starts with the systems based on steam power and these systems' becoming increasingly common. The second industrial revolution emerged with the production process in which a specific standardization and serial production of mass production technologies were adopted. In this period, what attracted the most attention in transportation was the production activity model which Ford company developed for the Model T. With the development of electricity, electronics and technology concepts and their becoming widespread in human life, the third industrial revolution can be stated to have started in the form of creating information technology (Lom, Pribyl, and Svitek, 2016). The fourth industrial revolution can be called an automation revolution involving various self-operating urban systems, production activities in which many recyclable and reusable elements, renewable energy sources are used. The fourth industrial revolution today, which we can also define as the fourth version of industrial development is used as Industry 4.0. With industry 4.0 energy and transformation in the used technology level are given in Table 1.

***Table 1**. Transformation lived during industrial revolutions (Recreated from Durmuş, 2019)*

Industrial ages	Date	Source of energy	Technology used
Industry 1.0	1784	Steam and coal	Basic machine and systems
Industry 2.0	1870	Electricity	Technological machine and systems
Industry 3.0	1969	Renewable energy and electricity	Advanced technology augmented reality
Industry 4.0	Now	Renewable energy, electricity, fuel cells	Sensors, autonomous systems, internet of things, artificial intelligence, machine learning, cloud computing systems

The concept of Industry 4.0 was first introduced in the world at the Hannover 2011 Fair under the leadership of the German government. This term has called the attention of the academic environment and politicians mostly. According to Kagermann (2015), the concept of Industry 4.0 is commented as the transfer of production, knowledge, and present tendency developed within the scope of a certain automation system. Fundamentally, the origin of the term Industry 4.0 comes from the production-focused strategies of the German government, from the activities in which information-communication technologies are used and from projects given the utmost priority for these activities. In the basic components of this strategy; data infrastructure, development of computer technologies, and connectivity level exponentially increasing from day to day, and broad-band communication networks working with less energy and power take place (Sung, 2018). The concept of Industry 4.0, as in every field, has distinguished itself in the issues of modes of transportation, transport systems, and technologies, too. Change stages in the transport systems and modes in the axis of the Industrial Revolution can be seen in Figure 1.



Industry 1.0
- Manpower based production
- Use of steampower
- Steam train
- Steam tram

Industry 2.0
- Mass production
- Mechanical powered systems
- Cable car
- Tram
- Electrik trains
- Car

Industry 3.0
- Production based on electrical power
- Using electrical power
- Electric vehicles
- High speed trains
- Monorail

Industry 4.0
- Object interactive production
- Extensive use of electricity and information
- Super speed train
- Air taxi
- Autonomous vehicles
- Vehicle to vehicle communication
- Electric vehicles
- Solar vehicles

Figure 1. *Industrial revolutions and transformation in transport technologies* *

In the concept of Industry 4.0, in the resource savings of our age, to create benefits such as productivity, the use of renewable energy, providing economic flexibility in production, the infrastructure of information and communication technology has great importance. To get the aforementioned benefits fast and efficiently, the requirement of a developed information and communication infrastructure grid arises. Infrastructure makes it possible to transfer information intersystem, between the system and system elements (Gubán and Kovács, 2017). In the context of Industry 4.0, the required information and communication infrastructure takes up space and, a grid is created between the system and the users. Cities which have grid being mentioned and advanced information and technology infrastructure stand as “smart city” in the context of Industry 4.0. According to The Institute of Electrical and Electronics Engineers (IEEE), smart cities, with their technology, cause significant changes in the community characteristic. As a result of these changes, the concepts of smart economy, smart mobility, smart environment, the smart society, smart life and smart governance have become current issues (Lom et al, 2016; Grob, 2009)

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The reflections of Industry 4.0 are extremely effective over a smart city and its components. In the perspective of Industry 4.0, the prominent components of the smart city are the Internet of Things working with the information-communication infrastructure in the integration of these components with each other and the Internet of services related to this. The content of these services, especially the concepts of intelligent transportation and smart convention are at the forefront. For instance, smart mobility and smart logistics are of these services. The concept of a city to be smart has been handled in the context of efficient use of the sources.

Today, transportation is considered a resource-consuming service with its economic, social, and environmental dimensions. Its economic dimension can be seen clearly with material resource depletion to make investments and to use them and its environmental dimensions can be seen with the use of land where investment will be realized. In the context of Industry 4.0 using the infrastructure of information and communication in the transportation systems created through a network being set up between the user and the system, maximum productive scenario is expected to be put into practice through real-time data.

Transport, energy, power, and services' being smart is because they form the advanced information and communication infrastructure of smart cities. Advanced information and communication infrastructure means Internet of Things, Internet of services, cyber-physical systems, and the infrastructure that will enable from human to human, from human to machine, from machine to machine telecommunication infrastructure (Davies, Coole and Smith, 2017). In other words, smart cities affiliating with Industry 4.0 need an infrastructure of information-communication that can transfer interactions and activities real-timely, are advanced in the context of especially transport modes and conveyance systems. Designing and using these systems carefully is important in every transport modes and in terms of every kind of transport system working perfectly in cities. The concept of Industry 4.0, according to must include six principles of design. These are (Schlick et al, 2014);

- Interoperability
- Virtualization
- Decentralization
- Real-time capacity
- Service orientation
- Modularity

These design principles are used in the smart applications of many cities today. For example, real time capacity and service orientation are the most basic principles that will meet us to solve problems faced in transport. Besides the valuation of smart approaches in transport, reducing the traffic congestion, increasing transfer speed, decreasing the cost of the transfer, lessening pollutions such as noise pollution and environmental pollution, and providing security are some of the profits to make. The impact of the ever-increasing world population over resource depletion brings forward the need for the local governments' decision to continue sustainability and to develop rational solutions. Developing attitudes towards transport through rational attitudes will have positive effects on the quality of life (Mezei and Lazányi, 2018). Thanks to interoperability that is used for the communication between things, smart stop applications have been created, transferred to kiosks, and even sometimes they can be conveyed to the user. The principle of real-time capacity, on the other hand, has been used for getting instant information about the occupancy rate in parking lots or determining alternative routes for the routes where traffic congestion has been suffered. For the principle of modularity, transport modes and systems operable with each other in an integrated way and can be integrated into transport systems in case of need can be given as an example Schlick, Stephan, Loskyll, and Lappe, 2014).

Industry 4.0 considers transport systems in smart cities as providing one of the basic services forming the city rather than the carriage of goods and passengers from one point to another in the traditional meaning. Evaluating digitalized world with Industry 4.0, Internet of Things with each other and with surrounding elements, communicating systems included with the help of sensors, intelligent transportation which is a component of smart cities and transportation systems within this context is important in creating the theoretical background in the focus of Transportation 4.0.

3.2. Intelligent transportation and transportation 4.0

Smart transportation, transportation systems and elements are the most basic components of a smart city. Definition of smart transportation, briefly, can be stated as the transportation system supported by informatics (IT) and communication technology infrastructure seen as an important building block of Industry 4.0 and structured transportation systems (Kırmızı, Kolağasıoğlu and Çalışkan, 2012). Four main components are affecting the working principle of intelligent transport systems. These components can be given as traffic data collection, data transmission, traffic data analysis, and traveler information (Heremobility, 2020a).

There exist various transport, traffic, and passenger management applications for intelligent transport systems carried out in Turkey and in the world. These implementations are (Heremobility, 2020a; Akıllı Şehir Terminolojisi, 2020; AUSDER, 2019);

- Traffic management systems
- Electronic charging systems
- Passenger information systems
- Smart systems for mass transport
- Smart motorway systems
- Smart parking management and solutions of payment
- Smart steering systems
- Cargo-fleet management systems
- Integrated infrastructure management
- Driver assistance and safety systems
- Commercial vehicle management

Intelligent transportation is the most important component of smart cities and for a city to have an intelligent transportation network, it must update and develop its present infrastructure harmoniously with intelligent transportation components because intelligent transport systems can be developed by adding technological facilities to this infrastructure and can be used more proactively in urban transportation (NEA, 2015). When the possibility of more preference of intelligent transportation modes and systems that are newly being used in Turkey with its infrastructure in future is taken into consideration, an evaluation is needed about how to use its present transport infrastructure in the fields of individual transportation, mass transportation, and freight transportation.

4. The future vision of transportation systems

When taken transportation as a concept, in the most classical sense, it can be stated as the movement of passengers and goods from one point to another at a certain time period. Meeting the need to transport as a result of the movements of passengers and goods with various dimensions and sizes from one point to another leads us to the concepts of individual transport, mass transport, and freight transport. While an important place is left for the driver in today’s transport technologies, the location of the driver in the transport chain has been re handled in the framework of transport technologies due to various reasons and traditional parameters forming transportation have been reformed. Another traditional point of view formed over the concept of transportation arises from the relationship between transport and land-use. The relationship between transport and land-use is weakening as a result of the reflection of technological developments over means of transport. In the context of transportation, the addiction of land-use built over the short distance between home and workplace will leave its place for new functions; a paradigm shift being experienced over urban space (Erdoğan, 2019).

New technologies inevitably impact transport modes and systems. Within this context, driverless vehicles are expected to become the greatest actors of the future. In urban transport, the use of autonomously driving vehicles will take place as an important element to solve traffic congestion, too. Moreover, mass transport companies’ leaving out the drivers from the system which is equivalent to 70 % of the cost of operating the business will be beneficial with regards to reducing the cost. If a development which is seeking profit and benefit-driven is supplied, it will be inescapable for transport systems to transform into a structure where there is individual transport-oriented hustle and bustle in the forefront realized by automobile just like in the past. It will reveal itself as electrical, hybrid, solar-powered mass transport vehicles. The use of drones and air taxis for urban freight carriage is on the agenda as well as mass transport

(Boyle, 2015). Furthermore, a transportation system in which new generation autonomous vehicles are used, regulations of a smart junction, road sensors, audio-visual warning signs, web-based systems, GPS assisted hybrid and electric vehicles communicating with the satellite and with each other, road assistants, and components offering a safe and comfortable transport to drivers and passengers constitute the basic building stones in intelligent transportation (Ulukavak and Önder, 2019).

Recently, it is a predominant probability that autonomous vehicles and air taxis will get ahead of traditional mass transport systems. This case gives a clue in how the future of transport systems will be affected by intelligent transport and how the concept of transport 4.0 will take form in the future. In the content of the components of intelligent transportation, to create effective and life-quality offering transport systems for metropolitan areas, four principles will be at the forefront. According to these principles (Watkins, 2018);

1) If transportation is an urban benefit, mobility is a service.
2) Private spatial areas must be constituted for traditional mass transport vehicles.
3) Primarily, customer satisfaction and service being offered must be at the forefront, technology must follow just after them.
4) Real-time information systems which are oriented for means of transport must be popularized.

While intelligent transportation runs within the frame of these principles, green and intelligent mobility are prioritized in the process lying behind transportation 4.0. When viewed from this aspect, green and intelligent mobility is related to autonomous robots, system integration, the Internet of Things, cyber security, cloud computing, artificial intelligence, machine learning, and big data. In terms of the service offered, mobility interacts with many services to provide the user with optimum supply. This case is realized through data collection, data exchange, and data analysis. Journey time, the purpose of travel, type of travel, data on daily mobility are registered in a big database, are merged, classified, analyzed, used and shared among the actors of the system (NEA, 2015). This big data is used, through the Internet of Things, in new services in transport and transportation area, in micro-mobility in the area of individual mobility, in the autonomous drive, in the distant coordinated drive, in drones, in the driverless smart mass transport systems and smart logistics extensively.

With the developing technologies; primarily the internet, information and communication infrastructure and the safety of infrastructure will be in a much more important position in the area of transportation in future and it will be a new component which constitutes city space where people's daily routine continue. Nevertheless, the use of new infrastructure requires people's being talented as to provide information transfer and vehicle handling to be able to use this talent. Therefore, the need to define information and communication infrastructure which is one of the important elements constituting Industry 4.0 with a new structure of society taking place in the synthesis of physical and virtual environment rises. Information and communication have a great importance in Industry 4.0. However, just like the industrial structure, the dynamics of the society have been improving and transforming.

The factor defining the change in the fluctuations of the industry has been stated to arise from production styles (Ślusarczyk, 2018). In the waves of social change, the factor defining change is the socio-economic component which provides the sustainability of society. Stated as passing on from hunting-foraging to agriculture, from agriculture to industrial activities, from industry to information sector, from information to human-centric society, society 5.0, stated as the last step of this structure is the production infrastructure of Industry 4.0 and urban users of its components (Japan Cabinet Office, 2020).

Super smart society called Society 5.0 which can keep up with the things Industry 4.0 brings will develop intelligent transport systems optimizing energy value chain to speed up the coordination competence in multi-systems and recover the competition as new main systems (Durmuş, 2019). In the future, super-smart society and individuals who are handled in Society 5.0 context, who will be able to use intelligent transport vehicles, do maintenance and will realize operating transport systems will be needed. For this reason, the need for design experts, operators and maintenance-repair experts who can coordinate intelligence-machine well are submitting know-how combining current affairs with occupational experience, qualified, improving himself continuously, will increase day by day. According to Durmuş (2019), if we integrate IT (informatics) infrastructure which is necessary to reach Society 5.0 into Transportation 4.0, by submitting the components cyber-security, big data, internet of things, artificial intelligence, hardware technology, web technology, robotic technology, sensor technology, material and nanotechnology in a developed framework of the system, all components of Transport 4.0 can be used appropriately.

The concept of Transportation 4.0 can be expressed as Akdemir and Önder state (2020) "With the help of information and communication technologies, using the achieved information efficiently, the change of place of passengers and freight between the functions of field usage as far as transport technology and capacity permit." Taking the concept of Transportation 4.0 as individual transportation, mass transportation and freight transportation in urban transportation in a general framework will be beneficial for determining in which content intelligent transportation will take place today and in the future.

4.1. Individual transportation

People who live in urban areas have to choose from various modes of transport in movement between locations and determine a transport pattern for this. Depending on people's demand for travel to the destination they would like to reach in the time period they wish, the most flexible modes of transportation used today are individual transportation modes such as bicycle, motorcycle, and automobile. Individual transportation modes offer more freedom of mobility within the context of time and space when compared to mass transportation systems. The automobile which is the fastest kind of individual transportation formed by the driver according to his desire is an important mode of flexibility in terms of time and route variables. The problem of supplying fossil fuel sources in terms of fuel the automobile consumes and triggering more problems in the future directly research producing automobile types that can run on new energy sources. This case necessitates the adoption and development of a green and smart mobility approach in individual transportation.

Recent developments about individual transportation today are for making automobile travel easy. Navigation systems integrated into vehicles, lane-keeping systems, parking sensors, systems specifying automatic maintenance period are gradually becoming widespread. Due to the possibility of people's making more mistakes and causing accidents compared to computer technologies and in order to make more qualified automobile journeys, lastly, driverless automobiles' getting widespread is remarkable (Nasır and Özçelik, 2017; Gökaşar and Dündar, 2018). According to Yetim (2016), three types of driverless automobiles can be mentioned. The first one of these is the realization of the drive with the support of technology, the second type is the vehicle intervention whenever desired and the third type is which is possible to drive without a driver with the support of software and hardware on a route settled before. According to Soylu (2018), driverless automobiles appear predominantly as the matter on the agenda of automobile improvers. Many studies state that 10 % of the American traffic system will consist of these vehicles in the near future.

In the context of transportation, sensor technologies' in vehicles, mobile systems' and equipment's becoming widespread in urban areas have a great impact on constituting optimized routes. In addition to this, information flow on subjects like traffic congestion, street lighting, and empty parking lot areas for automobiles will be greatly beneficial for drivers. Larger scaled benefits have importance in terms of autonomous drive and the prevention of traffic accidents. Making various gains in such topics through inter-machine communication is in harmony with the conceptual framework of Industry 4.0. Route optimization and navigation; It is at the focal point of various smart applications such as parking, light, accident detection, road anomaly, and infrastructure developed with the automobile in mind (Zantalis, Koulouras, Karabetsos, and, Kandris, 2019).

Today, there exist some individual mobility trends in which the concept of Transportation 4.0 is much-mentioned. The first of these is smart mobility. Smart mobility is a trend developed based on how people and loads move in cities, from the perspective of zero emissions, zero accidents, and zero ownership (Neckermann, 2017). There are five basic principles of smart mobility. These are flexibility, efficiency, integration, clean tecnology and safety. These five benefits have a great impact on the protection of the environment and energy in individual transportation, as well as in ensuring efficiency and safety in transportation. (Frost & Sullivan (n.d.); Siemens, 2018; Urban mobility, 2018).

The most important part of the smart mobility trend is the micro-mobility action that is environment-friendly and which we can also call a new generation mode of transport and infrastructure in which positive feedback is received in terms of time, space, cost, environment, and human resource in individual mobility. Micro-mobility, according to its pioneer Horace Dediu (2019) has fundamentally only one objective and that is to make human who is the most micro-element of transportation move. In this sense, micro-mobility can be realized through bicycle, skateboard, roller skate, e-scooter, and even though a golf cart. E-scooter organizations like Martı, MOBI, Hop!, Etku, Palm, BinBin, with their recording medium created on assisted platforms providing internet-mobile have become a mode of transport which the young generation use actively. This new mode of transportation can be used in an integrated way into campuses, airports, shopping malls, mass transportation stations and it is less costly and takes up less space as an alternative to traditional automobile journeys.

4.2. Mass transportation

Mass transportation is called as transportation systems which have the most fundamental structure, business, and business design principles in today's cities. The definition of mass transportation has been expressed as transportation service provided during intercity and an inter-zone trip for a prescribed fare (Owczarzak and Żak, 2015). Mass transportation is the system that more than one person uses jointly. Recently, the transportation industry has concentrated on two issues. The first one of these is transportation firms where mass transportation has been developed suitably for our present conditions and the second issue is autonomous vehicles where the driver isn't required. Driverless vehicles are considered to be outstanding in the future and ass transportation is thought to regain meaning with this new perspective (Watkins, 2018). Mass transportation systems have been reaping the benefits of the fourth Industrial Revolution with the help of technology. Mobile phone technologies and improvements of real-time vehicle tracking systems are examples of the most widespread infrastructure and technology. Passengers can reach information about the system to meet the demand for transportation through mobile phone applications. Transport systems provided through vehicles such as bus, trolleybus, tram, suburban train, ferryboat, and underground used widely in urban areas has become an important part of urban life addiction. The importance of smart mass transportation approaches is great with the impact of today's technology and smart city components in the quality of travel and travel satisfaction (Sutar, Koul, and Suryavanshi, 2016). One of the most important focuses on the management of smart mass transportation is optimization in transport. Self-driving new autonomous vehicles, thanks to nonrestrictive flexible working hours, will provide ease of use with higher efficiency and capacity (Durmuş, 2019). Mass transportation formed via an intelligent transportation network owns mass transportation management systems in which line and route optimization is realized. Mass transportation management system provides users demanding transportation related to a route information system and vehicle headway with real-time information flow; while giving information about accidents on one hand, it also conveys information about the danger on the pathway and the current situation, on the other hand (Akdemir and Önder, 2020).

According to a study in Konya, various results have been reached with the integration of the principle of intelligence in transportation into mass transportation. In the light of the study, users who benefit from transportation services can learn lines or routes of units constituting mass transportation systems, time of expeditions, estimated time of interaction of mass transportation vehicles with the stop, expedition headways, and the closest station to them. The basic reason for successfully operating of this system is shown as its internetaided real-time transportation infrastructure (Bilici and Babahanoğlu, 2018).

Mass transportation in intelligent transportation system emphasizes offering transportation system equipped with a trustworthy communication system of the top infrastructure of a smart city. When the target of enhancing the life quality of the smart city is taken into consideration, intelligent transportation infrastructure-especially in the content of mass transportation-is seen as a means to solve the transportation problems of the city. In a study in India, mass transportation system which is an important component of an intelligent transportation system has been brought into a position offering a higher quality service through smart applications. Among the aspects improved through smart applications, smart ticketing implementation, automated fare collection system, bus rapid transit systems, bus routes and stops integrated with smart GPS systems take place. Increasing mobility and road capacity in the infrastructure of mass transportation of the city via these applications, it is emphasized that benefit is obtained for individual transportation. Reducing the operating costs emerged in ticketing and receiving more productive results in terms of the management of route demand is emphasized. In addition to this, it is emphasized that in time-saving with the real-time database, working coordinately with GPS data, important efficiencies have been recorded in terms of both the system and the user (Vakula and Raviteja, 2017).

Mass transportation is one of the main components of transportation. However, not using reality-based data cause unwanted situations such as delays and traffic congestion. As a result of this situation, the management of the mass transportation system is affected negatively. Passengers, on the other hand, have difficulty in making travel plans (Sun, White, and Dubey, 2016). From this perspective, in the transportation system, tackling smart applications with the content of mass transportation is seen to be important.

When a great number of examples given above are taken into consideration, in the context of Transportation 4.0, mass transportation has been a crucial resource of savings economically, physically, and environmentally. The time of passenger having an economic return for the country, taking less physical space thanks to driving less number of cars through mass transportation, giving less harm to environmental aspects having structural features as producing less emission and being environment-friendly can be given as examples to these savings.

4.3. Freight transportation

In the transportation system, the concept of logistics which can be emphasized as the organizational structure of freightage is naturally intertwined with production habits of socio-economic routines of people. In the content of the transfer of the production from one point to another, just like in Industry 4.0, reflections of different technologies are effective from time to time. While freight is carried by steamboat and train in the period which can be called as Logistics 1.0; in the period called Logistics 2.0, electric power and mass production are seen as main driving forces of the logistics sector. In the continuation of the process, making use of the information system for the running of the logistics system meets us as Logistics 3.0. After this period, in the supply chain, an artificial network formed as a result of the Internet of Things, and the decisions of people can be expressed as the fundamental building block of Logistics 4.0 construction (Wang, 2016).

As the concepts of smart mobility and smart economy which are components of the smart city impact the production and consumption activities of the fourth industrial revolution, a reinterpretation of these concepts is inevitable in the context of developing technologies and in the context of urban freight carriage. Technologies cause the emergence of new strategies and developments in urban areas. It is of crucial importance to handle the impact of autonomous systems which are an important element of smart systems' overproduction and consumption in the area of freight carriage, that is in the area of logistics.

The term logistics meeting us in the freight carriage of transportation emphasizes the connected synthesis of intelligent transportation infrastructure with logistics infrastructure. In consequence of this synthesis, in the title of smart service in logistics arises the concept of smart logistics. Smart logistics, as a logistics system, meets us as a self-optimizing system according to market needs which show flexibility in the content of personal needs and developing directly in a consumer demand-focused way. The internet in the paradigm handled in the content of Industry 4.0 of the concept logistics is the basic infrastructure providing information communication between machines and consumers, that is to say people. The technological framework of this infrastructure leads to basic changes in the notion of logistics. Applications coming with technology develop the concept of logistics in terms of resource planning, management of storage enterprise, management of transportation enterprise, intelligent transportation systems, and information security (Barreto, Amaral, and Pereira, 2017).

Industrial production and the capacity of logistics change according to consumer demand. Today's production and consumption conjuncture is more individual product-oriented manufacturing and aims at minimum cost logistically. Although productive and logistic activities have reached maturity recently; widespread use of online shopping and internet-based transfer, and the emergence of a new consumer demand lead to the transformation of logistic systems through digitalization. To comprehend today's global logistic system, production variables and various freight hauling methods are seen to arise. It is still a controversial topic if present logistic systems will keep up with the systems like manufacturing individual products of the future or not. The future of the concept of Logistics is seen as Logistics 4.0 is a part of Industry 4.0 in some studies (Winkelhaus and Grosse, 2019). According to Timm and Lorig (2015), the definition of Logistics 4.0 is the migration of hardware oriented logistics to hardware-oriented. In Winkelhaus and Grosse's opinion (2019), Logistics 4.0 is the whole of systems meeting the demands of private customers sustainably and while doing this not increasing the costs, and supporting this development with production and commercial digital technologies. Logistics 4.0 infrastructure of smart cities of the future which is advancing in the light of Industry 4.0, with the meaning of transportation 4.0, should have the systems fulfilling the duties such as transportation management, storage management, inventory management, packaging and classification management, information management, transportation, warehousing, demand analysis, packaging, etc.

Web-based and information technology-based infrastructures which are important elements of Logistics 4.0, under the impact of the Fourth Industrial Revolution, motivate the development of e-commerce activities and at the same time the e-commerce constituent of logistics. China where individual commercial activities that have an impact on a global scale are realized states that cross-border e-commerce logistic activities grow rapidly, and the number of people online doing cross-border shopping from China rose to 35.6 million in 2018. Moreover, e-commerce logistic parks in Hong Kong where products are stored physically emerged as an element contributing to global trade. This construction called virtual e-commerce logistic parks has been named as the virtual initiative of more than one firm at the same quality to create a corporation using shared resources to adapt to the market. These virtual parks, with physical web support; have been planned to realize transferring containers used in freight haul easily integrating road transportation, railroad transportation, water transport, and airline transport into each other, and realize rapid, fruitful, and safe transportation. The physical web which is an important concept for the sector of logistics playing an active role especially during the period of planning intelligent transportation is considered to make freight haulage easy (Kong, Zhong, Zhao, Shao, Li, Lin, and, Huang, 2020).

5. Result and discussion

Today, one of the areas technology serves, mostly formed in line with human demand in the light of the developments the new industrial age brings, is transportation. While meeting the need for transportation, the realization of transportation in the shortest time, with the least cost, and the most efficiently during the history of transportation which may have started with the invention of the wheel has become one of the most laborious issues.

What matters is the embeddedness of city and transportation and the effect of changes in transportation over the city and town-dweller. It has been inevitable that the increase of automobile use converted singular city centers into the multi sub-central structure. It is evident that transportation modes using steam engine play an important role in constituting global cities and in the development of commerce. The impact of bullet trains running on electrical energy and having an advanced technology on forming urban areas, satellite towns and urban form which is getting widespread with each passing day shows us that transportation and transport technologies are driving forces in terms of urbanization. Furthermore, the latest developments in transportation and communication, autonomous vehicles, learning machines, systems communicating each other through the Internet of Things, mass transportation systems doing momentary route determination by self-optimizing through data provided from big database display the digital dimension of transportation.

In the age we live in, web-based correspondence and developments experienced in communication technologies produce different effects in urban transportation. In the future, under the impact of internet and correspondence technologies, spaces used widely can be converted into a small logistic center. On the other hand, the direct transfer of the demand of haul-transportation to production plants online may cause the exclusion of many links in the chain from production to consumption. Although shopping malls affect local craftsmen negatively, the existence of the negative effects of e-commerce services over malls will be a question of debate in near future.

As can be seen, the digitalization of transportation modes and systems will create an effect in every field of transportation. In this context, providing a good sense of management who can use digitalization in transportation well and able to bring it into the use of future generations, restructuring the present infrastructure in a smart and digital transportation-oriented way and planning it as to keep up with the times all have importance.

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