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Determining Logistics Students' Perceptions Regarding Industry 4.0 Applications in the Logistics Sector within the Technology Acceptance Model Framework

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Abstract
The study aims to increase awareness levels by determining the perceptions of logistics program students regarding Industry 4.0 before they start working, to examine the acceptance of these technologies, and to accelerate technological adaptation by enabling businesses in the sector to benefit more from these applications, thereby contributing to the sector and students. Due to the limited number of studies in the literature on Industry 4.0 applications in the logistics sector, the study also aimed to contribute to the literature on this subject. In this context, 156 data were obtained from students of the Logistics Program at Uşak University through a survey method and analyzed. The results of the analysis revealed that participants had a high level of awareness of Industry 4.0 and believed that the use of Industry 4.0 applications was easy and beneficial. It was concluded that perceived benefits, perceived ease of use, and intentions to use would increase usage behavior. Additionally, it was determined that intentions to use played a full mediating role in the relationship between perceived benefits and usage behavior. Having a high level of awareness about Industry 4.0 applications will be beneficial for both themselves and their businesses. Additionally, when they begin working, they can contribute to the competitiveness and development of logistics businesses by promoting the widespread use of these applications.

Keywords: Industry 4.0, Logistics 4.0, Technology acceptance model

Teknoloji Kabul Modeli Çerçevesinde Lojistik Öğrencilerinin Lojistik Sektöründeki Endüstri 4.0 Uygulamalarına İlişkin Algılarının Belirlenmesi

Öz
Araştırmada lojistik programı öğrencilerinin çalışmaya başlamadan önce Endüstri 4.0 algılarının belirlenerek farkındalık düzeylerinin artırılması, bu teknolojilerin kabulünün incelenmesi ve bu sayede sektördeki işletmelerin bu uygulamalardan daha fazla faydalanmalarını sağlayarak teknolojik uyumu hızlandırıp sektöre ve öğrencilere katkı sağlanması amaçlanmıştır. Literatürde lojistik sektöründeki Endüstri 4.0 uygulamaları ile ilgili çalışmaların sınırlı sayıda olmasından dolayı, bu konuda literatüre de katkı sağlaması hedeflenmiştir. Bu doğrultuda Uşak Üniversitesi Lojistik Programı öğrencilerinden anket yöntemi ile 156 adet veri elde edilip analiz edilmiştir. Yapılan analizler sonucunda, katılımcıların Endüstri 4.0 farkındalık düzeylerinin yüksek olduğu ve Endüstri 4.0 uygulamalarının kullanımının kolay ve faydalı olduğunu düşündükleri belirlenmiştir. Algılanan faydanın, algılanan kullanım kolaylığının ve kullanıma yönelik niyetlerinin kullanma davranışını artıracağı sonucuna ulaşılmıştır. Ayrıca kullanıma yönelik niyetlerinin algılanan fayda ve kullanma davranışı ilişkisinde tam aracılık rolü üstlendiği belirlenmiştir. Endüstri 4.0 uygulamaları hakkında farkındalık düzeylerinin yüksek olması kendileri ve işletmeler açısından faydalı olacaktır. Ayrıca çalışmaya başladıklarında da bu uygulamaların kullanımının yaygınlaşmasını sağlayarak lojistik işletmelerinin rekabetine ve gelişimine katkı sağlayabileceklerdir.

Anahtar kelimeler: Endüstri 4.0, Lojistik 4.0, Teknoloji kabul modeli

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Introduction

The Industrial Revolution, which started with the use of the steam engine, continued with the introduction of electricity and the internet, caused major changes. With Industry 4.0, which started to be expressed at the Hannover Fair in 2011, these changes have accelerated and a digital transformation has occurred. The concept of Industry 4.0, which is also used as the Fourth Industrial Revolution, is defined as "moving data to a level that will benefit production" (Culot et al., 2020, s. 2). Especially with the rapid changes in technology, while businesses and individuals in society have not yet adapted to Industry 4.0, the concept of Industry 5.0 came to the forefront in Japan in 2016.

The logistics sector is one of the sectors most affected by Industry 4.0 applications, which are critical for the competitiveness and sustainability of businesses. Industry 4.0 applications in the logistics sector, which has been affected by all Industrial Revolutions from the past to the present, are referred to as Logistics 4.0 or Smart Logistics. Since it is not possible for the supply chain and logistics activities of enterprises not to be affected from these changes, some large enterprises around the world have started to create their digital supply chain and logistics structures in this direction (Lin and Jones, 2009). Because businesses have started to use supply chains and logistics activities as a key to compete with their competitors in the international market (Li et al., 2006). In addition, with the increase in the world trade volume, the importance of the logistics sector has increased even more and has reached the band of 8-12 trillion dollars globally (Maidan, 2020). This value is expected to grow by 7.4% annually and reach 16 trillion dollars in 2026 (Transparency Market Research, 2019). Therefore, Industry 4.0 applications are a new and critical issue in the logistics sector, which is considered one of the most important sectors for businesses and countries. As Abriad and Kristian (2021) expressed, in terms of competitiveness and sustainability, all logistics businesses need to adapt to these technologies and more research needs to be done on this issue (Abdirad and Krishnan, 2021). However, researchers such as Ulusoy, 2019; Taş and Alagöz, 2021; Bolat, 2019; Özdemir and Özgüner, 2018; Ekincioğlu, 2019; Çıkmak and Yazgan, 2023 concluded in their research results that logistics businesses in Turkey cannot benefit from these applications at the expected level. As a reason for this, it was stated that logistics enterprises do not have a qualified workforce suitable for this technology, their Industry 4.0 awareness levels are low and they do not have sufficient knowledge about these technologies (Ulusoy, 2019; Taş and Alagöz, 2021; Bolat, 2019; Özdemir and Özgüner, 2018; Ekincioğlu, 2019; Çıkmak and Yazgan, 2023; Geissbauer et al., 2016; Pouermehdi et al., 2022; Jabbour et al., 2018).

However, as a result of their research, Khan et al. (2022) included the willingness to invest in Logistics 4.0 and education and training among the top ten critical success factors in Logistics 4.0 adaptation (Khan et al. 2022). Such research results are widely encountered in the literature regarding the importance of Industry 4.0 technologies in the logistics sector. In order to contribute to the solution of these problems expressed in the literature on Industry 4.0 technologies in the logistics sector, it is thought that it is very important for the logistics sector and students to increase the level of awareness of students studying in the logistics program before they start their business life in the sector and thus to improve themselves about technology. For this reason, the aim of the study is to increase the awareness levels of logistics program students by determining their perceptions of Industry 4.0 before they work in the sector, to examine the acceptance of these technologies, and thus to contribute to the sector and students by accelerating technological adaptation by enabling businesses in the sector to benefit more from these applications. For this purpose, the technology acceptance model, which is widely preferred in the literature and used to determine the adoption of technologies by individuals, was used in the research. In line with the research purpose, the research question is "what is the level of awareness of logistics program students about Industry 4.0 technologies and is there a relationship between perceived benefit, perceived ease of use, intention to use and usage behaviors related to these technologies? "was determined as follows.

As a result of the study, students will be able to respond to the sector's need for qualified personnel by developing themselves within the framework of Industry 4.0 applications. Thus, by making more use of Industry 4.0 applications in the sector, it will be possible to keep up with digital transformation and gain competitive advantage. As a result, it will be possible to contribute to the formation of global logistics companies and employment. In addition, although studies on Industry 4.0 are widely available in the literature, there are fewer studies on logistics 4.0, which includes the logistics sector. In a sector that is of great importance for businesses and countries, there is no study that examines the awareness levels of individuals with the technology acceptance model and the relationship between the determined variables in the mediator variable dimension. Therefore, this study aims to contribute to the literature and to the researchers who will conduct future research in this field. In the study, after the Industrial Revolutions were

explained respectively, information was presented about the reflections of these Industrial Revolutions on the logistics sector. Then, the importance of Logistics 4.0 applications in the logistics sector is mentioned and short information is presented about some technologies commonly used in the logistics sector within the scope of Industry 4.0 and the technology acceptance model. Then, the purpose, population, model, hypotheses, analysis and findings of the research are presented. Finally, in line with the research findings, the study is completed with the conclusion section, which includes the contributions of the research to theory and practice, limitations and suggestions for future studies.

Conceptual Overview of the Study

Industry 1.0 Concept

The invention of the steam engine by Thomas Newcoms in 1712 and its development and use in the industry by James Watt in 1763 is called Industry 1.0 or the First Industrial Revolution (Musiad, 2017). The steam engine was first used to pump water in mines (Metin, 2019), and when used in these areas, it could only move linearly. Later, it was developed by working on it and its usage area was expanded by making it capable of circular movement. Thus, it began to be used in different areas such as the textile industry, paper industry, breweries, and mills (Challoner, 2022). John Fitch used the steam engine on steamboats (Parsons, 2012), and American Robert Fulton used it on ships in 1807, enabling steamboats and ships to move with machines (Musiad, 2017). Its use on ships, especially on international voyages, has provided great convenience and advantage (Metin, 2019). Later, in 1812, steam engines began to be used in locomotives and thus the railway was developed (Musiad, 2017). All these developments contributed to the development of trade. The Industrial Revolution, which can be considered a milestone in human history, is the beginning of events in economic, political, and social fields. The effects of these developments continued for a long time. They made great economic contributions to countries by shortening production time and increasing efficiency (Özdemir, 2023). The invention of the steam engine, which was a revolution, accelerated the economic growth of countries such as the United States and England (Musiad, 2017).

During the First Industrial Revolution, the use of steam power in other machines continued. In addition, the use of coal instead of wood as fuel became more widespread in this period. Coal, which started to be preferred due to its cost advantage, was also used in metal production and thus the prices of metal products decreased and products such as wire and nails started to be produced (Agarwal, 2017). Such effects of the Industrial Revolution continued for many years and the first examples of the use of many machines until 1900 were in this period. In fact, the first examples of the use of some of the machines used and developed today date back to this period (Özdoğan, 2018).

Industry 2.0 Concept

The Second Industrial Revolution (Metin, 2019), which started in the mid-19th century and continued until the First World War, emerged with the use of electricity in industry and thus, technological tools began to be invented for use in production (Agarwal, 2017). Oil and petroleum products becoming important in the economy, the development of the automotive sector and electricity are among the important developments that marked this period (Musiad, 2017). Steam power and coal, which were widely used in the First Industrial Revolution and caused great changes, were replaced by oil-derived resources and electricity in the Second Industrial Revolution. The internal combustion engine and petrol invented in this period started to be used as an energy source (Metin, 2019). Electrical energy was utilized in machinery and production lines (Görçün, 2017) and used in industrial production, especially in regions where coal stocks were not sufficient (Metin, 2019). Thus, production processes became standardized, transformable according to need and flexibility increased (Görçün, 2017). The Second Industrial Revolution enabled the production of products in parts and was used in production by Henry Ford. By inventing the mass production line, Ford started a new era in the automotive sector and then increased productivity by using it in other sectors (Özdemir, 2023).

With the increased production due to the use of electricity in industry, products were transported by railways and steamships developed in the First Industrial Revolution and trade increased further (Musid, 2017). The use of steam power in ships provided great convenience, but the use of oil-powered ships during the Second World War further reduced costs and overseas trade increased further (Özdemir, 2023). In this period, the use of the telephone and telegraph in communication also contributed significantly to the development of trade (Musid, 2017).

Industry 3.0 Concept

The Third Industrial Revolution (Musiad, 2017), which refers to the period between the Second World War and the 1980s, is also called the Digital Revolution or the Computer Revolution. Personal computers and the Internet have effective to use this expression (Schwab, 2016). During the Third Industrial Revolution, innovations in information communication systems and communication technologies are among the important developments. These technologies were also used in industry and transport systems, affecting the supply chain and marketing (Görçün,2017). The introduction of the Internet has primarily enabled supply chain management to be expressed in economic life (Musiad, 2017). Later on, the change in the internet caused elements such as e-commerce and social media to be included in trade (Sarı and Yılmaz, 2020). In addition, in the Third Industrial Revolution, nuclear energy became a source of energy and the need for physical labour decreased with the transition to automation in production.

Industry 4.0 Concept

Industry 4.0, which is defined as "the process in which advanced internet, communication, and information technologies are integrated with the strengths of the industry used in the traditional sense", (Schmidt et al., 2015) was first introduced at the Hannover Fair in Germany in 2011. Then, it was expressed different names in different countries and the paths to be followed within this framework were determined. The foundation of Industry 4.0, which is expressed with different names such as "Smart Manufacturing Coalition" by the UK, "Future Industry Initiative" by France, "Factories of the Future" by the European Union (Öztemel and Gürsev, 2018, s. 158), are digital connectivity, new technology and innovative production that emerged thanks to the internet (Rainnie and Dean, 2019, s. 3). In Industry 4.0, which uses information technologies, sensors and machines, machines, equipment, and products communicate with each other and create smart systems (Kovacs and Kot, 2016). Smart networks control the mechanism between the parts in the system by connecting the workpieces and systems in the enterprise (Mueller, 2017). In this direction, Industry 4.0 includes many different applications such as robotic systems, simulations, digital designs, data mining, and intelligent production systems and establishes close cooperation between them by using information communication technologies (Zhou et al., 2015). These applications included in Industry 4.0 are expressed in Figure 1.

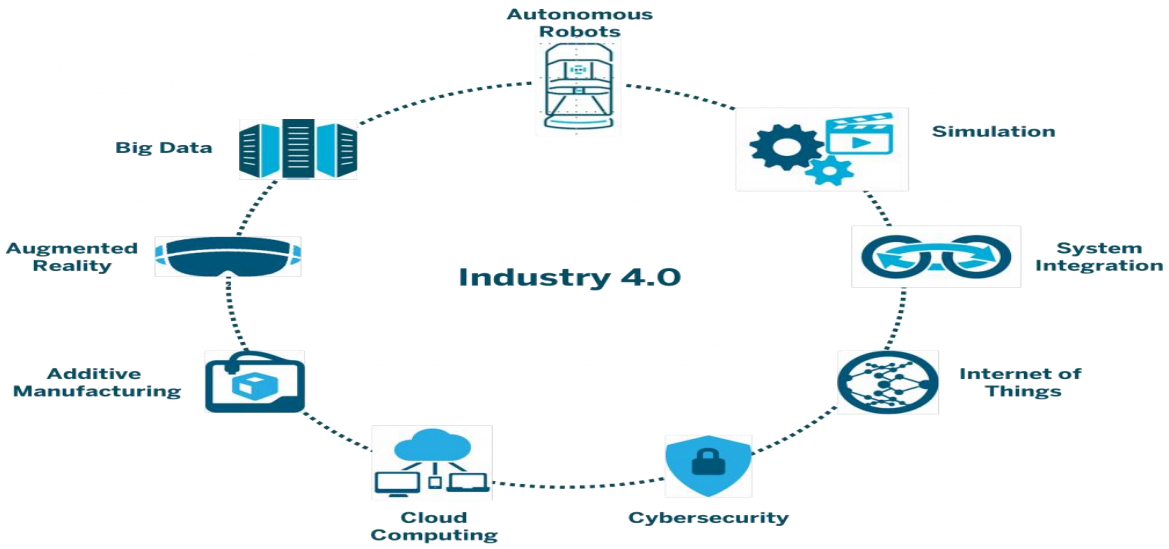

Figure 1. *Basic Building Blocks of Industry 4.0 Technology (https://www.endustri40.com/endustri-tarihine-kisa-bir-yolculuk).*

In the 21st century, technology is developing very rapidly. Technologies that are called the newest can be replaced by other technologies in a few months. For this reason, it is very difficult for businesses to ensure continuity and compete if they don't follow the technology (Musiad, 2017). Industry 4.0 applications are applications that are based completely on digital transformation. Since these applications cause significant changes in the business processes of enterprises, enterprises must make plans for this digital transformation process (Alipour, 2018). As a result of the technology and applications use with coordination, improvements achieves in different areas such as productivity increases, energy saves, quality increases, and products can be test with simulation techniques before introduce to the markets (Öztemel

and Gürsev, 2018). Since production is made using sensors and robots that can exchange information (BTİK, 2021), human mistakes can reduce by switching to mass production, the obligation to keep stock can eliminate, costs can reduce, waste can reduce, and efficiency and effectiveness can increase (Ak and Kağnıcıoğlu, 2021). However, for businesses to achieve all these benefits, they must comply with the following 4 basic principles when using Industry 4.0 (Metin, 2019);

- Interoperability: Machines, devices, people and sensors need to communicate and coordinate with each other through Internet of Things technology.
- Information Transparency: Data collected through sensors should be processed using information communication technologies.
- Technical assistance: Assistance systems should be used to support people by accurately collecting and visualizing information to make the right decisions. In addition, if there are situations that put people in a difficult situation in terms of occupational safety, cyber-physical systems should be preferred.
- Decentralized decision-making: Cyber systems must make decisions themselves and perform tasks independently.

Industry 5.0 Concept

Society 5.0, which started to be expressed with the 5th Science and Technology Basic Plan approved by the Japanese Cabinet on 22 January 2016, is a technology that aims to create a sustainable society to improve people's quality of life by using cyber-physical systems (Fukuda, 2019). Although Industry 5.0, also referred to as Society 5.0, is an Industrial Revolution that emerged in Japan, it is based on the welfare of the whole society, not just individuals living in Japan. Society 5.0, aims to make all people happy by developing technologies to contribute to the solution of social problems for people to enjoy life (Fukuyama, 2018). While businesses and individuals have not yet adapted to Industry 4.0, the changes experienced have revealed the concept and practices of Society 5.0. The Industrial Revolutions experienced in this process are shown in Figure 2.

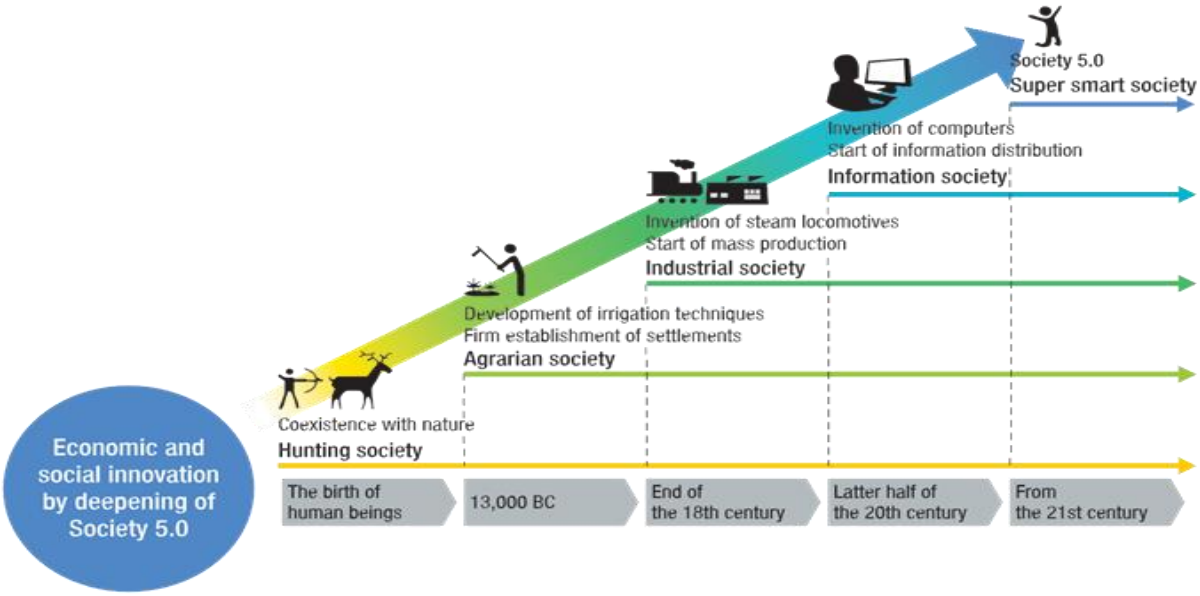

Figure 2.*Society 5.0 Development Process (https://www.japan.go.jp/abenomics/_userdata/abenomics/pdf/society_5.0.pdf).*

While Society 5.0 is a technology that aims for robots to work under human control and communicate with collaborative robots, Industry 4.0 aims to connect robots and physical systems (Baygın, 2022). Since machine-based production is adopted in Industry 4.0, people will be unemployed, poorness will arise, and thus economic and social problems will reduce the quality of life of individuals. Therefore, Industry 5.0 technology is based on the use of technology for the benefit of society by involving people at critical points, emphasizing creativity in production, producing individual products and thus creating societies with high welfare levels.

Transition Process From Logistics 1.0 To Logistics 4.0 Digital Transformation

One of the sectors most affected by the changes in society is the logistics sector. In the process from Industry 1.0 to 5.0, changes in the field of industry have also emerged in the logistics sector. Because the logistics system, like production systems, must be flexible and nimble. Therefore, during the period of the First Industrial Revolution, the period referred to as Logistics 1.0 was experienced and this period started with the use of water and steam power in physical systems. This process was described as the beginning of global transport operations (Çiçekli, 2017) and operations were carried out with trolleys in the warehouse and used transport vehicles powered by steam. With the use of steam power in ships, transport operations were carried out by trading with distant countries. In the period referred to as Logistics 2.0, both electricity and oil started to be used in transport activities (Galindo, 2016). Thus, new vehicles were used, resource planning and automatic storage operations were made. With Logistics 3.0, information communication technologies were used in logistics processes and thus accessed information faster (Cengiz, 2020).

Logistics 4.0, also referred to as Digital Logistics or Smart Logistics, is defined as "the applications and effects of Industry 4.0 technologies on logistics" (Müller and Voigt, 2018). According to Barreto et al. (2017), Logistics 4.0 is "an inbound and outbound logistics optimization that needs to be supported by intelligent systems with databases and software that process relevant information collected and shared with systems based on the Internet of Things to provide an advanced level of automation"(Barretto et al., 2017, s. 1248). One of the application areas of Industry 4.0 technologies is the logistics sector, and the emergence of Logistics 4.0 was caused by the developments in Industry 4.0 (Strandhagen et al., 2017). Logistics 4.0 has enabled the digital management of logistics activities among supply chain members (Barretto et al., 2017). By combining production and consumption with artificial intelligence, it has digitized the supply chain (Bukova et al., 2018) and enabled humans and machines to communicate via the internet (Barretto et al., 2017). As important as the concept of Industry 4.0 is for factories, Logistics 4.0 is just as important for the supply chains of businesses. Since the logistics sector serves all sectors, it must adapt to these changes in the industry (Yılmaz and Duman, 2019). In smart factories, it is not possible for the logistics sector not to be affected by a technology in which there are no working limits and the need for manpower is reduced thanks to robotic systems that use robots under the control of artificial intelligence, eliminating errors, reducing defective products, warning against the possibility of machine breakdown and reminding maintenance times (Tang and Veelenturf, 2019). In fact, since the logistics sector is one of the sectors most affected by technological changes, it is unlikely that businesses in supply chain and logistics activities will pretend that they are not affected by these changes.

Figure 3 shows the transition process from Logistics 1.0 to Logistics 4.0. In parallel with the changes in the industry, changes have also emerged in the logistics sector and the complexity of logistics activities has increased from Logistics 1.0 to Logistics 4.0. Beginning in the first quarter of the 21st century, Logistics 4.0 continues to develop today (Yılmaz and Duman, 2019); (Dembinska, et. al, 2018). Although the concept of Industry 5.0 started to be used in 2016, the process of adaptation to Industry 4.0 still continues in many sectors. Especially in the technologies used after Logistics 3.0, it is known that the internet has come to the forefront and is important for many technologies.

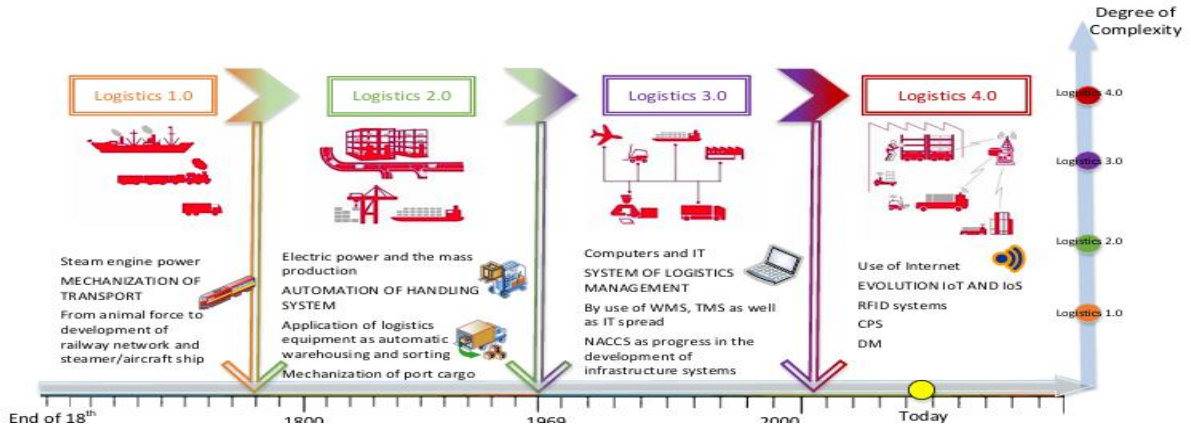

Figure 3. *Development of Logistics (Galindo, 2016, s. 26).*

Logistics 4.0 Technologies and Benefits in the Logistics Sector

There are many Industry 4.0 technologies that businesses can use in their supply chains and logistics activities. These technologies are needed in this period as in the past to ensure the competitiveness and sustainability of businesses. Because these technologies can be effective in solving many problems. One of these technologies that is important for the sector is the internet of things. The Internet of Things (IoT) is "a system that connects devices and enables accurate and real-time information communication"(Yang et al., 2022). It is one of the important technologies that is widely used in the logistics industry and creates new opportunities (Witkowski, 2017). IoT is an effective technology in reducing damages to goods and workers by providing convenience to businesses in identifying risks that may be caused by storage in warehouses. Thanks to the Internet of Things in warehouses, objects can be connected to objects and operators to objects, so that shelves, pallets, equipment and people can be monitored, and information can be integrated into other systems and responded quickly (Trab et al., 2017). It can also provide information on whether pallets are open during transportation, the location and safety of products (DHL, 2015). It also makes a great contribution to reducing errors in transportation, eliminating waste in loading, ensuring operational efficiency and safety, and performing route operations (Lee and Lee, 2015). It enables the goods to be tracked and managed in all logistics processes, and the data obtained through this technology are analyzed and shared among the chain members in full time and information flow is provided (Demir et al., 2020).

In a period when information is becoming more and more important every day, another important technology among these technologies is big data. The data obtained during the activities of supply chain and logistics are very valuable for businesses. These data collected through software systems need to be separated, analyzed and used when necessary. In this direction, data stacks, referred to as big data, are used in the warehouse where data collected from different sources at the same time through sensors are recorded for processing by smart objects (Banger, 2018). This data in big data can be analyzed and used in strategic decisions and logistics planning can be made with future forecasts (Aylak, 2022; Facchini et al., 2019).

Another technology that provides great ease to supply chain and logistics activities is blockchain technology. Popularized in 2008 after the article published by Stuart Haber and Scott Stornetto, Blockchain is "a unique cryptocurrency system in which data set transactions are effectively distributed" (Jiang et al., 2020). This technology, which is expressed as one of the most important inventions after the invention of the Internet (Efanov and Roschin, 2018), was announced as one of the top ten emerging technologies by the World Economic Forum in 2016 (Myeong and Jung, 2019). This technology, which is also suitable for use during the realization of supply chain and logistics activities (Hinckeldeyn and Jochen, 2018), is used in integration with the Internet of Things (Gupta, 2017). IBM Toyota, Maersk, Walmart, Ford, Ford, Apple, Nestle, UPS are some of the important businesses that use blockchain technology in supply chain and logistics activities (Kshetri, 2018; Kırkan, 2022; International Bussiness Machines (IBM), 2017).

Thanks to blockchain technology, smart contracts are prepared within the supply chain and all transactions of the supply chain are securely recorded and can be followed instantly by users (Baygın, 2022). The technology does not allow any changes to the contract without the approval of the members of the supply chain, and only after all conditions have been completed does the payment process automatically take place (Rodrigue, 2018). Cambio, a coffee company, uses this technology to share all the processes of its products from harvesting to reaching the customers, eliminating customers' worries about the product (Koç, 2020). Walmart and Hyperledger have also set up a food tracking system by using this technology. In this way, they reduced the time in mango following from 7 days to 2 seconds and thanks to the technology, they created a sense of trust in their customers for meat products (Hyperledger, 2019). UPS uses these technologies in cargo tracking, Maersk in container tracking, IBM in food supply. Thus, they contribute to the minimization of supply chain members, decrease in costs and prevention of fraud (Zheng et al., 2017). The use of technology is expected to increase in the next years due to the benefits gained by using technology in supply chain and logistics activities.

In addition, autonomous vehicles such as robots in transportation operations, goods counting and drones in transportation operations are some of the promising technologies that have started to be used in supply chain and logistics activities. In addition, artificial intelligence applications are used in the logistics sector to prevent malfunctions, minimize failure to meet customer expectations, and predict customer demands (Aydan, 2019). In this direction, Maersk has achieved a 9% productivity increase by using an AI-supported container loading system (MAERSK, 2020).

The increase in global competition, rapid changes in customer needs, and new trends emerging with technological developments have forced businesses to think about how to make better use of digitalization in order to better manage their logistics activities (Marinagi et al., 2014). Disruptive innovations, especially in the context of Industry 4.0, are expected to greatly impact logistics and supply chain efficiency and offer great benefits to businesses (Henesey and Philipp, 2019) (Philipp, 2020) (Philipp et al., 2020). The opportunities provided by these technologies are different from sector to sector Çıkmak and Yazgan, 2023). Businesses that want to benefit from these technologies in the logistics sector need to invest in the right technologies. Bigliardi et al. (2021) stated that these technologies are useful for logistics businesses to collect and analyze accurate and reliable data (Bigliardi et al., 2021). Logistics 4.0 applications contribute to the integration between supply chain members and ensure the smooth flow of materials and information. By allowing the offering of information-based logistics services, it ensures that changes in demand are monitored in full time. Thanks to technologies, the effectiveness and efficiency of businesses increase and the ability to answer customers also develops (Barleta et al., 2019). In addition, at a time when environmental sensitivity is increasing day by day, Logistics 4.0 has critical benefits for environmental sustainability. These applications will allow for the recycling of packaging materials and ease reverse logistics activities. With effective route optimizations, it is stated that transportation times can be shortened and traffic density and therefore harmful carbon emissions can be reduced (Pan et al., 2020; Bamberg et al., 2012; Issaoui et al., 2021). In addition, studies emphasize that these technologies offer strategic advantages to businesses in terms of cost, transparency, planning, performance increase and production (Bardakçi, 2020; Skapinyecz et al., 2018; Alnıpak, 2023). However, just as these technologies provide different advantages to each sector, the problems faced in their application on the bases of sectors may differ from business to business. According to Çıkmak and Yazgan (2023), the most important of these problems are "lack of awareness of senior management about Industry 4.0, lack of digital strategy and lack of methodology in application (Çıkmak and Yazgan, 2023). Perotti et al. (2022) categorized the barriers to Industry 4.0 applications in logistics as strategic, economic, cultural, technological and security (Perotti et al., 2022). Szymanska et al. (2017) also reported that high investment costs are among the most important disadvantages (Szymańska et al., 2017). According to Bamberger et al. (2017), the problems that logistics businesses may face if they use Logistics 4.0 technologies are as follows (Bamberger et al., 2017):

- Lack of interest of businesses to adopt new business models,
- Unable to make new investments due to cash and capital requirements
- Not open to external ecosystems,
- Struggle to combine new technologies with old systems,
- Difficulty in managing financial risk and uncertainty.

Despite these problems faced by businesses, it is thought that it will be beneficial for businesses to follow and use these technologies very closely. Because, companies that pay attention to this digital transformation will be able to provide a decisive competitive advantage, while companies that do not pay attention to it may fail in competition (Jeschke, 2018).

Technology Acceptance Model

Technology acceptance models describe the factors and process of adoption of a new technology. These models are used to identify and explain the factors that affect the process of technology adoption. Many studies have been conducted on technology acceptance models, this shows the popularity and importance of the subject. The most widely used technology acceptance model is the technology acceptance model developed by Davis in 1985. This model is based on the "theory of reasoned action" developed by Fishbein and Ajzen in 1975. The model was accepted as the application of this theory, but it was reported that the model did not include the subjective thought variable in the theory (Ursavaş, 2022). At first, the model included ease of use, perceived usefulness, attitude towards use and usage behavior, but in 1989, Davis et al. removed attitude towards use and added intention to use as a new variable.

In the model, considering that ease of use and perceived benefit will affect individuals' intention to use the technology and consequently their acceptance of the technology, these two variables are expressed as the two main factors affecting the acceptance of technology. Therefore, according to the model, acceptance of technology depends on the ease of use of that technology and the individuals' belief that the use of technology will benefit them (Davis et al., 1989). Intention to use in the model is defined as "the likelihood

of an individual to perform any behavior" (Oliver, 2010). In other words, it is the intention of individuals to use or reject technology. Perceived ease of use refers to "the level of people's belief that the new technology will not require too much effort and will be easier to use". If a new technology is perceived to be effortless to use compared to others, most people can prefer it. Perceived benefit refers to the positive or negative thoughts that users have about the increase in performance in the organization if they use the technology (Davis, 1989). Using behavior is a term that expresses the degree of frequency of individuals' use of technology (Çivici and Kale, 2007)

Aim and Importance of the Study

Industry 4.0 technology, which is undoubtedly one of today's popular topics, is a technology that has provided new opportunities to many countries and created great changes. The logistics sector has been one of the sectors most affected by this revolutionary Industry 4.0 technology, as it has been affected by all other Industrial Revolutions. In the intensely competitive environment in which the logistics sector is involved, businesses need to keep up with this technological transformation and innovations caused by technology in terms of continuity. It is very important for both businesses and the country's economy that the logistics sector makes sufficient use of these applications, which enable the emergence of innovations in many stages of logistics activities and provide many advantages, especially cost and competitive advantage, to businesses. In the results of academic studies conducted by different researchers on this technological transformation, which has such a vital importance for both countries and businesses, it has been stated in the previous sections of the study that businesses active in Turkey cannot benefit from Industry 4.0 applications at the expected level. In their research results, Aygün and Satı (2022) and Küçük (2023) stated the obstacles to the applications as lack of knowledge and awareness about Industry 4.0 and lack of qualified personnel (Aygün and Satı 2022; Küçük, 2023). Similar to the results of this research in the literature, the reasons for the insufficient use of Logistics 4.0 applications are that logistics enterprises do not have a qualified workforce suitable for these technologies, low level of awareness of Industry 4.0 and lack of sufficient knowledge about these technologies. In order to solve these problems, it is emphasized that it is necessary to have a qualified workforce and to increase the awareness levels of individuals in the logistics sector. According to the research findings of Kipper et al. (2021), as a result of the innovations created by Industry 4.0, employees who are qualified about these technologies can be more beneficial to businesses instead of employees who perform routine tasks (Kipper et al., 2021). Gorzelany et al. (2022) also stated that after Industry 4.0 technology, a concept also referred to as employee 4.0 has emerged and in this framework, the skills that employees should possess have gained a special importance (Gorzelany et al., 2022). They also emphasized that the skills of employees affect the organizational success of businesses. Güngör (2024), on the other hand, concluded that studies on Logistics 4.0 should be increased and the training of sector employees on this subject should be improved (Güngör, 2024).

In this framework, in terms of the technology acceptance model widely used in the literature, it is aimed to increase the awareness levels of logistics program students by determining their perceptions of Industry 4.0 before working in the sector, to examine the acceptance of these technologies, and thus to contribute to the sector and students by accelerating technological adaptation by enabling businesses in the sector to benefit more from these applications. According to the technology acceptance model, it is important to determine the current level of university students in the context of other variables in the model for the realization of usage behavior. With the research, individuals will increase their level of awareness about Industry 4.0 before they start working in the sector, and they will be able to be in the sector as knowledgeable and qualified personnel. In the face of these new technologies, it has become a necessity for individuals in the logistics sector to have knowledge about these technologies and to adapt to these technologies in terms of employment, competitiveness and sustainability. Increasing the awareness of individuals about these technologies, which need very critical investments, can increase their intentions related to the adaptation of all components (Alnıpak, 2023). The research findings are important in determining the impact of Industry 4.0 on logistics students and how they adapt to this digital transformation. Because raising awareness and training individuals on this issue in order to adapt to the developments in technology is of strategic importance for businesses, the sector and the country. As Belmonte et al. (2023) stated in their research, students' logistics education is vital for their professional future (Belmonte et al., 2023).

The findings of the research can provide guidance in terms of contributing to the digital transformation of the logistics sector, contributing to the development of Logistics 4.0 by making Logistics 4.0 applications widespread, and raising awareness of individuals in the sector and ensuring their integration with these technologies. As a result of the research, if students do not intend to use the technologies or do not think

that the technologies are useful, the reasons for this can be investigated and necessary solutions can be determined. It is also expected that the research results can provide valuable information to industry partners and researchers. Conducting this research in the logistics sector, which can be defined as the main center of businesses and thus the main center of supply chains, increases the importance of the research even more. Therefore, it is thought that the research on Industry 4.0 technology, which has a significant impact on the logistics sector, which provides services to all sectors and is in contact with other sectors, should be discussed in the logistics sector.

Due to the critical importance of the subject for businesses, studies on Industry 4.0 are of great interest to researchers. However, it has been determined that there are scarce studies on Logistics 4.0 in the logistics sector, which contributes significantly to the development of countries. There is no research that investigates the perceptions of logistics students about Logistics 4.0 applications and aims to increase their awareness levels with the technology acceptance model widely used in the literature. This shows the originality of the study. Therefore, the research can offer a new perspective to the literature and contribute to completing an important gap in the literature and thus expanding the literature. The fact that the research topic is actual and the adaptation to Industry 4.0 technology is still in the development process makes the research important and is expected to lead the researchers by providing a new perspective to the limited number of studies in the literature. In addition, the fact that logistics students, who may be the qualified logistics personnel of the future, are likely to work in international logistics enterprises or logistics enterprises in other countries reveals the importance of the research results not only for Turkey but also for other countries. In addition, it is thought that a similar study can be an exemplary study in terms of making comparisons by applying similar research to students in logistics programs of other countries.

Method

Universe- Sample

The research population consists of students studying at Uşak University Faculty of Applied Sciences Logistics Management Program and Eşme Vocational School Logistics Program in 2023-2024. The fact that the researchers are lecturers in this university has been effective in determining the students of the Logistics program of Uşak University to the research population. It was thought that it would be useful to make a research on this research population to provide a contribution to the employment of students. The research population was limited to logistics program students in order to ensure the widespread use of Industry 4.0 technologies in the logistics sector. However, the fact that the participants consisted of individuals from different cities/regions is important in terms of research data and results.

Data Collection Scales

To collect data from this research population, the survey method was applied and the surveys were done face-to-face. The scales used in the research were prepared according to the 5-point Likert type and there are 5 sections in the survey. The first part of the survey includes 7 items related to the demographic characteristics of the participants, the second part includes 4 items related to the perceived usefulness scale, the third part includes 4 items related to the perceived ease of use scale, the fourth part includes 3 items related to the intention to use scale, and the fifth part includes 4 items related to the usage behavior scale, for a total of 22 items.

Perceived usefulness and perceived ease of use scale was developed by Davis (1989), intention to use and usage behavior scale was used and developed by Hu et al. (2003), translated into Turkish by Turan (2011), and used by Torun and Cengiz (2019) through reliability and validity analysis. In the study, 1 data was collected from each student and 156 data were obtained and analyzed in the SPSS program.

The research model used in the study and developed by Davis et al. (1989) is shown in Figure 4.

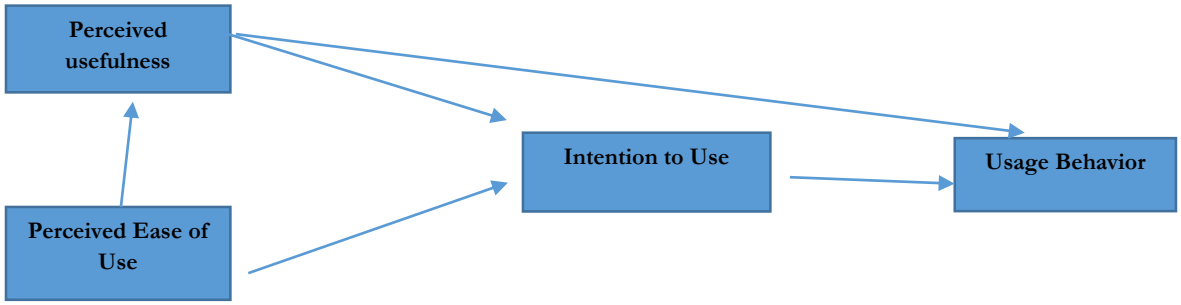

Figure 4. *Technology Acceptance Model*

Analysis of Data

The data obtained in the study were analyzed using the SPSS (Statistical Package for Social Sciences) for the Windows 23.0 program.

Findings

Demographic Findings

Information on the demographic distribution of the individuals participating in the study is given in Table 1.

Tablo 1. *Demographic Distribution of Individuals*

Variables		***n***	***%***
Gender	Female	69	44.2
	Male	87	55.8
Age	18-24 years old	149	95.5
	25-34 years old	7	4.5
Institution of Study	Esme Vocational School	28	17.9
	Faculty of Applied Sciences	128	82.1
Class	1. Class	70	44.9
	2. Class	59	37.8
	3. Class	2	1.3
	4. Class	25	16.0
Family Monthly Income Status	7,500 and below	25	16.0
	7,501-15,000	60	38.5
	15.001-22.000	34	21.8
	22.001-30.000	17	10.9
	30,001 and above	20	12.8
Having Previously Received Training or Course on Information Communication Technologies	Yes	16	10.3
	No	140	89.7
Daily Average Internet Usage Time (Extracurricular)	1-3 hours	27	17.3
	4-6 hours	91	58.3
	7-10 hours	33	21.2
	11 hours or more	5	3.2
Total		**156**	**100.0**

44.2% of the individuals participating in the research are women and 55,8% are men. 95,5% of them are between the ages of 18-24, and 4,5% are between the ages of 25-34. 17,9% of them are studying at Eşme Vocational School and 82,1% are studying at the Faculty of Applied Sciences. According to the variable of family income status, it was concluded that 16% have an income of 7.500 and below, 38,5% have an income of 7.501-15.000, 21,8% have an income of 15.001-22.000, 10,9% have an income of 22.001-30.000, 12,8% have an income of 30.001 and above. 89,7% of the participants had not received any training or course on information communication technologies before. It is seen that 17,3% of the participants use the internet for 1-3 hours outside of class, 58,3% for 4-6 hours, 21,2% for 7-10 hours, and 3,2% for 11 hours or more.

Reliability Analysis and Normality Test

The most preferred method for reliability analysis in the literature is internal consistency analysis. In internal consistency analysis, Cronbach's Alpha Coefficient (α) is calculated (Saruhan and Özdemirci 2011).

and this coefficient determines whether the statements in the scale express the whole or not. Commonly, Cronbach's Alpha coefficient (α) is required to be at least 0,70 (Altunışık et al., 2010). As a result of the internal consistency analysis conducted in the research, Cronbach's Alpha value was calculated as 0,924 and it was determined that the scale had excellent reliability.

In the study, skewness and kurtosis values were examined to determine whether the data conform to normal distribution. For the data to exhibit normal distribution, the skewness kurtosis values should be between ±3 (Terzi, 2019). According to Table 2, it can be seen that the skewness and kurtosis values of the research data are within these limits and therefore exhibit a normal distribution.

Tablo 2. *Normality Analysis Results of the Scales*

Scale and Dimensions	*Skewness*	*Kurtosis*	*Situation*
Perceived Usefulness Dimension	-1,248	2,973	Normal
Perceived Ease of Use Dimension	-0,535	1,468	Normal
Intention to Use Dimension	-0,784	1,923	Normal
Usage Behavior Dimension	0,804	1,312	Normal

Findings Related to Industry 4.0 Subscales

The evaluation of the items in the Likert-type scale used in the research was based on the criteria in Table 3. It was assumed that the response intervals of the statements were equal. While calculating the arithmetic averages, the formula (Highest value - Lowest value)/5 was used and the ranges were calculated as 0,80 (Baş, 2013).

Tablo 3. *Evaluation Range of Arithmetic Averages According to 5-point Likert Scale*

Options	*Points*	*Score Range*	*Scale Evaluation*
Absolutely Disagree	1	1,00 - 1,80	Very low
Disagree	2	1,81 - 2,60	Low
Undecided	3	2,61 - 3,40	Medium
Agree	4	3,41 - 4,20	High
Absolutely Agree	5	4,21 - 5,00	Very High

Table 4 shows the averages related to Industry 4.0 subscales. The mean value of answers of the students participating in the research regarding perceived usefulness is high (A=3,8510). Therefore, students think that Industry 4.0 applications are beneficial for businesses and that businesses performance will increase if these applications use. The mean values of answers regarding perceived ease of use (A=3,4722) and intention to use (A=3,7404) are high. Participants think that Industry 4.0 applications will be easy to use and effective in solving problems. They stated that they can use these applications because they think that they will be easy to use and useful. It is seen that the mean value of answers regarding the use behaviour (A=2,7906) is at a medium level. Since the students have not yet started to work in the sector, it can be concluded that this value has a lower level than the others.

Tablo 4. *Means Regarding Industry 4.0 Dimensions*

	N	*Average*	*Min.*	*Max.*
Perceived usefulness	156	3,8510	1,000	5,000
Perceived ease of use	156	3,4722	1,000	5,000
Intention to use	156	3,7404	1,000	5,000
Usage behavior	156	2,7906	1,000	5,000
Industry 4.0	156	3,5080	1,000	5,000

Confirmatory Factor Analysis Results

Confirmatory factor analysis was performed to determine whether the scale, which was collected under four predetermined factors, was similar to the sample in the study and whether the factors and the model were verified with the sample data (Meydan and Şeşen, 2015). Table 5 shows that as a result of the analysis, the factor loading for the item "I can use Industry 4.0 technologies frequently" under the dimension of using behaviour value was below 0.40. When the item was included under the intention to use dimension, the factor loading value was 0,77 and therefore this item was evaluated within the intention to use dimension. Thus, as a result of the factor analysis, it was determined that all of the factor loadings of the items were above 0,40 and the correlation relations between the variables were significant. The average variance value for the factors was calculated as 0,79204. Since the average variance value is above 0,40, convergent validity is provided. The average variance value for the factors was calculated as 0,79204.

Tablo 5. *Confirmatory Factor Analysis Results*

Factors	*Items*	*Factor Loads*
Perceived Usefulness	1- Using industry 4.0 technologies improves my performance.	0,782
	2- Using industry 4.0 technologies increases my productivity	0,825
	3- Using industry 4.0 technologies increases my effectiveness	0,809
	4- I find it useful to use Industry 4.0 technologies	0,580
Perceived Ease of Use	1- Using industry 4.0 technologies is clear and understandable	0,606
	2- Using industry 4.0 technologies does not require much mental effort	0,761
	3- Industry 4.0 technologies are easy to use	0,838
	4- It is easy to do what I want using Industry 4.0 technologies	0,694
Intention to Use	1- I intend to use Industry 4.0 technologies in the future	0,789
	2- I plan to use Industry 4.0 technologies in the future	0,809
	3- I predict that I will use Industry 4.0 technologies in the future	0,777
	4- I can use Industry 4.0 technologies frequently	0,777
Usage Behavior	1- I cannot work efficiently without Industry 4.0 technologies	0,526
	2- I do not use Industry 4.0 technologies	0,925
	3- I rarely use Industry 4.0 technologies	0,847

Hypothesis Tests of Results

One-way regression analysis and multiple linear regression analysis were applied to determine the relationships between the research variables. While the relationship between one independent variable and one dependent variable was determined by simple regression analysis, the relationship between more than one independent variable and one dependent variable was determined by multiple linear regression analysis

In addition, the mediating role of intention to use in the relationship between perceived benefit and usage behavior was investigated by linear regression analysis. There are many techniques used to test mediation models in the literature. One of the oldest and widely used traditional methods is the method of "Baron and Kenny" (Gürbüz and Bayık, 2021; Rasoolimanesh et al., 2021). According to this method, each step or way is expected to be statistically significant. According to the method, the conditions necessary for a variable to be a mediator are as follows:

- The independent variable should significantly affect the dependent variable.
- The relationship between the independent variable and the mediator variable should be significant.
- The mediator variable should have a significant effect on the dependent variable.
- When the mediator variable is included in the model, the disappearance of the significance of the previously significant relationship between the independent variable and the dependent variable means full mediation, the weakening of the relationship means partial mediation, and the absence of a significant difference means no mediation (Baron and Kenny, 1986; Hofmann and Rüsch, 2017).

Table 6. One-Way Regression Analysis Results

Dependent Variable	*Independent Variable*	*ß*	*t*	*p*	*F*	*Modal (p)*	*R²*
Perceived Usefulness	Constant	1,507	6,589	0,000	109,124	0,000	0,415
	Perceived Ease of Use	0,675	10,446	0,000			
Intention to Use	Constant	1,355	6,2069	0,000	123,935	0,000	0,446
	Perceived Ease of Use	0,687	11,133	0,000			
Intention to Use	Constant	0,728	3,892	0,000	268,263	0,000	0,635
	Perceived Usefulness	0,782	16,379	0,000			
Usage Behavior	Constant	1,772	5,717	0,000	11,194	0,001	0,068
	Perceived Usefulness	0,265	3,346	0,001			
Usage Behavior	Constant	1,868	6,052	0,000	9,258	0,003	0,057
	Intention to Use	0,247	3,043	0,003			

One-way regression analyses were done to determine the relationship between the variables in Table 6. The data obtained in Tables 6-7-8 were analyzed at 95% significance level. A P value less than 0.05 (p<.05) indicates that the relationship is significant, while a P value greater than 0.05 (p>.05) indicates that the

relationship is insignificant. A positive ß value indicates that the relationship is positive, while a negative ß value indicates that the relationship is negative. R^2 value shows how much the change in the independent variable causes a change in the dependent variable.

As a result of the analysis, it was determined that the participants' perceptions of ease of use significantly ($p< .05$) and positively (ß= 0.675) affected their perceptions of perceived benefits. A change of 1 unit in the perceived ease of use variable causes a change of 0,415 units in the perceived benefit variable (R^2=0,415). Therefore, hypothesis H_1 is accepted. Therefore, it is determined that the participants think that Industry 4.0 applications are easy to use and thus the technology can be beneficial for them. In some studies in the literature, it has been stated that individuals think that Industry 4.0 applications are not easy to use, so the technology is not used sufficiently. As in the result obtained, the fact that individuals think that Industry 4.0 applications are easy to use may lead them to think that these applications can be useful. Thus, it is expected that Industry 4.0 applications can be benefited from more in the sector.

It was determined that participants' perceived ease of use significantly ($p< .05$) and positively (ß= 0,687) affected their intention to use. A change of 1 unit in the perceived ease of use variable causes a change of 0,446 units in the intention to use variable (R^2=0,446). Therefore, the hypothesis H_2 is accepted. Individuals who think that Industry 4.0 applications are easy to use will increase their intention to use them. If individuals in the sector can be made to think that Industry 4.0 applications are easy to use, it is likely that these technologies can be used more in the sector.

It has been determined that the participants' thoughts on perceived usefulness have a significant ($p< .05$) and positive (ß= 0,782) effect on their intention to use. A change of 1 unit in the perceived benefit variable causes a change of 0,635 units in the intention to use variable (R^2=0,635). The H_3 hypothesis was also accepted. The fact that individuals think that technology is useful indicates that the use of Industry 4.0 applications in the sector will increase. Introducing Industry 4.0 applications to individuals in the sector more comprehensively and explaining their benefits can increase the usability of the applications in the sector.

Participants' perceived benefit levels have a significant ($p< .05$) and positive (ß= 0,265) effect on usage behavior. A change of 1 unit in the perceived benefit variable causes a change of 0,068 units in the usage behavior variable (R^2=0,068). Therefore, hypothesis H_4 is accepted. Individuals who think that Industry 4.0 applications are beneficial in the logistics sector will be more likely to use these technologies.

Participants' intention to use has a significant ($p< .05$) and positive (ß= 0,247) effect on usage behavior and hypothesis H_5 is accepted. A change of 1 unit in the intention to use variable causes a change of 0,057 units in the usage behavior variable (R^2=0,057). Individuals' intention to use Industry 4.0 applications has a direct effect on usage behavior.

Tablo 7. *Multiple Regression Analysis Results*

Dependent Variable	*Independent Variable*	*ß*	*t*	*p*	*F*	*Modal (p)*	R^2
Intention to Use	Constant	0,428	2,256	0,025	159,660	**0,000**	**0,676**
	Perceived usefulness	0,615	10,426	0,000			
	Perceived Ease of Use	0,271	4,388	0,000			

Multiple regression analysis was conducted to determine the effects of perceived usefulness and perceived ease of use variables on intention to use. As a result of the analysis, it was determined that perceived usefulness (ß=0.615) and perceived ease of use (ß= 0,271) had a significant ($p< .05$) and positive (ß= 0,615; ß= 0,271) effect on intention to use. Therefore, hypothesis H_6 determined in the study was also accepted. When the effects of perceived usefulness and perceived ease of use independent variables were examined together, the degree of explaining the dependent variable of intention to use was determined as 0,676 (R^2=0,676).

Tablo 8. *The Mediating Role of Intention to Use in the Relationship between Perceived Usefulness and Usage Behavior*

Dependent Variable	*Independent Variable*	*ß*	*t*	*p*	*VIF*	R^2
Usage behavior	Constant	1,708	5,250	0,000		**0,070**
	Perceived usefulness	0,197	1,498	0,136	2,742	
	Intention to Use	0,087	0,651	0,516	2,742	

Whether intention to use has a mediating effect on the effect of perceived usefulness on usage behavior was investigated by linear regression analysis. Before analyzing the mediating role, it was investigated whether the effects stated by Baron and Kenny (1986) were significant or not. In the analyses conducted, it was determined in Table 6 that perceived usefulness has a positive and significant effect on usage behavior and intention to use, and intention to use has a positive and significant effect on usage behavior. According to these results, Baron and Kenny's (1986) three primary conditions were realized (Baron and Kenny, 1986). When intention to use was included in the analysis as a mediating variable, the result was not found to be statistically significant ($p > .05$) and the intention to use mediating variable distorted the effect of perceived usefulness on usage behavior ($p>.05$). Therefore, it was determined that intention to use played a full mediating role in the effect of perceived usefulness on usage behavior and hypothesis H_7 was accepted.

Discussion, Conclusion and Recommendations

Since the logistics sector interacts with all sectors, any change in this area can make significant contributions to other sectors. Therefore, as a result of the digital transformation, it is not possible for businesses in the sector to act independently of Industry 4.0 applications. Because of the intense competition in the logistics sector, which is one of the sectors most affected by the changes in technology and industry, businesses need to keep up with these digital transformations in order to gain competitive advantage and ensure sustainability.

While businesses that take this digital transformation into consideration and invest will gain a significant competitive advantage, businesses that do not take it into account will fail in competition (Ursavaş, 2022). In particular, some large enterprises in the logistics sector have started to make significant investments to take advantage of these technological developments. According to Bigliardi et al. (2021), these technologies offer significant opportunities for logistics businesses to collect and analyze accurate and reliable data (Bigliardi et al., 2021). However, most of the enterprises in Turkey cannot benefit from these developments at an sufficient level. Although it contributes greatly to the development of logistics and supply chain activities (Witkowski, 2017), offers various opportunities, and is gaining more and more importance in the logistics sector (Karagöz and Doyduk, 2020), research shows that Industry 4.0 applications in the logistics sector have not yet developed at the desired level (Hofmann and Rüsch, 2017). As a result of their research, Aygün and Satı (2022) pointed to the lack of knowledge and awareness about Industry 4.0 and the lack of qualified workforce as reasons for this (Aygün and Satı, 2022). Küçük (2023), on the other hand, reported that the main barrier to Logistics 4.0 applications is again the lack of skilled workforce (Küçük, 2023). As reported in the research, different researchers have reached similar conclusions in the literature. However, in a period when the importance of the logistics sector is increasing day by day, in the research results of researchers such as Güngör, 2024 (Güngör, 2024), Khan et al., 2022 and Abriad and Krishan, 2021, it is emphasized that the adoption of Industry 4.0 applications in the field of supply chain and logistics and education and training in this field are critical and more research should be done on this subject. Because, as Gorzelany et al. (2022) state, the competencies that employees should have with Industry 4.0 technology have become even more important for organizational success (Gorzelany et al., 2022). With Logistics 4.0 technology, while the need for physical power is decreasing, the need for qualified employees is increasing day by day. In this framework, the study aims to increase the awareness levels of logistics program students by determining their perceptions of Industry 4.0 before they start working in the sector within the framework of the technology acceptance model widely used in the literature, to examine the acceptance of these technologies, and thus to contribute to the sector and students by accelerating technological adaptation by enabling businesses in the sector to benefit more from these applications. The focus of Logistics 4.0 is on the use of new and new technologies. Because the performance of businesses can be optimized and increased as a result of the use of new and innovative technologies. Therefore, the adoption of Industry 4.0 technologies by logistics program students was investigated with the technology acceptance model, which is still widely used by many researchers.

As a result of the research, it was determined that 89,7% of the logistics program students have not received any training or course related to information technologies before. However, despite this, the awareness levels of the individuals participating in the research about Industry 4.0 applications were high. The high level of awareness of students on this issue will enable them to improve themselves in this regard and thus start working in the sector as qualified personnel with the necessary technological qualifications needed by the sector. In addition, when they start working in the sector, they will be able to contribute to the competitiveness and globalization of logistics enterprises by ensuring the widespread use of these applications in the sector.

As a result of the analyses conducted to test the hypotheses determined in the research, the hypothesis **H_1**. there is a relationship between perceived ease of use and perceived benefit was accepted. This result may be due to the high level of awareness of students about technologies. According to the technology acceptance model, if all variables in the model have the same degree of importance, it is stated that the benefits provided will increase as the use of technology becomes simpler, that is, perceived ease of use will affect the benefits. This result is similar to the research results of researchers in the literature such as (Özbek et al., 2014; Türker and Türker, 2013; Porter and Donthu, 2006; Nagy, 2018; Chau, 1996; (Farahat, 2012; Orel and Arık, 2020; Lee et al., 2005).

The hypothesis "**H_2**. There is a relationship between perceived ease of use and intention to use" was accepted in the study, as in the research results of Şekkeli (2022) and Yelkikalan et al. (2019). In the literature, it is widely emphasized that technologies have not become widespread in the sector due to lack of knowledge about industry 4.0 technologies. As in the research result, the perception that these technologies are easy to use can increase the intention to use them. Therefore, creating the perception of sector representatives that these technologies are easy to use may increase the intention to use them and thus ensure the widespread use of the technology in the sector. Similarly, the hypothesis **H_3**. There is a relationship between perceived usefulness and intention to use was also accepted. Individuals' understanding that technologies are useful may increase their intention to use these technologies. In addition to the results supporting this conclusion in the literature (Yılmaz, 2018; Özçifçi, 2020; Bozkurt, et al., 2021; Yelkikalan et al., 2019; Şeker and Hoş, 2021). There are a limited number of studies that do not reach this conclusion (Turan and Haşit, 2014; Kalyoncuoğlu, 2018).

As a result of the analysis, a relationship was determined between perceived benefit and usage behavior and hypothesis **H_4** was accepted. This result shows that the belief that technology is beneficial for businesses will lead to the realization of the act of use. According to Davis (1989), if individuals have high beliefs that the system will increase the performance of the organization, they will be able to use the system. However, if these beliefs are low, they will not want to use it. Again, a similar result was determined between intention to use and usage behavior and hypothesis **H_5** was accepted. This result supports the research results of researchers such as (Kuo et al., 2013; Walczuch et al., 2007; Rahman et al., 2017; Hallikainen and Laukkanen, 2016) in the literature. According to the technology acceptance model, the most important factor in individuals' adoption and application of technology is the users' intentions (Serçemeli and Kurnaz, 2016). Hypothesis **H_6** was also tested and a relationship was determined between perceived usefulness and perceived ease of use and intention to use, and the hypothesis was accepted. The last hypothesis, **H_7**, was also accepted and it was concluded that intention to use plays a full mediating role between perceived usefulness and usage behavior.

As Belmonte et al. (2023) emphasized in their research, training students on logistics 4.0 is of great importance for the sector (Belmonte et al., 2023). In the research, it is expected to determine the perceptions and intentions of individuals who will work in the logistics sector about these technologies and to contribute to their employment and personal development by increasing their awareness levels. By ensuring that individuals work in the sector as qualified personnel, it will be easier for logistics enterprises to understand the changing technologies well, to quickly adapt to these technologies and to become a global logistics enterprise. Thus, investments to be made in the logistics sector can contribute to the development of the country's economy and help achieve economic goals more easily.

The research is expected to make significant contributions to the field by providing a new perspective to the literature. Although research on Industry 4.0 in the literature is increasing day by day, research on logistics 4.0, which includes the logistics sector, has still remained more limited. It was also emphasized in the research results regarding the need to increase research on this subject. With the technology acceptance model, which is widely used in the literature to determine individuals' perceptions of technologies, there is no research that aims to determine the perceptions of logistics program students on Industry 4.0 and increase their awareness. Therefore, this research is an unique study in this field, and it is expected that the findings of the research can make a great contribution to the logistics program students and the logistics sector as well as researchers.

In line with the results obtained, it is suggested to share the usefulness and ease of use of technology with the individuals in the sector and to create awareness on this issue in order to ensure that the use of technology in the sector becomes more widespread. In this context, it may be useful to include sector representatives in the research population of future studies. Thus, it will be possible to contribute to the

solution of the problem described in the literature that the low awareness levels of individuals in the sector are low. It may even be useful to provide trainings on these technologies to the relevant enterprises by the relevant public institutions in order to popularize the use of these technologies. Since the widespread use of Industry 4.0 applications in the logistics sector can increase the competitive advantage of the sector, it is also thought that investments in the sector should be increased in the in the short term. Universities play an important role in training qualified personnel compatible with these technologies. For this reason, it is important that universities have courses suitable for Industry 4.0 technologies in order for the personnel in the logistics sector to learn these technologies. For this, the program should be adapted in order for students to be successful in business life and to act proactively in the face of problems. It is thought that trainings with project-based learning methods, especially on technologies that cause major changes in the logistics sector such as the Internet of Things and blockchain, can be beneficial to students and thus to the sector. Simulation methods and applications related to the problems that students may encounter in the sector will broaden students' perspectives. Increasing university-industry cooperation on this subject may contribute to the development of the content of these trainings. In addition, the inclusion and realization of infrastructure and implementation plans that will accelerate the transformation of enterprises into industry 4.0 technologies in the action plans to be prepared by the public will provide great opportunities for the technological development of the sector.

The research is limited to students in the logistics program at Uşak University. However, these students are also likely to work in logistics enterprises in other countries operating in the international arena. Therefore, the research may also be useful for businesses in the sector in other countries. In addition, the inclusion of students in logistics programs in other universities in the research population will contribute to both enriching the literature and raising awareness on this issue. It is thought that applying a similar study to students studying in the same programs in other countries and even making a comparison can also contribute to the international literature.

Ethical Statement

"*Determining Logistics Students' Perceptions Regarding Industry 4.0 Applications in the Logistics Sector within the Technology Acceptance Model Framework*" was written in accordance with scientific rules, ethics and citation rules; no falsification was made on the collected data and this study was not sent for evaluation to any other academic publication environment. The necessary ethics committee permissions were obtained at the meeting of Uşak University Social and Human Sciences Scientific Research and Publication Ethics Committee dated 13.12.2023 and numbered 2023-241 and 2023-242.

Etik Beyan

"Teknoloji Kabul Modeli Çerçevesinde Lojistik Öğrencilerinin Lojistik Sektöründeki Endüstri 4.0 Uygulamalarına İlişkin Algılarının Belirlenmesi" başlıklı çalışmanın yazım sürecinde bilimsel kurallara, etik ve alıntı kurallarına uyulmuş; toplanan veriler üzerinde herhangi bir tahrifat yapılmamış ve bu çalışma herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiştir. Gerekli olan etik kurul izinleri Uşak Üniversitesi Sosyal ve Beşeri Bilimler Bilimsel Araştırma ve Yayın Etik Kurulu'nun 13.12.2023 tarihli ve 2023-241 ile 2023-242 numaralı kararları ile alınmıştır.

Statement of Contribution Rate of Researchers

The contribution rates of the authors in the study are equal.

Araştırmacıların Katkı Oranı Beyanı

Yazarların çalışmadaki katkı oranları eşittir.

Declaration of Conflict

There is no potential conflict of interest in the study.

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Bu makalenin yazımında yapay zeka ve türleri kullanılmamıştır.

Data Sharing Statement

We declare that, upon reasonable request for the purpose of verifying the findings, we can share the data of this study according to the conditions specified in the relevant section of the "ethical principles and publication policy".

Veri Paylaşım Beyanı

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References

Abdirad, M., & Krishnan, K. (2021). Industry 4.0 in logistics and supply chain management: A systematic literature review. *Engineering Management Journal, 33*(3), 187–201. https://doi.org/10.1080/10429247.2020.1783935

Agarwal, H., & Agarwal, R. (2017). First industrial revolution and second industrial revolution: Technological differences and the differences in banking and financing of the firms. *Saudi Journal of Humanities and Social Sciences, 2*(11), 1062–1066.

Ak, A. E., & Kağnıcıoğlu, C. H. (2021, December). Endüstri 4.0'in etkisiyle gelişen lojistik 4.0: Sistematik bir literatür incelemesi. In *international sustainable business and economic strategies congress* (pp. 10–11).

Alipour, S. P., Ustundag, A., Cevikcan, E., Sarvari, P. A., Kaya, I., & Cebi, S. (2018). Technology roadmap for Industry 4.0. In A. Ustundag & E. Cevikcan (Eds.), *Industry 4.0: Managing the digital transformation* (pp. 95–103). Springer. https://doi.org/10.1007/978-3-319-57870-5_6

Alnıpak, S. (2023). Dijitalleşen lojistik: Akıllı lojistik kavramı ve teknoloji ile ilişkisi. *International Journal of Disciplines in Economics and Administrative Sciences Studies, 9*(52), 1406–1421.

Altunışık, R., Coşkun, R., Bayraktaroğlu, S., & Yıldırım, E. (2010). *Sosyal bilimlerde araştırma yöntemleri* (6. Baskı). Sakarya: Sakarya Publishing.

Aydan, A. (2019). Impact of artificial intelligence on agricultural, healthcare and logistics industries. *Annals of Spiru Haret University. Economic Series, 19*(2), 167–175.

Aygün, D., & Satı, Z. E. (2022). Evaluation of Industry 4.0 transformation barriers for SMEs in Turkey. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, 17*(1), 239–255.

Aylak, B. L. (2022). The effects of the applications of blockchain technology on the logistics sector. *Avrupa Bilim ve Teknoloji Dergisi*, (34), 148–152.

Bamberg, B., Johann, A., & Waldow, P. (2012). Energy efficiency in logistics – SmartKanban as an intelligent intra-logistics architecture for Kanban scenarios. *Information Technology, 54*(1), 34–41.

Bamberger, V., Nansé, F., Schreiber, B., & Zintel, M. (2017). Logistics 4 – Facing digitalization-driven disruption. *Prism, 1*, 38–41.

Banger, G. (2018). *Endüstri 4.0-ekstra*. Dorlion Yayınları.

Bardakçi, H. (2020). Benefits of digitalization in international. *International Journal of Social Science and Economic Research, 5*(6), 1476–1489.

Barleta, E. P., Pérez, G., & Sánchez, R. J. (2019). Industry 4.0 and the emergence of Logistics 4.0. *FAL Bulletin*. Erişim adresi: https://www.cepal.org/en/publications/45455-industry-40-and-emergence-logistics-40

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Barreto, L., Amaral, A., & Pereira, T. (2017). Industry 4.0 implications in logistics: An overview. *Procedia Manufacturing, 13*, 1245–1252. https://doi.org/10.1016/j.promfg.2017.09.032

Baş, T. (2013). *Anket - Nasıl hazırlanır? Nasıl uygulanır? Nasıl değerlendirilir?* (7. Baskı). Seçkin Yayıncılık.

Baygın, N. (2022). *Endüstri 5.0 platformları için blok zincir tabanlı akıllı kitlesel özelleştirme yöntemlerinin geliştirilmesi* [Doctoral thesis]. Fırat Üniversitesi.

Belmonte, L. M., Segura, E., de la Rosa, F. L., Gómez-Sirvent, J. L., Fernández-Caballero, A., & Morales, R. (2023). Training industrial engineers in Logistics 4.0. *Computers and Industrial Engineering, 184*, 109550. https://doi.org/10.1016/j.cie.2023.109550

Cengiz, Ö. (2020). *Lojistik iş süreçlerinin dijital dönüşü: Lojistik 4.0 uygulamalarında Türkiye'de mevcut durum* [Doctoral thesis]. Kafkas Üniversitesi.
Challoner, J. (Ed.). (2022). *1001 inventions that changed the world*. Simon & Schuster.
Chau, P. Y. (1996). An empirical assessment of a modified technology acceptance model. *Journal of Management Information Systems, 13*(2), 185–204.
Çiçekli, S. (2017). Sanayi 4.0'ın lojistik sektörüne etkileri. *Kalkınmada Anahtar Verimlilik, 352*, 1–4.
Çıkmak, S., & Yazgan, H. İ. (2023). Lojistik sektöründe endüstri 4.0 teknolojilerinin önündeki engellerin bulanık delphi yöntemiyle incelenmesi. *Elektronik Sosyal Bilimler Dergisi, 22*(88), 2065–2086.
Çivici, T., & Kale, S. (2007). Mimari tasarım bürolarında bilişim teknolojilerinin kullanımını etkileyen faktörler: Bir yapısal denklem modeli. *4. İnşaat Yönetimi Kongresi Bildiriler Kitabı, 30*(31), 119–128.
Culot, G., Nassimbeni, G., Orzes, G., & Sartor, M. (2020). Behind the definition of Industry 4.0: Analysis and open questions. *International Journal of Production Economics, 226*, 107617. https://doi.org/10.1016/j.ijpe.2020.107617
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319–340.
Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982–1003.
Dembinska, I., Tundys, B., Frankowska, M., & Malinowski, M. (2018). *Smart logistics*. Wydawnictwo edu-Libri.
Demir, S., Paksoy, T., & Kochan, C. G. (2020). Logistics 4.0: SCM in Industry 4.0 era: Changing patterns of logistics in Industry 4.0 and role of digital transformation in SCM. In *Logistics 4.0* (pp. 15–26).
DHL. (2015). *Internet of Things in logistics: A collaborative report by DHL and Cisco on implications and use cases for the logistics industry*. DHL.
Efanov, D., & Roschin, P. (2018). The all-pervasiveness of the blockchain technology. *Procedia Computer Science, 123*, 116–121. https://doi.org/10.1016/j.procs.2018.01.019
Ekincioğlu, O. (2019). *Lojistik yöneticilerinin endüstri 4.0'ın işletme düzeyindeki etkilerine ilişkin görüşleri üzerine nitel bir araştırma: Bursa örneği* [Master's thesis]. Celal Bayar Üniversitesi.
Facchini, F., Oleśków-Szłapka, J., Ranieri, L., & Urbinati, A. (2019). A maturity model for logistics 4.0: An empirical analysis and a roadmap for future research. *Sustainability, 12*(1), 86. https://doi.org/10.3390/su12010086
Farahat, T. (2012). Applying the technology acceptance model to online learning in the Egyptian universities. *Procedia - Social and Behavioral Sciences, 64*, 95–104. doi :10.1016/j.sbspro.2012.11.012
Fukuda, K. (2020). Science, technology and innovation ecosystem transformation toward society 5.0. *International Journal of Production Economics, 220*, 107460. doi:10.1016/j.ijpe.2019.07.033
Fukuyama, M. (2018). Society 5.0: Aiming for a new human-centered society. *Japan Spotlight, 27*(5), 47–50.
Galindo, L. D. (2016). *The challenges of logistics 4.0 for the supply chain management and the information technology* [Master's thesis]. Norwegian University of Science and Technology.
Geissbauer, R., Vedso, J., & Schrauf, S. (2016). *Industry 4.0: Building the digital enterprise*. Erişim adresi: https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf
Görçün, Ö. F. (2017). *Dördüncü Endüstri Devrimi Endüstri 4.0*. Beta Yayıncılık.
Gorzelany-Dziadkowiec, M., Gorzelany, J., Kosala, M., Smutek, H., & Kubula, S. (2022). People and technology – Employee competency profile in Industry 4.0. *Przegląd Organizacji*, (6), 37–46.
Güngör, Ş. (2024). *Lojistik işletmelerinin lojistik 4.0 algılarının incelenmesi: Akdeniz Bölgesi örneği* [Doctoral thesis]. Tarsus Üniversitesi.
Gupta, M. (2017). *Blockchain for dummies*. Erişim adresi: https://www.studocu.com/en-us/document/olympian-high-school/ap-macroeconomics/blockchain-for-dummies/64709856
Gürbüz, S., & Bayik, M. E. (2021). A new approach for mediation analysis: Is Baron and Kenny's method still valid? *Türk Psikoloji Dergisi, 37*(88), 15–19.
Hallikainen, H., & Laukkanen, T. (2016). How technology readiness explains acceptance and satisfaction of digital services in B2B healthcare sector? In *PACIS 2016 Proceedings* (Paper 294).
Henesey, L., & Philipp, R. (2019). Evaluating LNG bunkering automation technology. In *World of Shipping Portugal: An International Research Conference on Maritime Affairs* (pp. 16–17).
Hinckeldeyn, J., & Jochen, K. (2018, June). Developing a smart storage container for a blockchain-based supply chain application. In *2018 Crypto Valley Conference on Blockchain Technology* (pp. 97–100). https://doi.org/10.1109/CVCBT.2018.00017
Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry, 89*, 23–34.
Hu, P. J. H., Clark, T. H., & Ma, W. W. (2003). Examining technology acceptance by school teachers: A longitudinal study. *Information and Management, 41*(2), 227–241.
Hyperledger. (2019). *How Walmart brought unprecedented transparency to the food supply chain with Hyperledger Fabric*. Erişim adresi: https://www.hyperledger.org/learn/publications/walmart-case-study
International Business Machines (IBM). (2017, December 14). *Walmart, JD.com*. Erişim adresi: https://newsroom.ibm.com/2017-12-14-Walmart-JD-com-
Issaoui, Y., Khiat, A., Bahnasse, A., & Ouajji, H. (2021). Toward smart logistics: Engineering insights and emerging trends. *Archives of Computational Methods in Engineering, 28*, 3183–3210.

Jabbour de Sousa, A. B. L., Jabbour, C. J. C., Foropon, C., & Godinho Filho, M. (2018). When titans meet – Can Industry 4.0 revolutionize the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting and Social Change, 132*, 18–25.

Jeschke, S. (2018). Logistics 4.0 – Do you know your potential? The Logistics 4.0 Maturity Benchmark Tool. *Erişim*, 11, 3811–3816.

Jiang, P., Guo, F., Liang, K., Lai, J., & Wen, Q. (2020). Searchain: Blockchain-based private keyword search in decentralized storage. *Future Generation Computer Systems, 107*, 781–792. doi: 10.1016/j.future.2017.08.036

Kalyoncuoğlu, S. (2018). Tüketicilerin online alışverişlerindeki sanal kart kullanımlarının teknoloji kabul modeli ile incelenmesi. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 20*(2), 193–213.

Kanduza, B. S. (2023). *Lojistik 4.0 uygulamalarını etkileyen fırsatların ve zorlukların sürdürülebilirlik bağlamında belirlenmesi: Ankara Lojistik Üssü'nde bir araştırma* [Master's thesis]. Necmettin Erbakan Üniversitesi.

Karagöz, B., & Doyduk, H. B. B. (2020). Lojistik 4.0 uygulamaları ve lojistik firmalarının bakış açısı. *İnsan ve İnsan, 7*(23), 37–51.

Khan, S., Singh, R., Haleem, A., Dsilva, J., & Ali, S. S. (2022). Exploration of critical success factors of logistics 4.0: A DEMATEL approach. *Logistics, 6*(1), 1–14.

Kipper, L. M., Iepsen, S., Dal Forno, A. J., Frozza, R., Furstenau, L., Agnes, J., & Cossul, D. (2021). Scientific mapping to identify competencies required by Industry 4.0. *Technology in Society, 64*, 101454.

Kırkan, A. (2022). *Tedarik zincirinde blokzinciri (blockchain) teknolojisi ve uygulama örnekleri*. Ekin Yayınevi.

Koç, E. (2020). Tedarik zinciri izlenebilirliği ve sürdürülebilirliğinde yeni paradigma: Blokzincir. *Journal of Bingöl University Graduate School of Social Sciences (BUSBED), 10*(20), 417–437. doi: 10.29029/busbed.731939

Kovács, G., & Kot, S. (2016). New logistics and production trends as the effect of global economy changes. *Polish Journal of Management Studies, 14*(2), 115–126.

Kshetri, N. (2018). Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management, 39*, 80–89. doi: 10.1016/j.ijinfomgt.2017.12.005

Küçük, B. (2023). *Limanlarda etkinliğin artırılmasında akıllı lojistik başarı kriterlerinin ağırlıklandırılması ve en ideal süreç yönetimi yaklaşımının seçimi: Samsun ili örneği* [Master's thesis]. Giresun Üniversitesi.

Kuo, K. M., Liu, C. F., & Ma, C. C. (2013). An investigation of the effect of nurses' technology readiness on the acceptance of mobile electronic medical record systems. *BMC Medical Informatics and Decision Making, 13*(1), 1–14. https://doi.org/10.1186/1472-6947-13-1

Lee, I., & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons, 58*(4), 431–440.

Lee, M. K., Cheung, C. M., & Chen, Z. (2005). Acceptance of Internet-based learning medium: The role of extrinsic and intrinsic motivation. *Information and Management, 42*(8), 1095–1104.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., & Rao, S. S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega, 34*(2), 107–124.

Lin, B., & Jones, C. A. (2009). Digital supply chain management and implementation: A research review. *SWDSI Proceedings, 589*, 592.

MAERSK. (2020). *Logistics' digital revolution: The transformation of data and technology in supply chain logistics*. Maersk.

Maidan, T. (2020). How big is the logistics industry? Erişim adresi: https://www.freightwaves.com/news/how-big-is-the-logistics-industry

Marinagi, C., Trivellas, P., & Sakas, D. P. (2014). The impact of information technology on the development of supply chain competitive advantage. *Procedia – Social and Behavioral Sciences, 147*, 586–591.

Metin, S. (2019). *İşletmelerin dijital dönüşüm (Endüstri 4.0) farkındalık ve algı düzeyinin değerlendirilmesi: Elazığ OSB örneği* [Doctoral thesis]. Fırat Üniversitesi.

Meydan, C. H., & Şeşen, H. (2015). *Yapısal eşitlik modellemesi: AMOS uygulaması* (2. Baskı). Detay Yayıncılık.

Mueller, E., Chen, X. L., & Riedel, R. (2017). Challenges and requirements for the application of Industry 4.0: A special insight with the usage of cyber-physical system. *Chinese Journal of Mechanical Engineering, 30*(5), 1050–1057.

Mueller, J. M., & Voigt, K. I. (2018). The impact of Industry 4.0 on supply chains in engineer-to-order industries – An exploratory case study. *IFAC-PapersOnLine, 51*(11), 122–127.

Müstakil Sanayici ve İşadamları Derneği (MÜSİAD). (2017). *Endüstri 4.0 ve geleceğin lojistiği: 2017 lojistik sektör raporu*. https://www.musiad.org.tr/icerik/yayin-40/ptn-3

Myeong, S., & Jung, Y. (2019). Administrative reforms in the Fourth Industrial Revolution: The case of blockchain use. *Sustainability, 11*(14), 3971. doi: 10.3390/su11143971

Nagy, J. T. (2018). Evaluation of online video usage and learning satisfaction: An extension of the technology acceptance model. *International Review of Research in Open and Distributed Learning, 19*(1). https://doi.org/10.19173/irrodl.v19i1.2886.

Oliver, R. L. (2010). *Satisfaction: A behavioral perspective on the consumer* (2nd ed.). Routledge.

Orel, F. D., & Arık, A. (2020). Sosyal medya pazarlamasının tüketici satın alma niyetine etkisinin teknoloji kabul modeli aracılığıyla incelenmesi. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, (57), 205–232.

Özbek, V., Alnıaçık, Ü., Koç, F., Akkılıç, M. E., & Kaş, E. (2014). Kişilik özelliklerinin teknoloji kabulü üzerindeki doğrudan ve dolaylı etkileri: Akıllı telefon teknolojileri üzerine bir araştırma. *International Review of Economics and Management, 2*(1), 36–57.

Özçifçi, V. (2020). Sosyal medyanın tüketicilerin satın alma niyeti üzerindeki etkisi. *Ahi Evran Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 6*(1), 206–223.

Özdemir, A., & Özgüner, M. (2018). Endüstri 4.0 ve lojistik sektörüne etkileri: Lojistik 4.0. *İşletme ve İktisat Çalışmaları Dergisi, 6*(4), 39–47.

Özdemir, A. (2023). *Dijital dönüşümün örgütsel çevikliğe etkisi* [Doctoral thesis]. Karabük Üniversitesi.

Özdoğan, O. (2018). *Endüstri 4.0: Dördüncü sanayi devrimi ve endüstriyel dönüşümün anahtarları*. Pusula Yayıncılık.

Öztemel, E., & Gürsev, S. (2018). Türkiye'de lojistik yönetiminde endüstri 4.0 etkileri ve yatırım imkânlarına bakış üzerine anket uygulaması. *Marmara Fen Bilimleri Dergisi, 30*(2), 145–154.

Pan, X., Li, M., Wang, M., Zong, T., & Song, M. (2020). The effects of a smart logistics policy on carbon emissions in China: A difference-in-differences analysis. *Transportation Research Part E: Logistics and Transportation Review, 137*, 101939. https://doi.org/10.1016/j.tre.2020.101939

Parsons, C. A. (2012). *The steam turbine: The Rede Lecture 1911*. Cambridge University Press.

Perotti, S., Santacruz, R. F. B., Bremer, P., & Beer, J. E. (2022). Logistics 4.0 in warehousing: A conceptual framework of influencing factors, benefits and barriers. *The International Journal of Logistics Management, 33*(5), 193–220.

Philipp, R. (2020, June). Digital readiness index assessment towards smart port development. In *Sustainability Management Forum | NachhaltigkeitsManagementForum*, *28*(1), 49–60. Springer. https://doi.org/10.1007/s00550-020-00510-4

Philipp, R., Prause, G., & Meyer, C. (2020). Blue growth potential in South Baltic Sea region. *Transport and Telecommunication Journal, 21*(1), 69–83.

Porter, C. E., & Donthu, N. (2006). Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics. *Journal of Business Research, 59*(9), 999–1007.

Pourmehdi, M., Paydar, M. M., Ghadimi, P., & Azadnia, A. H. (2022). Analysis and evaluation of challenges in the integration of Industry 4.0 and sustainable steel reverse logistics network. *Computers and Industrial Engineering, 163*, 107808. https://doi.org/10.1016/j.cie.2021.107808

Rahman, S. A., Taghizadeh, S. K., Ramayah, T., & Alam, M. M. D. (2017). Technology acceptance among micro-entrepreneurs in marginalized social strata: The case of social innovation in Bangladesh. *Technological Forecasting and Social Change, 118*, 236–245.

Rainnie, A., & Dean, M. (2020). Industry 4.0 and the future of quality work in the global digital economy. *Labour and Industry: A Journal of the Social and Economic Relations of Work, 30*(1), 16–33.

Rasoolimanesh, S. M., Wang, M., Roldan, J. L., & Kunasekaran, P. (2021). Are we in right path for mediation analysis? Reviewing the literature and proposing robust guidelines. *Journal of Hospitality and Tourism Management, 48*, 395–405. https://doi.org/10.1016/j.jhtm.2021.07.013

Realizing Society 5.0. (n.d.). Erişim adresi: https://www.japan.go.jp/abenomics/_userdata/abenomics/pdf/society_5.0.pdf

Rodrigue, J. (2018). Efficiency and sustainability in multimodal supply chains. *International Transport Forum Discussion Paper*. https://doi.org/10.1787/0f457717-en

Sarı, T., & Yılmaz, B. (2020). Endüstri 4.0 uygulamaları ve akıllı fabrikalar. In G. Telli & S. Aydın (Eds.), *Dijital dönüşüm içinde* (pp. 275–292).

Saruhan, Ş. C., & Özdemirci, A. (2011). *Bilim, felsefe ve metodoloji: Araştırmada yöntem problemi – SPSS uygulamalı*. Beta Yayıncılık.

Schmidt, R., Möhring, M., Härting, R. C., Reichstein, C., Neumaier, P., & Jozinović, P. (2015, June). Industry 4.0: Potentials for creating smart products: Empirical research results. In *18th International Conference on Business Information Systems* (pp. 16–27). https://doi.org/10.1007/978-3-319-19027-3_2

Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.

Şeker, Y., & Hoş, S. (2021). Muhasebe meslek mensuplarının dijital muhasebe uygulamalarını kullanımlarına ilişkin bir araştırma. *Anadolu Üniversitesi Sosyal Bilimler Dergisi, 21*(4), 953–972.

Şekkeli, Z. H. (2022). Dijital dönüşüme dair algıların teknolojiye hazır olma ve kabul modeli (TRAM) ile analizi: Kahramanmaraş Sütçü İmam Üniversitesi MYO öğrencileri üzerinde ampirik bir çalışma. *Bilge Uluslararası Sosyal Araştırmalar Dergisi, 6*(2), 78–89.

Serçemeli, M., & Kurnaz, E. (2016). Denetimde bilgi teknoloji ürünleri kullanımının teknoloji kabul modeli (TKM) ile araştırılması. *İstanbul Üniversitesi İşletme Fakültesi Dergisi, 45*(1), 43–52.

Skapinyecz, R., Illés, B., & Bányai, Á. (2018). Logistic aspects of Industry 4.0. *IOP Conference Series: Materials Science and Engineering, 448*, 012025. doi: 10.1088/1757-899X/448/1/012025

Strandhagen, J. O., Vallandingham, L. R., Fragapane, G., Strandhagen, J. W., Stangeland, A. B. H., & Sharma, N. (2017). Logistics 4.0 and emerging sustainable business models. *Advances in Manufacturing, 5*, 359–369. https://doi.org/10.1007/s40436-017-0198-1

Szymańska, O., Adamczak, M., & Cyplik, P. (2017). Logistics 4.0 – A new paradigm or set of known solutions? *Research in Logistics and Production, 7*(4), 299–310.

Tang, C. S., & Veelenturf, L. P. (2019). The strategic role of logistics in the Industry 4.0 era. *Transportation Research Part E: Logistics and Transportation Review, 129*, 1–11. https://doi.org/10.1016/j.tre.2019.06.004

Taş, A., & Alagöz, S. B. (2021). Lojistik sektörü özelinde Endüstri 4.0 farkındalık düzeyleri üzerine bir araştırma. *Karamanoğlu Mehmetbey Üniversitesi Sosyal ve Ekonomik Araştırmalar Dergisi, 23*(41), 404–417.

Terzi, Y. (2019). *SPSS ile istatistiksel veri analizi*. Erişim adresi: https://avys.omu.edu.tr/storage/app/public/yukselt/64430/SOS5

Torun, N. K., & Cengiz, E. (2019). Endüstri 4.0 bakış açısının öğrenciler gözünden teknoloji kabul modeli (TKM) ile ölçümü. *Uluslararası İktisadi ve İdari İncelemeler Dergisi, 22*, 235–250.

Trab, S., Bajic, E., Zouinkhi, A., Thomas, A., Abdelkrim, M. N., Chekir, H., & Ltaief, R. H. (2017). A communicating object's approach for smart logistics and safety issues in warehouses. *Concurrent Engineering, 25*(1), 53–67.

Transparency Market Research. (2019, July). Globalization to drive global logistics market, notes TMR.

Turan, B. (2011). *Bilgi ve iletişim teknolojileri kullanımının teknoloji kabul modeli ile incelenmesi ve sınıf öğretmenleri üzerinde bir uygulama* [Master's thesis]. Bilecik Üniversitesi.

Turan, B., & Haşit, G. (2014). Teknoloji kabul modeli ve sınıf öğretmenleri üzerinde bir uygulama. *Uluslararası Alanya İşletme Fakültesi Dergisi, 6*(1), 109–119.

Türker, A., & Türker, Ö. G. (2013). Turistik ürün satın alma davranışının teknoloji kabul modeli ile incelenmesi. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 15*(2), 281–312.

Türkiye Endüstri 4.0 Platformu. (n.d.). *Endüstri tarihine kısa bir yolculuk*. Erişim adresi: https://www.endustri40.com/endustri-tarihine-kisa-bir-yolculuk/

Ulusoy, G. (2019). *Endüstri 4.0 uygulamalarının lojistik sektöründe operasyonel verimlilikle ilişkisi üzerine bir araştırma* [Master's thesis]. Marmara Üniversitesi.

Ursavaş, Ö. F. (2022). Technology acceptance model: History, theory, and application. In *Conducting technology acceptance research in education: Theory, models, implementation, and analysis* (pp. 57–91). Springer International Publishing. https://doi.org/10.1007/978-3-030-86333-5_4

Walczuch, R., Lemmink, J., & Streukens, S. (2007). The effect of service employees' technology readiness on technology acceptance. *Information and Management, 44*(2), 206–215. https://doi.org/10.1016/j.im.2006.12.005

Witkowski, K. (2017). Internet of Things, Big Data, Industry 4.0 – Innovative solutions in logistics and supply chains management. In *7th International Conference on Engineering, Project, and Production Management. Procedia Engineering, 182*, 763–769. https://doi.org/10.1016/j.proeng.2017.03.197

Yang, C., Yan, S., Wang, J., & Xue, Y. (2022). Flow experiences and virtual tourism: The role of technological acceptance and technological readiness. *Sustainability, 14*(9), 5361. https://doi.org/10.3390/su14095361

Yelkikalan, N., Özcan, S., & Temel, K. (2019). Endüstri 4.0 farkındalığının belirlenmesi: Çanakkale Onsekiz Mart Üniversitesi örneği. *Girişimcilik ve Kalkınma Dergisi, 14*(1), 31–44.

Yılmaz, Ö. (2018). Tüketicilerin online alışveriş niyetlerinin Teknoloji Kabul Modeli bağlamında incelenmesi. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi, 20*(3), 331–346.

Yılmaz, Ü., & Duman, B. (2019). Lojistik 4.0 kavramına genel bir bakış: Geçmişten bugüne gelişim ve değişimi. *Bilecik Şeyh Edebali Üniversitesi Sosyal Bilimler Dergisi, 4*(1), 186–200.

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017, June). An overview of blockchain technology: Architecture, consensus, and future trends. In *2017 IEEE International Congress on Big Data (BigData Congress)* (pp. 557–564). IEEE. https://doi.org/10.1109/BigDataCongress.2017.85

Zhou, K., Liu, T., & Zhou, L. (2015, August). Industry 4.0: Towards future industrial opportunities and challenges. In *12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD)* (pp. 2147–2152). IEEE. https://doi.org/10.1109/FSKD.2015.7382284

GENİŞLETİLMİŞ ÖZET

İşletmelerin rekabet edebilirliği ve sürdürülebilirliği açısından kritik öneme sahip olan Endüstri 4.0 uygulamalarından en fazla etkilenen sektörlerden birisi de lojistik sektörü olmuştur. İşletmelerin tedarik zinciri ve lojistik faaliyetlerinin de bu değişikliklerden etkilenmemesi mümkün olmadığı için, Dünya genelindeki bazı büyük işletmeler dijital tedarik zinciri ve lojistik yapılarını bu doğrultuda oluşturmaya başlamışlardır (Lin ve Jones, 2009: 589). İşletmeler uluslararası pazarda rakipleri ile rekabet edebilmek için tedarik zincirlerini ve lojistik faaliyetlerini anahtar olarak kullanmaya başlamışlardır (Li vd., 2006: 107). Bu yüzden işletmeler ve ülkeler açısından en önemli sektörlerden birisi olarak kabul edilen lojistik sektöründe, Endüstri 4.0 uygulamaları yeni ve bir o kadar da kritik bir konudur. Abriad ve Kristian (2021)' nında ifade ettiği gibi rekabet edebilirlik ve sürdürülebilirlik açısından bütün lojistik işletmelerinin bu teknolojilere uyum sağlaması ve bu konuda daha fazla araştırmanın yapılması gerekmektedir. Fakat Ulusoy, 2019; Taş ve Alagöz, 2021; Bolat, 2019; Özdemir ve Özgüner, 2018; Ekincioğlu, 2019; Çıkmak ve Yazgan, 2023 gibi araştırmacılar ise araştırma sonuçlarında Türkiye'deki lojistik işletmelerinin bu uygulamalardan beklenildiği düzeyde faydalanamadıkları sonucuna ulaşmışlardır. Buna gerekçe olarak da lojistik işletmelerinin bu teknolojiye uygun nitelikte iş gücüne sahip olmaması, Endüstri 4.0 farkındalık düzeylerinin düşük olması ve işletmelerin bu teknolojiler hakkında yeterli bilgiye sahip olmamaları belirtilmiştir (Ulusoy, 2019; Geissbauer vd., 2016; Taş ve Alagöz, 2021; Bolat, 2019; Özdemir ve Özgüner, 2018; Ekincioğlu, 2019; Çıkmak ve Yazgan, 2023; Pouermehdi vd., 2022; Jabbour vd., 2018). Bu sorunların giderilmesi için de bu konuda nitelikli iş gücüne sahip olunması ve lojistik sektöründe bireylerin farkındalık düzeylerinin artırılması gerektiği vurgulanmıştır. Benzer şekilde Güngör (2024) yaptığı araştırma sonucunda Lojistik 4.0 hakkında çalışmaların artırılması gerektiği ve sektör çalışanlarının bu konuda eğitiminin iyileştirilmesi gerektiği sonucuna ulaşmıştır. Bu çerçevede araştırmada literatürde yaygın kullanılan teknoloji kabul modeli çerçevesinde lojistik

programı öğrencilerinin sektörde yer almadan önce Endüstri 4.0 algılarının belirlenerek farkındalık düzeylerinin artırılması, bu teknolojilerin kabulünün incelenmesi ve böylece sektördeki işletmelerin bu uygulamalardan daha fazla faydalanmalarını sağlayarak teknolojik uyumu hızlandırıp sektöre ve bu sektörde çalışacak öğrencilere katkı yapılması amaçlanmıştır. Teknoloji kabul modeline göre kullanma davranışının gerçekleşmesi için modeldeki diğer değişkenler bağlamında üniversite öğrencilerinin mevcut durumunun belirlenmesi önem arz etmektedir. Araştırma ile bireyler sektörde yer almadan Endüstri 4.0 hakkında farkındalık düzeyleri artacak, bu konuda bilgili ve nitelikli eleman olarak sektöre adım atabileceklerdir. Bu yeni teknolojiler karşısında lojistik sektöründe yer alacak bireylerin bu teknolojiler hakkında bilgi sahip olmaları, bu teknolojilere adapte olmaları istihdam, rekabet edebilirlik ve sürdürülebilirlik açısından bir gereklilik haline gelmiştir. Araştırma evreni, 2023-2024 yılında Uşak Üniversitesi Uygulamalı Bilimler Fakültesi Lojistik Yönetimi Programında ve Eşme Meslek Yüksekokulu Lojistik Programında öğrenim gören öğrencilerden oluşmaktadır. Araştırma evrenine Uşak Üniversitesi Lojistik öğrencilerinin seçilmesinde araştırmacıların bu kurumda öğretim elemanı olmaları etkili olmuştur. Öğrencilerin istihdamına katkı sağlamak amacıyla bu araştırma evreni üzerinde bir araştırmanın yapılmasının faydalı olacağı düşünülmüştür. Bu araştırma evreninden veri toplamak için anket yönteminden faydalanılmış ve anketler yüz yüze yapılmıştır. Araştırmada her öğrenciden 1 adet veri toplanarak 156 adet veri elde edilerek SPSS programında analiz edilmiştir. Araştırma sonucunda lojistik programı öğrencilerinin % 89.7'lik kısmının daha önce bilgi teknolojileri ile ilgili herhangi bir eğitim ya da kurs almadıkları belirlenmiştir. Fakat buna rağmen araştırmaya katılan bireylerin Endüstri 4.0 uygulamaları hakkında farkındalık düzeyleri yüksek çıkmıştır. Öğrencilerin bu konuda farkındalık düzeylerinin yüksek olması kendilerine bu konuda geliştirmelerini ve böylece sektörün ihtiyaç duyduğu gerekli teknolojik donanıma sahip nitelikli eleman olarak sektörde yer almalarını sağlayabilecektir. Ayrıca sektörde yer aldıklarında da bu uygulamaların sektörde kullanımının yaygınlaşmasını sağlayarak, lojistik işletmelerinin rekabet edebildiğine ve küresel işletmeler olmalarına katkı sağlayabileceklerdir. Araştırma da belirlenen hipotezleri test etmek amacıyla yapılan analizler sonucunda H_1, H_2, H_3, H_4, H_5, H_6, H_7 hipotezleri kabul edilmiştir. Belmonte vd. (2023)'nin de araştırmalarında vurguladıkları gibi, öğrencilerin lojistik 4.0 konusunda eğitilmesi sektör açısından büyük önem arz etmektedir. Araştırma ile lojistik sektöründe yer alacak bireylerin bu teknolojiler hakkında algılarının ve niyetlerinin belirlenmesi ve farkındalık düzeylerinin artırılarak istihdamına ve kişisel gelişimlerine katkı yapılması beklenmektedir. Bireylerin nitelikli eleman olarak sektörde yer almasının sağlanmasıyla birlikte lojistik işletmelerinin değişen teknolojileri iyi anlamalarına, bu teknolojilere hızla uyum sağlayarak küresel boyutta lojistik işletmesi olmalarında kolaylık sağlayabilecektir. Böylece lojistik sektörüne yapılacak olan yatırımlarda ülke ekonomisinin gelişmesine katkı sağlayarak ekonomik hedeflerin daha kolay ulaşılmasına yardımcı olabilecektir. Araştırmanın literatüre de yeni bir bakış açısı sunarak alana önemli bir katkılar sunması beklenmektedir. Alanyazında Endüstri 4.0 ile ilgili araştırmalar her geçen gün ilgi görerek artmasına rağmen, lojistik sektörünü içine alan lojistik 4.0 ile ilgili araştırmalar daha kısıtlı kalmıştır. Bu konuda araştırmaların artırılması gerektiği de araştırma sonuçlarında vurgulanmıştır. Bireylerin teknolojilere bakış açılarını belirlemeye yönelik literatürde yaygın bir şekilde kullanılan teknoloji kabul modeli ile lojistik programı öğrencilerinin Endüstri 4.0 algılarını belirleyip, farkındalıklarını artırmayı amaçlayan araştırmaya rastlanılmamıştır. Bu yüzden araştırma bu alanda yapılmış özgün bir çalışma olup, araştırma bulgularının lojistik programı öğrencileri ile lojistik sektörünün yanı sıra araştırmacılara da büyük katkı sağlaması, literatürdeki önemli bir boşluğu doldurması ve böylece literatürün de zenginleşmesini sağlaması beklenmektedir. Ulaşılan sonuçlar doğrultusunda, sektörde teknolojinin kullanımının daha da yaygınlaşmasının sağlanması amacıyla sektördeki bireylere de teknolojinin faydalı ve kullanımının kolay olduğunun aktarılması ve bu konuda farkındalığın oluşturulması önerilmektedir. Bu çerçevede daha sonra yapılacak çalışmaların araştırma evrenine sektör temsilcilerinin dahil edilmesi de faydalı olabilecektir. Böylece literatürde ifade edilen sektördeki bireylerin farkındalık düzeylerinin düşük olduğu sorununun çözümüne de katkı sağlanabilecektir. Hatta bu teknolojilerin kullanımının yaygınlaştırılması adına ilgili kamu kurumları tarafından ilgili işletmelere bu teknolojilerle ilgili eğitimlerin verilmesi de faydalı olabilecektir. Lojistik sektöründe Endüstri 4.0 uygulamalarının yaygınlaşması sektörün rekabet avantajını artırılabileceği için, yakın zamanda sektörde bu konuda yatırımların artırılması gerektiği de düşünülmektedir. Üniversiteler bu teknolojilere uyumlu nitelikli personellerin yetiştirilmesi konusunda kilit rol üstlenmektedir. Bu yüzden lojistik sektöründeki personellerin bu teknolojilere hakim olmaları adına üniversitelerde de Endüstri 4.0 teknolojilerine uygun derslerin yer alması önem arz etmektedir. Bunun için öğrencilerin iş hayatında başarılı olmaları, sorunlar karşısında proaktif davranabilmeleri adına müfredatın uygun hale getirilmesi gerekmektedir. Özellikle nesnelerin interneti, blockchain gibi lojistik sektörü açısından büyük değişiklikleri beraberinde getiren teknolojilerle ilgili proje tabanlı öğrenme yöntemleriyle yapılacak olan eğitimlerin öğrencilere dolayısıyla sektöre faydalı olabileceği düşünülmektedir. Simülasyon yöntemleriyle öğrencilerin sektörde karşılaşabileceği sorunlarla ilgili uygulamaların yapılması öğrencilerin bakış açılarını genişletebilecektir. Bu konuda üniversite - sanayi işbirliğinin artırılması bu eğitimlerin içeriğinin geliştirilmesine katkı sağlayabilecektir. Ayrıca kamu tarafından hazırlanacak eylem planlarında işletmelerin endüstri 4.0 teknolojilerine dönüşümünü hızlandıracak altyapı ve uygulama planlarına yer verilmesi ve hayata geçirilmesi sektörün teknolojik anlamda gelişmesine büyük fırsatlar sunabilecektir.