APPLICATION OF ARTIFICAL INTELLIGENCE TECHNOLOGY IN GOODS TRANSPORT

ÖNVEZETŐ TECHNOLÓGIA ALKALMAZÁSA ÁRUSZÁLLÍTÁSBAN

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Abstract

Nowadays, self-driving vehicles are becoming more common on public roads. There is no doubt that self-driving car technology has undergone significant development in recent years and now allows drivers to hand over control to a vehicle under appropriate predictable conditions. The concept of fully autonomous vehicles exists, however, their capabilities in navigating on public roads are still a far cry from reality. There are also several technological and ethical issues to consider concerning autonomous driving, which are expected to be addressed and fully resolved shortly. The research aims to provide an overview of the current stage of technological development of autonomous vehicles through a complex literature review and explore the progress of automation in the case of Hungarian logistics companies in the framework of a quantitative questionnaire. This research will further assess the future and applicability of self-driving vehicles based on the opinions of the interviewed company managers.

Keywords

self - driving vehicles, Autonomous trucks, logistics, shipment, safety, AI.

Absztrakt

Manapság egyre elterjedtebbek az önvezető járművek a közutakon. Kétségtelen, hogy az önvezető autók technológiája jelentős fejlődésen ment keresztül az elmúlt években, és mára lehetővé teszi a sofőrök számára, hogy megfelelő előrelátható körülmények között átadják az irányítást a járműnek. A teljesen autonóm járművek koncepciója létezik, azonban a közutakon való navigálási képességeik még mindig nagyon távol állnak a valóságtól. Az autonóm vezetéssel kapcsolatban számos technológiai és etikai probléma is megfontolandó, amelyeket várhatóan rövidesen megoldanak és teljesen megoldanak. A kutatás célja, hogy egy komplex szakirodalmi áttekintésen keresztül áttekintést adjon az autonóm járművek technológiai fejlődésének jelenlegi stádiumáról, és kvantitatív kérdőív keretében feltárja az automatizálás előrehaladását a magyar logisztikai vállalatok esetében. Ez a kutatás a megkérdezett cégvezetők véleménye alapján tovább méri az önvezető járművek jövőjét és alkalmazhatóságát.

Keywords

önvezetőjármű, autonóm kaminon, mesterséges intelligencia, logisztika, szállítmányozás.

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INTRODUCTION

In the last decade, the world economy has faced significant challenges. Increasing globalization, the importance of sustainability and technological development has come to the foreground and initiated deep structural changes in society. With globalization, the volume of goods transported has increased, which has facilitated the division of labor and also enabled the development of new technologies. The negative effects of globalization and internationalization have manifested themselves in the environment, with increased levels of pollution and C02 emissions.

Due to significant emissions from transport, there has been a growing demand in recent years for transport solutions that are reliable, efficient, and eco-friendly. Reducing the number of pollutants emitted by vehicles has become a primary task for vehicle manufacturers.

With the spread of globalization, consumer transportation needs have also changed. Many online platforms now allow us to order products from home with the push of a button, and the demand for accurate and fast delivery has thus increased substantially.

Advances in technological development brought on by Industry 4.0 provide a solution to many of the aforementioned challenges. We are witnessing nothing short of a technological revolution that will not only alter the way companies operate but will also transform our everyday lives.

The research aims to present self-driving technology, its application possibilities in the field of logistics, and to describe the economic and social changes and expectations that the technology will bring about.

With the help of a quantitative questionnaire, we are looking to determine the extent to which the respondents' experiences and expectations correspond to the changes predicted by the literature. In the quantitative survey, we collected the opinions of the employees and chief executives of logistics companies, and the answers were visually represented in graphs, diagrams and we further made statistical inferences.

LITERATURE REVIEW

The development of electric vehicles has laid the foundations for the introduction of a higher level of automation in the field of transport in the future.

The development of vehicles, especially road vehicles has accelerated in recent years, with more and more computer processing units appearing in vehicles. These include engine control, which affects the operation of the vehicle, an electronic stability program that increases the safety of the vehicle, and also cruise control systems that remove additional workload from drivers making the driving experience more comfortable. Some modern vehicles already have communication systems integrated into their processing units, thereby enabling vehicles to connect to other vehicles or the surrounding infrastructure. [1] Currently, the literature defines the following forms of communication: V2V (Vehicle to vehicle), V2I (Vehicle to infrastructure), and V2X (Vehicle to Everything) communication technologies.

In addition to features connected to convenience, data collected while driving is becoming increasingly important. More and more detailed information is emerging about travel, which is currently mostly used separately and independently. Huge opportunities open up, when considering using the information collected while traveling that form the

concept of Big Data. Research involving Intelligent Transport Systems (ITS) is becoming increasingly popular and aims to merge intelligent transport infrastructures that can create a complex network with semi or fully autonomous vehicles.

For decades, these technical innovations have allowed us to consider the possibility of a self-driving car. Cars driving on public roads without a driver are, of course, still perceived with aversion today. [2]

Concept and levels

We have reviewed foreign works on the topic of self-driving vehicles and found that the term autonomous vehicle is frequently used interchangeably with driverless car can be found in numerous terms, such as autonomous car, driverless car, self-driving car, and robotic car. [3]

A generally accepted definition of a self-driving car is that of a vehicle driven without human intervention, using digital technologies, that is able to travel in road traffic, senses the details of its surroundings, and navigates itself. Ironically characterized by alapjarat "There are four key stages to self-driving technology - without a foot, without a hand, without an eye, without thinking - driving assistance systems will be gradually replaced by a self-driving system."[4]

Levels of self-driving

At the lowest level of the stairs is the current knowledge of current cars. On the 1st level there are mainly cars equipped with parking assistance systems, such as reversing radar, but all movements and instructions are decided by man. The driver performs all driving operations, and the vehicle is fully human is under control.[5]

They start at level 2 with driver assistance and self-driving on the highway implementing vehicles that are already able to intervene actively in driving, such as lane keeping. The driving assistance system is the steering or take over the braking and acceleration operation or help make it safer operation. However, the vehicle is completely under human control.

Level 3 is equivalent to maneuvers such as the Tesla Autopilot can also be found in the system, such as overtaking on the highways, the car fully man-controlled, the driving environment is the automated system watching. We are now at level 3 in everyday use.[6]

There are two more levels left to achieve full self-direction, the 4th step is already complete

allows the car autonomy, but the driver must always be prepared to intervene if necessary, and the car must be given sufficient time to do so to the driver. The highest level 5, called complete self-drive, is already possible makes the car invent itself in any traffic situation.[7]

Implementing self-driving requires three main components, a perception, ie the recognition of the environment, decision-making and subsequent action, that is, issuing commands to the car. The first component is perception, recognizing the environment for which one is great precision laser rangefinder is mounted on the top of the car but the car at various points, several additional cameras also help to map the environment. [8] This the camera system helps the driver orient himself, giving the driver an image as if the car would have been picked up from above. The driver of the vehicle sees what is going on on a screen

behind, in front of and next to the car.[9] This high definition camera has lights and white-boards it also plays a role in recognizing the data from the laser rangefinder are compared to a high-precision map database so that vehicle control is aware of the area with applicable traffic regulations. Even a GPS sensor is essential, which can determine the position of the car with an accuracy of a few meters.[10] The camera system contains a kind of artificial intelligence called neural network-based recognition and 3D reconstruction of the environment, so we know to tell where we are in space, what is around us and how that changes, given we can track objects and predict their location.[11]

APPLICATION OF AUTONOMOUS DRIVING SOLUTIONS

Research topic, assumptions

The research aims to present self-driving technology and its application possibilities in the field of logistics, with a strong emphasis on environmental impacts. The scope of the research covers the opportunities and obstacles inherent in the introduction of self-driving technology in vehicles, their expected economic benefits, and environmental impacts.

The following assumptions were made while conducting the research:

- A. It is assumed that technological development hinders the introduction of self-driving trucks in logistics.
- B. We assume that the cost of trucks will inevitably increase in the future with the introduction of new technologies, which is why the range of companies is expected to change. The size of well-established logistics and truck manufacturing companies is likely to increase, while it will become harder for new companies to enter the market and to compete.

The research seeks to find answers to the following questions:

- Q1. What are the barriers to the introduction of autonomous trucks, according to the respondents?
- Q2. What are the expected benefits and drawbacks of the introduction and usage of autonomous trucks, according to the respondents?
- Q3. According to the respondents when can we expect autonomous trucks to be used in commerce and shipments?

Methodology

The paper presents the term autonomous vehicles from several angles and how self-driving technology is expected to affect the operations of logistics and shipping companies. The aim is to summarize and explore all those factors and challenges shipping companies are expected to face when following the introduction of autonomous transporting vehicles.

The study is based on a quantitative method, as it is one of the most suitable ways to measure the expected behavior of enterprises, and the data can be well analyzed using quantifiable and statistical methods. Within this framework, the questionnaire method was used.

In compiling the questionnaire, questions were formulated to compare the expected changes that come with the introduction of autonomous vehicles in literature with those obtained in the survey from respondents. We also considered how well the expected changes, opportunities, and obstacles mentioned in the literature meet the expectations of the selected employees and executives.

Results

The demographic composition of the survey shows that 57% of the chief employees of companies are men. More than half (57%) of the respondents were between the ages of 30 and 45, while those employees under 30 comprised 29% of the total population. The smallest group included people between 45 and 60, making up 14% of the total.

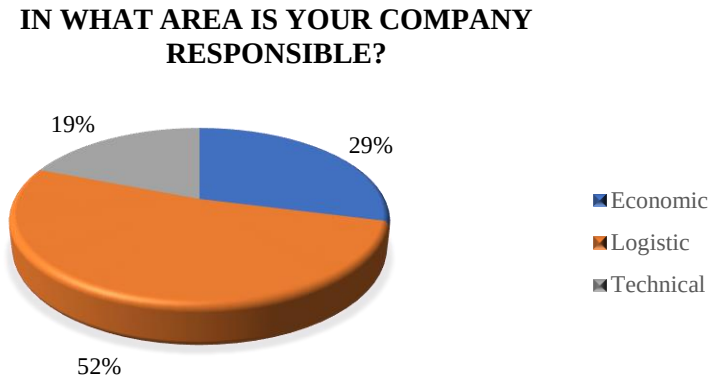

Figure 1:Field of responsibilities of the surveyed employees.Source: own research

Over half of the respondents (52%) identified logistics as their primary field of responsibilities at work. At the same time, 29% perform economics-related activities in their companies and 19% of the respondents work in the field of engineering and technology. The composition of the respondents confirms that the target group selection method ensured that the majority of the respondents had a certain level of knowledge in the field of transport and technology in the field of logistics.

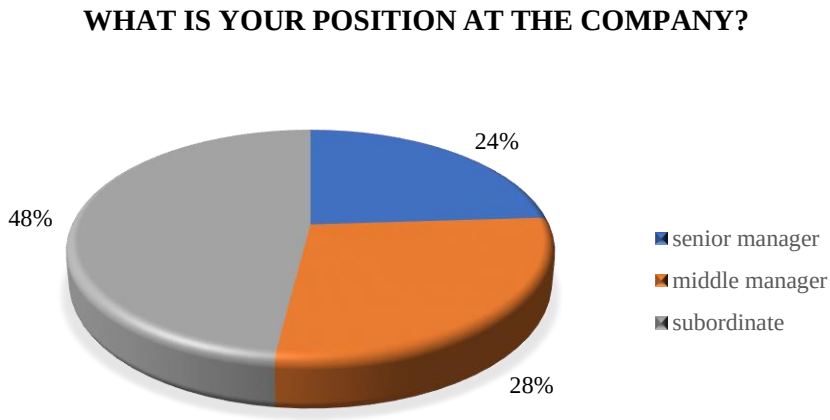

Figure 2: Positions of the employees in their companies. Source: own research

There was a nearly equal number of upper- and middle-level managers among the respondents. 24% of the respondents are top managers and 28% are middle managers.

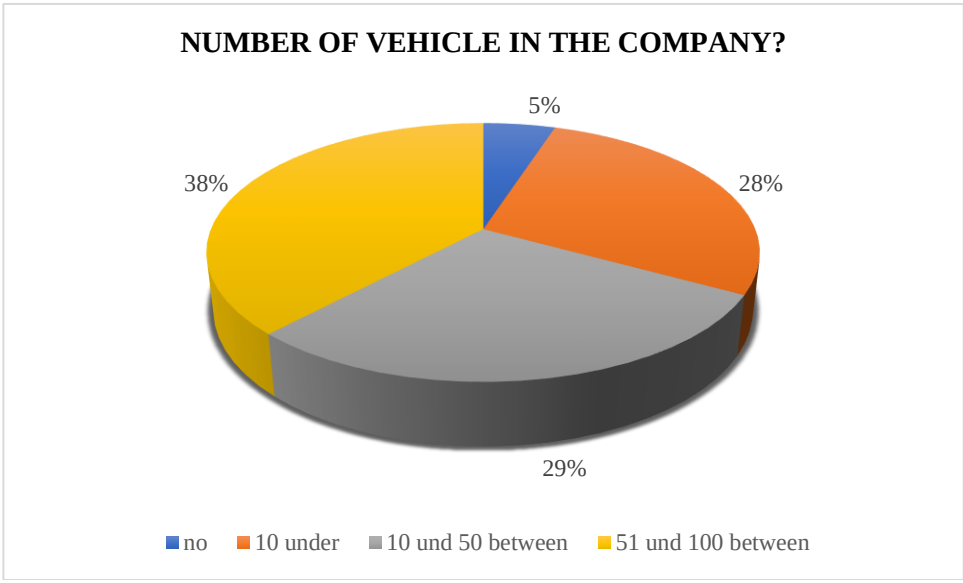

Figure 3 : Number of vehicles used in commercial activities of companies. Source: own research

It is typical for the respondents to work for bigger logistics and transportation companies with a lot of and operational vehicles. 38% of the companies use 50 to 100 transporting vehicles for their operations, while 29% use 10 – 50 vehicles. Almost a third of the companies (28%) operate with a number of vehicles that is equal to or lower than 10. Five percent of the respondents reported that they do not use any sort of transporting vehicles at all for their operations.

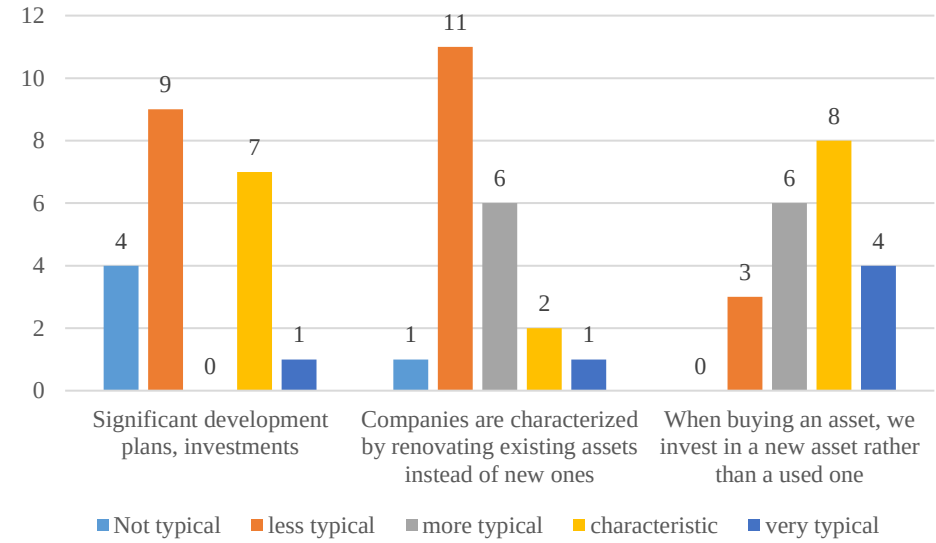

Figure 4: Company statements. Source: own research

According to the respondents, 8 out of 21 companies have a strategic plan and 18 companies prefer to buy a new asset in case of investment. Respondents reported that only 8 companies would prefer utilizing existing equipment instead of investing in a new one. Based on this, it can be concluded that the respondents are relatively willing to invest and prefer purchasing new assets.

15 out of the 21 respondents highlighted the exact same issues when answering to the question of obstacles and difficulties their companies face today. One of the most common responses was labor shortages, in particular, driver shortages, which were mentioned by 10 respondents. In addition, the following problems were highlighted:

- Increases in fuel prices, tolls, vehicle and parts prices, compulsory third party vehicle insurance.
- Freight rates and a rapidly changing market environment.
- High dependance on operation of transport, outsourcing and foreign workers.
- Issues with subcontractors

Autonomous driving technology awareness

Respondents were almost completely familiar with the concept of self-driving technology, with 20 of the 21 respondents providing positive answers to the question of : "Have you heard of self-driving technology?".

For an open ended question of "What, in your opinion, is meant by autonomous driving technologies?" the respondents gave specific answers mentioning a certain area of application of self-driving technology. The respondents referred to the following forms of autonomous vehicles:

- Forklifts in warehouses (1 answer)
- Application of robots (2 answers)
- Automated driving without human intervention (12 answers)
- Platooning (1 answer)

Some of the respondents with a deeper knowledge of the subject gave detailed answers, for instance:

„Driving is performed with "smart vehicles" that communicate with each other and with other interfaces instead of being controlled directly through human intervention. Such vehicles are also equipped with additional functions, such as safety, energy saving, comfort and environmental friendliness"

„ Autonomous vehicles are technologically controlled vehicles capable of travelling without human intervention. However, to the best of my knowledge, current "self-driving" vehicles still need a human presence and sometimes control."

The effects of autonomous vehicles, barriers of implementation

Seven questions were formulated regarding the introduction of self-driving technology, self-driving trucks, the expected effects and the factors hindering their introduction into commerce and shipment. The summaries of the received answers can be seen in the diagrams below.

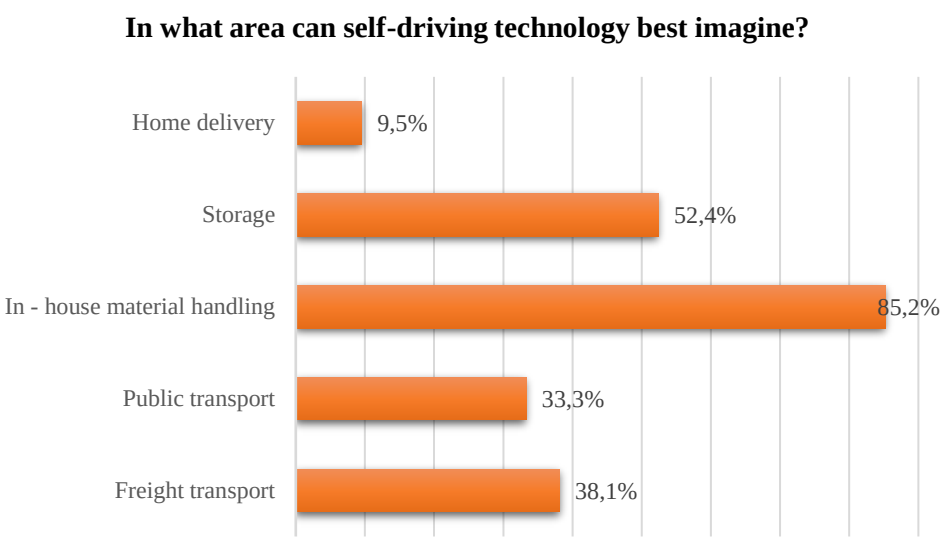

Figure 5: Areas self-driving technologies could be implemented in. Source: own research

Respondents are most likely to imagine the use of self-driving technology in the field of intra-factory logistics and handling, with 85.7% indicating this answer. Warehousing is also considered an important area, as every second respondent can imagine introducing it in this area as well. Its use in freight transport and public transport was chosen by 38.1% and 33.3% of the respondents, respectively. Delivery was indicated by only two respondents.

According to the respondents, the current condition of critical infrastructure poses the main threat, and simultaneously, the largest obstacle for the development and introduction of technology on public roads. 90.5% of respondents believe that this factor will hinder the spread of self-driving vehicles. 61.9% of the respondents mentioned the speed of technological development to be the main factor hindering the spread of autonomous vehicles. Every third respondent believes that technical development is not yet at the level to be introduced into everyday use in the near future. 52.4% believe that prejudice and lack of trust will be barriers to the adoption of the technology. The development of legal regulations and IT networks was perceived as an impediment by 38.1% of respondents, while less than the previous ones.

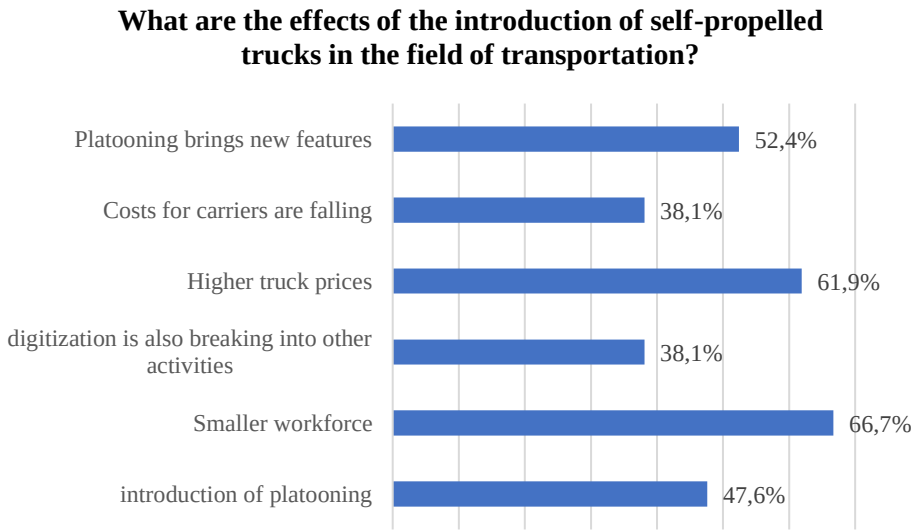

Figure 6: The effects of introduction of autonomous trucks in shipping and logistics. Source: own research

Among the expected effects of the introduction of self-propelled trucks, the respondents mentioned that the field of transportation is influenced by two main factors. The first one is that there is a significantly smaller need for a workforce in the case of this technology, with 66.7% of respondents saying this will have a significant impact on the shipping industry. The other is the high price of self-driving trucks, which could drive smaller companies out of the market, according to 61.9% of respondents. As a result of the introduction of the platooning technology, 52.4% of the respondents reported that they may create new services, while 47.6% mentioned that they will increase the utilization of vehicles. The least influential factors were reported to be digitalization and reduction of operating costs for haulers, both of which were identified by 38% of the respondents.

According to 95.2% of the respondents, the development of the road network is the biggest obstacle to the introduction of self-driving trucks. This factor was also highlighted in question 13 when examining the barriers of introduction of self-driving vehicles. The other main obstacle is the efficient and successful handling of the drivers' tasks. This answer was indicated by 66.7% of the respondents. Purchasing price and legal regulations were identified by 52.4%, with technical equipment being the least disruptive, with only 23.8% choosing it. Three of the listed factors could be identified.

SUMMARY

When choosing the research topic, we did not possess a deeper knowledge of self-driving technology, mainly because of the curiosity and topicality of the topic and its connection to the field of logistics. During the processing of the literature, we were enriched with interesting information. Numerous articles can be read online about self-driving technology, related developments, companies involved in the development, experiments demonstrating its use, but the evaluation of the expected barriers and impacts of the introduction receives less attention. More detailed articles and studies related to the topic are still

available primarily in foreign literature. The choice of topic, however, has limited a lot of possibilities, the analysis of the individual highlighted factors and effects could also be the topic of an independent research in the future.

- Research has shown that self-driving technology will significantly transform all sectors of the economy and change the labor market and our working conditions. The changes that most affect our daily lives may be the following:
- Public transportation is expected to gain more traction and popularity in the future, reducing the number of privately owned vehicles.
- The increase of public transport on roads will reduce emissions from transport by orders of magnitude, additionally, it will improve air quality and have a positive impact on health.
- Areas currently used for parking may become vacant, making cities less congested and more livable, and safer. The vacated areas will be used to alleviate the housing shortage, so other areas of the economy may also be positively impacted.
- Self-driving cars will also allow mobility for those who are currently unable to afford a car or are currently unable to drive, like the elderly or disabled.
- Cheaper transport leaves resources that can be spent freely by households, some of which will appear as additional consumption by households and businesses.
- Traffic jams are reduced, traffic becomes safer, as the number of cars reduces.
- One of the most vivid effects this will have on our daily lives is that the time spent on leisure will increase. We will be able to spend our time on other activities.

It will also fundamentally change the field of shipping and will result in substantial changes, the most important of which are:

- In the field of logistics, several applications will become more widespread, for example, autonomous forklifts will be able to handle materials on their own, programmed robots will be used to sort goods, and wire-based transport can be a new way of transporting online orders. A new mode of freight transportation strategy will gain spread - platooning, the essence of which is that self-driving trucks will travel in convoys and only the leading car will have a driver behind the wheel, followed by other units without a driver, braking, accelerating, and performing evasive maneuvers at the same time
- As a result of self-driving technology, the composition of the workforce of logistics companies will inevitably change. The current large-scale logistics business will operate with a smaller workforce, as there will be no need for drivers, at least not on this scale.
- The composition and role of transport participants are changing, and new activities are emerging or disappearing. New activities emerge from the replacement of tasks performed by the driver by A. I include the online management and tracking of shipments, the operation of online certification systems (CMR, transport documents, invoice, customs). The new process will involve significant digitization, IT development, and manpower.
- Reductions in fuel costs are due, among other things, to favorable changes in external factors affecting consumption, such as the driving technique and the route chosen. Maintenance costs are also reduced, as electric vehicles have a much lower chance of failure.

- A significant increase in the cost of transport equipment is expected. Due to the high cost of transport, only large, capital-intensive companies can initially invest in self-driving vehicles, which may result in small companies being pushed out of the market in the initial stages of the technologies' introduction.

The research summarized the changes and effects expected with the introduction of self-driving technology. It also highlighted the obstacles to its introduction and drew attention to the changes generated by self-driving technology, which we can prepare for and the transition of which we can manage.

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