Controlling In The Logistics of Transport of Autonomous Vehicles and Devices

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Abstract

In the article, we analyzed in detail the environment of autonomous vehicles and device, from a general and logistical point of view, we evaluated their advantage / disadvantage, we examined the use of this technology in practice and evaluated what procedure to maintain in their use. Logistics companies have long been trying to automate their processes and use autonomous vehicles and device to transport various products, semi-finished products, raw materials and other things. In recent years, there have been great technological advances in this area and their popularity is growing (Industry 4.0, Internet of Things, and others). Thanks to the rapid development of autonomous control technologies such as sensors, camera systems, wireless communications and software, autonomous vehicles, device and virtual assistants are becoming more accessible. There will be more and more vehicles and device with autonomous functions in transport and distribution.

Keywords: Autonomous transport. Artificial intelligence. Logistics. Management. Management Assistant. Autonomous device. Automation. UAV. ADAS. ADS. AND IN.

Introduction

As our customer requirements for delivery by a logistics company grow, such as delivery time, the topic of the use of autonomous vehicles and device in logistics is becoming more and more topical and is also related to current technological trends. The main goal of the article is to evaluate the use of technology, based on the knowledge gained in our analysis. We begin with an analysis of the environment and the perception of autonomous vehicles and device by the general public. The work includes an analysis of the logistics environment from the point of view of autonomous vehicles, defines the advantages and obstacles of implementation. The thesis contains important findings and facts from the field of logistics of autonomous vehicles and device, contains conclusions from case studies concerning the use of autonomous vehicles and device in logistics. We solve its current application and its direction into the future. From this knowledge, we will take an expert opinion and propose a recommended strategy for companies.

AV technologies are beginning to appear in our company thanks to the gradual technological development and implementation of modern autonomous systems into ordinary commercial vehicles. These technologies in conventional cars and device are used to reduce the number of accidents, help with various activities in logistics, or directly help people (Choi and Ji, 2015). For example, autonomous vehicles are preferred for their greater comfort when traveling, especially on long distances. The main driving force for the development and implementation of autonomous systems is their ability to detect and repair, or completely eliminate human factor failures such as fatigue, inattention, emotional control such as anger, stress, fear and the like. According to the National Highway Traffic Safety Administration (NHTSA report), these

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reasons result in up to 94% of all accidents. From the point of view of driving system automation, the international standard SAE J3016, we know five stages.

The first stage - the driver's assistant - is a state in which the driver-driven vehicle in its device provides intelligent auxiliary functions. In this case, ADAS can perform smaller sub-tasks than brake / accelerate in case of danger, or keep the vehicle in the lane - not both at the same time. Second stage - partial automation have vehicles that can, under certain conditions, such as danger, combine acceleration / braking functions with steering the vehicle. The driver controls the vehicle all by himself for the remaining time. The third stage - conditional automation is the state of the vehicle with the ADS system. The vehicle can perform all its driving under certain conditions, during which the driver must constantly monitor the surroundings and be ready to take control of the vehicle back and drive it himself. The fourth stage - high automation is a state of autonomy, in which the ADS system performs the control of the vehicle itself and at the same time monitors the surroundings. Under some conditions, it may prompt the rider to take the lead, which is only recommended to monitor the surroundings. Fifth stage - full automation is an autonomous vehicle in which the ADS performs all control functions. The human element is no longer a driver, but rather a passenger, and in addition to its own will, it will never be involved in the driving process.

This division is also interesting from the point of view of autonomous devices when we can use a similar principle, the logic of things and apply it in the logistics of the industry as such. Scientific theories about the effects of a possible full transition to autonomous vehicles and device in logistics and other industries say that highway capacity could increase capacity by up to 80% for greater driving efficiency, and up to 40% for urban minor roads (XingZhu, 2018) . These conditions could occur after a shortening of the reaction time compared to human, effective braking and starting without creating a traffic slowdown, while maintaining the current traffic regulations. In the case of adjusting the regulation and allowing the reduction of distances, increasing the density of cars, adjusting the speed limits, mutual communication between cars and the like, the road capacity of vehicles could be increased by up to 270% (Tientrakool et al., 2011).

Autonomous vehicles environment in logistics and companies

The transport of goods or people plays a prominent role in our economy and daily life. The global economy faces several key challenges, such as the growing importance of sustainability, uncontrollable population growth, globalization and technological innovation. These trends directly affect the existing structures of the logistics industry and have an impact on the state of its operational activities (Fritschy, 2019). Especially with increasing globalization, transport services are becoming more and more important. Globalization not only increases the transport of goods, but facilitates the division of labor and enables the development of new technologies around the world. The negative consequence of this situation is also the impact on the environment. Increasing road density has an impact on increasing CO^2 emissions (Veen-Groot and Nijkamp, 1999) With increasingly stringent carbon regulations, it is in the interest of logistics companies to prioritize transport solutions that are reliable, efficient and produce significant levels of CO^2 emissions. Autonomous vehicles and device and their use in logistics can improve each of these shortcomings. They are not a new phenomenon, but one of the most disruptive innovations of today (Wyman 2017). Since the Industrial Revolution, we can see constant progress and growth in production and logistics processes, limiting the failure of the human factor by trying to fully automate all processes and make the entire production and supply process as efficient as possible.

One of DHL's logistics companies already in 2014 published their perspective on the implication of AV in the logistics process. They emphasize the advantages of these vehicles, which they use in a controlled environment such as warehouses, logistics centers and the like. The company has been recording positive results with this technology for a long time and expects benefits from them in other sectors of operation. Autonomous vehicles and device will have a positive impact on the costs of logistics companies, primarily in terms of the cost of compensating for human-caused damages, while solving the long-standing problem of long distances, which are extremely difficult for the average driver. The results obtained from test-runs of Google cars (Poczter, 2014) show a significantly lower risk than ordinary average drivers, either due to the fast reaction time or, as a rule, better safety device of these vehicles and device. Based on the analyzed studies, we can identify the following opportunities and barriers associated with the entry of autonomous vehicles into the logistics process:

- Improving safety (Koopman and Wagner, 2017) A conventional intelligent autonomous vehicle is safer in traffic than a vehicle driven by the average driver. Therefore, when applying AV, companies would be able to save on fees for compensation for the transport of material. When comparing safety in humans, we have to take into account several factors - age, experience, eyesight, etc. When implementing AV, we can exclude all these variables from the process and only take care of updating the latest software.

- Reducing Transportation Costs (Kaddoura, 2020) Reducing transportation costs, along with vehicle price, is the most important factor in deciding whether to procure autonomous and electric vehicles, according to a University of California survey (Howard, 2014). Fully autonomous vehicles are technologically advanced and often electric

vehicles, compared to the cost of petrol / diesel, as a Scottish case study clearly demonstrates energy savings throughout the year, mostly in the summer. (Milev, 2020)

- Environmental impact (Igliński and Babiak, 2017) A full reduction in exhaust emissions has a positive impact on the environment compared to the combustion of biofuels (Milev, 2020). In the case of constantly tightening EU laws, the latest up to 55% emission limit by 2030 (European Commission, 2020), it is an investment for the company in the future.

- Careful use of vehicles (Rödel, 2014) Careful use of vehicles consists in eliminating shortcomings in the mistreatment of a vehicle, where it can be used carelessly due to the driver, fuel or the like and can cause damage over time that will require service. A joint study by an Italian university presented the results of how AI is constantly running diagnostic tests in cars, comparing the results with its / online database and learning lessons from driving (Ullah, 2020).

- More efficient use of human resources (Claude, 2020) After avoiding the need to employ drivers, the company can more efficiently use free human resources, or funds for free human resources, for any needs.

High development and security costs are the most common and represent the biggest barrier. Companies have long been aware of the potential of this technology, but the complexity of the problems causes them to be in the background for even longer. Other obstacles that prevent logistics companies from introducing autonomous vehicles and device and thus replacing the old ones are:

- Regulation and legislation (Coca-Vila, 2018) Laws concerning the implication of AV are the biggest obstacle to their use and spread in society on a large scale. In both the EU and US laws in this case hardly know the exception (NielsenIQ, 2020), the rule of ownership applies - that is, if the car against the rules of the road and causes damage to property or health, the owner is responsible. In the case of the company, it is even very demanding, so logistics companies are not very involved in this sector.

- Software security (Yan et al., 2013) The analysis reveals many cyber dangers associated with intelligent autonomous cars. Those like any such device may contain a lot of sensitive personal data that is misused. In addition to the attack on personal data, the analysis also mentions attacks on sensors and shows successful attacks on Tesla car sensors. Magnetic intelligence sensors, which, for example, can detect surrounding objects, can be attacked and disabled by attackers. Such an attack could cause fatal traffic damage and even in the event of averting an accident can permanently damage the sensors.

- Social and ethical barriers are various prejudices that accompany cars without the need for human driving. The negative attitude of ordinary people and legislators is slowing down. It is important to realize that the point and power of increasing confidence in car driving algorithms lies in their constant improvement and demonstrating progress over ordinary drivers. (Smith, 2019) A study carried out for Nielsen Global Media (NielsenIQ, 2020) suggests that despite awareness and rough knowledge of technological advances in vehicle autonomy, future generations (now 8-18 years old) would still prefer to drive in the future. the vehicle itself (more than 60%). However, current estimates of the future state are that by 2035, up to 75% of vehicles will be autonomous.

- The last important issue is unacceptable infrastructure. Artificial intelligence is often programmed to drive a car with infrastructure in ideal conditions. Unfortunately, this is often not really the case, and old paths, for example, are often narrower than modern regulations, lacking lines, horizontal marks, and other features that AI can take into account. (Gopalswamy and Rathinam, 2018) Quality infrastructure is therefore certainly an important point for reliable driving, on the other hand, we must also count on programming the AI for worse conditions than the ideal ones.

Examples of autonomous vehicles in logistics

DHL is the best example of using AV, albeit at an ever-increasing level. In its 2020 report, it describes their use, sectors and results. In the last two years, their AV has been slowly leaving the warehouses and premises of logistics centers. (DHL, 2020) They state that they consider autonomous trucks to be able to reduce delivery time and operating costs. At the end of 2019, their autonomous truck drove a load of butter from California to Pennsylvania and covered a route longer than 4,500 km in 3 days. The road was during bad weather, to the races in the snowy areas. Similar transport would normally take about 9, in the case of accelerated direct transport 5 days. However, they state that a large number of tests and especially the standardization of rules and regulations will be needed so that this transport can fulfill its full potential for the logistics industry.

The "Last-mile Delivery Rover" is a novelty that they started two years ago and started using more actively during the Covid-19 pandemic. A small autonomous delivery rover that does not use roads but sidewalks can deliver orders over short distances has proven to be a useful thing at this time. Even at this point, they emphasize that due to strict laws and regulations, it is unfortunately not possible to use these devices more extensively. Almost every major car manufacturer has stated that it is actively working on AV development, including Audi, VW, Mercedes-Benz, BMW, Ford, GM, Toyota, Volvo, Renault, or Tesla (Meldert and Boeck, 2014), not just cars, even lorries. These are the most important in logistics. Unfortunately, there are not many successful examples of adaptation so far.

As early as 2005, Komatsu launched the development of the Autonomous Haulage System (AHS), which was used in a carbon mine in Chile. This system consists in the autonomous removal of coal from the mine and back, in specific geographical areas, implemented in 2008. It is one of the first implementations of an unattended autonomous system in logistics and is still used today. (Kotas AHS, 2020).

Furthermore, in 2016, Volvo and Daimler completed a test week of autonomous driving of their autonomous truck across Europe. Volvo is constantly involved in the development of such trucks, in 2018 they introduced their Volvo Vera model (Volvo Vera, 2020).

In 2017, Tesla introduced an electric semi-truck called Tesla Semi, which will be available in limited numbers at the beginning of 2021. (Tesla Semi, 2020) This concept is not completely autonomous. Tesla is aware of the long adaptation of complete autonomous trucks on the road and has a slightly more realistic approach. During its operation, the presence of the driver is required, but he only supervises the operation. It focuses more on the stable market of trucks, attracts in comparison with conventional models with its technologies, comfort and the like.

Until recently, Starsky Robotics (tarsky Robotics, 2020) has been focusing on the development of autonomous trucks since 2015. In 2016, they came up with the first American street-legal truck to be involved in the logistics process on the road without a person behind the wheel. However, the company ceased operations after 5 years.

Examples of autonomous devices – UAV

This way of using UAV device, drones, is a very current topic in logistics and overall represents a trend not only for large distribution companies but also for small businesses or end customers. However, this technology has several advantages but also major limitations in terms of legislation. Of course, distribution via UAVs has very great potential, especially for transport companies, because in this way it is possible to deliver goods many times faster than conventional methods, and also with much lower transport costs.

According to the authors Jakub and Tomáš (2016), it will be necessary to create air corridors within which UAV facilities will move so as to minimize the probability of a collision with an obstacle. The use of special sensors will ensure the early detection of obstacles and thus allow them to fly independently. These technologies already exist in reality, but the mass deployment of these devices, especially in densely populated areas, is still limited by national legislation. It is only a matter of time before the use of UAV device for transport and logistics becomes an everyday part of life. The question is when it will be, as the main criterion for implementing such a solution is first and foremost the safety of people.

The use of UAV devices in this way has certain advantages (Gonzalez et al, 2016; Yao et al, 2019; Ampatzidis and Partel, 2019; Shakhatreh, 2019; Mozzaffari, 2016; Jakub and Tomáš, 2016; Jankal and Jankalova, 2016; Varmus et al., 2018; Dorcak et al., 2015; Dorcak et al., 2017):

- The first advantage can be the transport of small consignments to hard-to-reach places, without compromising the safety of the transported cargo and being able to meet deadlines effectively.

- There is a large space for use in warehouses or industrial areas, where UAVs would have an adequate amount of room for maneuver. These drones can thus replace the human factor and handle items in stock more efficiently.

- Another advantage can be the transport of various objects and aids, which can be very useful e.g. in saving human life. Examples of such deployments include the use of UAVs in the medical industry, humanitarian aid, assistance in various natural disasters or epidemics. The UAV device can more effectively reach the required location, such as lifebuoy device, defibrillator transport, communication device transport, and others.

- In the business industry, it can be used for food and beverage delivery services in restaurant services. This mode of transport has been tested several times in China.

- The future of UAVs may also lead to possible uses for the transport of people, property or things. Although this mode is severely limited by legislation, it is currently banned in most countries, but it is likely that this mode of transport will be improved and used in the future.

Discussion and Conclusion

To form the basis of this issue and its future application, we will be based on an analysis of current knowledge. The direction and development of autonomous vehicles and device is a topic of the present. From the results of an extensive Delphic scenario study for 2040 (Fritschy and Spinler, 2019), it is possible to examine the assumptions, direction and development that autonomous vehicles and device will await. The results show that the use of autonomous trucks in the logistics process will bring a significant competitive advantage over companies that do not address this sector. The gradual increase of autonomous vehicles and device will improve the collection of data for their subsequent optimization, during which we will see better connectivity and transparency in the distribution and transport logistics network in the future. We can expect transport and transportation logistics operations to run without human intervention. They will respond much more dynamically to customer needs. They will also regulate the number of vehicles and means of transport on the roads, which will result in not only better infrastructure but also lower transport costs.

Why should businesses and company direction consider autonomous vehicles and device?

From a technological point of view, autonomous vehicles and device are currently experiencing the development and growth of this technology sector. It was not long ago that we saw them in scientific journals as concepts, and today vehicles with level 3 autonomy commonly operate in industry and commerce, or as consumption by the end customer. Autonomous functions are appearing in increasingly available vehicles and device and are becoming a sought-after part of all activities of the human world.

An interesting and very valuable advantage in terms of environmental friendliness and cost reduction is the non-use of emitting fuels (petroleum products). In this case, it is not entirely appropriate to compare the average price of diesel with the average price of electricity. It is true that diesel for trucks can be cheaper than ordinary, but electricity is also cheaper for large companies. The calculation in this case really depends on where you are, what kind of energy supplier you have and so on, the calculation is only rough and indicative: The average truck, according to EU statistics, consumes 29.9L of diesel per 100 km. The average price of diesel during the year 1.118 (28 Average price of diesel for 2019) In this case, we will pay 33.42 euros per 100 km. In the case of Tesla Semi it is 1.12 kWh / km (range 850km, battery 950kWh). If the price of electricity for large factories is € 57 per MWh (29 Average price of electricity for production plants for 2020), which is certainly the large logistics centers, then the cost per 100 km is € 6.8. This represents a € 26.6 saving per 100 kilometers.

This is only part of the amount saved, which will be reflected in the company's costs. The following are the salaries of drivers, dispatchers, etc. Of course, some service of the logistics process is still envisaged, so the controller must properly optimize the level between the number of redundancies due to redundancy to minimize costs and the number of others operating the new system to be sufficient for full functionality and avoidance of collapse. However, the correct use of the connectivity of autonomous vehicles for the subsequent operation of the logistics system will represent a significantly smaller number of people. If the system is of high quality software, it will also regulate itself after collecting data from vehicles. This can "deprive" the managers themselves or controllers of their jobs. They would naturally move from the position of directly influencing the logistics process to the consulting position in its programming.

What prevents companies from thinking about autonomous vehicles and device?

One of the starting points preventing the use of autonomous devices and vehicles is their application itself. He mentions DHL, which is still considering the introduction of these technologies due to road traffic laws and regulations. It is obvious that, with such considerable advantages, logistics companies would have long ago implemented autonomous vehicles and device on the road much more. They therefore use autonomous vehicles and device much more in closed conditions than on public transport channels and the public. Legislative amendments need to be adopted for the greater application of autonomous vehicles and device, and in particular the most important ethical / social barriers need to be broken.

The current workforce and the jobs derived from it - employees who would be affected by these changes - are also a problem. A large number of jobs in this area would suddenly more or less disappear and a mass of people would have to lose their jobs. It would be necessary to develop retraining and find new jobs for these employees before the introduction of autonomous vehicles and device takes place. Many countries are beginning to consider taxing this and similar automation, such as robots in the automotive industry. (Davenport, 2019; Hittmar et al., 2015; Zrakova et al., 2017). Because it is precisely because of these facilities that the state loses money that can be allocated elsewhere - for example, to create new jobs.

We examined the current use of this technology in practice and evaluated what procedure to maintain in the planned use. We have come to the conclusion that the industry has long been ready for the application of autonomous vehicles and device, but full and mass introduction will not take place until the ethical and social barriers to this technology are addressed. We suggest being prepared for this change. Businesses should invest in the development of this technology over the long term in order to have a competitive advantage in the future and slowly test it in small quantities on an ongoing basis.

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