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## THE INFLUENCE OF SELF-DRIVING TRANSPORT VEHICLES ON THE FIELD OF LOGISTICS

### Abstract

The demands for transport are presently at quite high level. There are few transport branches which are used now, but in fact the road transport is the one used most. Transport actions are ought to deliver goods from point A to point B, and thus they influence the goals of logistics referred as 5R. Providing the right resource, in right place, on the right time, in right cost and in right quality, depend mostly on transport services. Using of the autonomous technology in transport allow to achieve better results in the field of logistics services. The purpose of this article was to present the benefits of autonomous transport and its influence on the logistics. Theoretical considerations were summarized with conclusions, which may become during the deliberation about the usage of autonomous transport vehicles.

**Keywords:** logistics, autonomous technology, autonomous vehicles

### Introduction

In a very simple way, logistics actions goal is to ensure the right resources for enterprise to enable the production of goods or services. One of the key activities of logistics is the transportation process, which aim is to deliver resources to enterprise and of course finished goods for the final client. In that way, it is one of the most important elements of logistics service. Transport is a crucial thing as it influences every goal of the 5R rule<sup>1</sup>. Right now, the road transport is the most popular branch of transportation on the whole world (Łacny, 2008).

<sup>1</sup> 5R rule as the purpose of the logistics which is providing the right resource, in a right place, right time, with the right quality and right cost.

As the transport processes are important it is quite valid to improve them, as it might lead to improvement of the logistics service. One of the possible ways to make transport better is autonomous technology. This relates to the purpose of the article which is to indicate the positive aspects of autonomous technology usage and its influence for the logistics. Article has review character, based on the logistics literature and many internet sites about modern autonomous technologies in transport.

## 1. Transport and logistics

All the human actions require some skills and right resources. Every rational and purposeful require specific materials (resources). One activity will be possible to make when the actions from the field of logistics service are made properly. Mirosław Chaberek defines logistics as a process which aim is to serve every rational activity of human, which goal is to fulfill the specific purpose by providing the right resources in the right spot and time, and in the right quantity and quality, with the right cost, in a way that all activities of accomplishing the main goal are realized in an effective and beneficial way (Chaberek, 2011). The other definition was created by the Council of Logistics Management which states that logistics is the planning process, realization and control of effective of resources flow, along with information in the terms of economy, from the place of origin up to the place of consumption (Coyle, Bardi, Langrey, 2002). On the basis of such definitions it is possible to state that no actions, especially in the field of productions is possible without the logistics service. Additionally, it is important to present the goals of logistics which are per the 5R rule, which concern the ability to ensure (Chaberek, 2002):

- right resources,
- to the right place,
- in right quality,
- on the right time,
- with the right quantity.

In this case the word “right” concern the needs of main process, as it is the main purpose of when, where and in which quantity there will be demand on right resources (fig. 1).

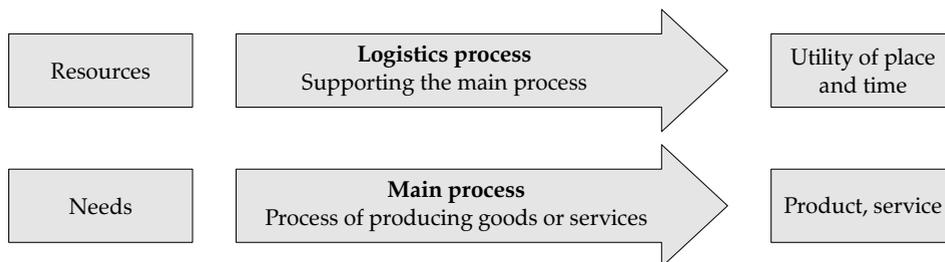


Figure 1. Parallel process of main and logistic process  
Source: (Chaberek, 2002)

One main process may be serviced by one or more logistics processes, per the fact of how complex the main process is and how much resources does it require. When it comes to the goals of the logistics and the definitions it is also important to reveal its two functions which are: integration and maintenance. Logistics activities are crucial aspect when it comes to the integration of resources flow processes. The integrative function has two spheres. One concerns the integration between many processes supporting the main one. This sphere relates to connectors between enterprises which are responsible for various actions within the system of logistics support. The other sphere is about integration between suitable elements of logistics and main processes. Despite the second sphere it is important to maintain right coordination. The purpose of this timing is to control that the right logistics processes support the right main process. The coordination is responsible for the regular course of the production process, and therefore may influence the level of customer service or the prices of final goods (Chaberek, 2002). The other function of logistics concerns the service of main process. It is the essence of every logistics processes, because there are no of them which are servicing. In situation when main process (production) is ought to produce some goods, the supporting process (logistics) must provide all the essentials resources in accordance to the 5R rule (Chaberek, 2002).

Every production or service activity will require the right amount of service from the logistics processes. It is worth to mention that the quality and efficiency of logistics processes will have impact on many effects which relate to main process such as: quality of the final goods, cost or time of production. In that way, it is important to understand the value of integrative function of logistics. Jan Długosz claims that logic relations are main purpose of modern logistics (Długosz, 2000). Such opinion should be complemented with the fact that logistics activity is conscious and purposeful. It relies on the realization of specific goals, using of appropriate technical, infrastructure, organizational and legal means, while using at the same time selected methods through the activities of relevant logistical process engineers. Overall these actions and means are specified as logistics support system (Chaberek, Karwacka, 2009). Specified logistics support system allows to act and use the specifics techniques and means which allow to achieve the goal of ensuring the right resources to carry out the main process. Logistics support system (LSS) consist many components which are to support the course of main process. The actions which takes place within LSS starts with choosing the technique of production, determination of the size, up to the utilization actions of used goods. In a shortcut, it is possible to designate the main actions of LSS (Chaberek, 2002):

- providing of necessary equipment, machines and devices,
- providing the access to the required maintenance services,
- providing all the resources.

All the actions of LSS which are necessary for the production highlight one of the very important activities of LSS which is transport. The transport processes relate to the physical movement of the goods, people or waste. This activity is directly responsible for the situation when the specific goods or resources must be delivered for right place in right time. The actions from the field of logistics in

transport concern most of all the decision about the right branch of transport in accordance of what should be moved. In such case the decision about the branch of transport may affect indirectly the time, quality and the cost of transportation, so it is possible to state that transport affects all the purposes of the logistics (5R) (Chaberek, 2002). The choosing of way of the transport, technology of loading and unloading and the protection of the commodities during the movement will determine, how effective the logistics purpose will be fulfilled. In long time range it will influence the quality of the final goods, price of availability for the final clients. The transport actions are also one of the biggest costs from the overall logistics costs, so it is important for these actions to be done as efficiently and effectively as possible.

## 2. Self-driving vehicles in logistics

Autonomous vehicles, or in some cases the vehicles which do not require the presence of the driver existed in many thoughts and plans of automotive industry, even in the 50s of 20 century. Despite many of technological limitations, this idea was developed up until now, where we can for the first time present the fully autonomous vehicles. Self-driving car were defined as vehicles which do not require the direct actions of human such as steering, accelerating or braking (NHTSA). Per the institution of National Highway Traffic Safety Administration, in autonomous truck the driver is not obliged to observe the road for the whole time during the "auto-pilot" mode. Of course, the definitions are clear in a fact that such vehicles are not automatic driving cars, which relates to the fact that the drivers should be present in the cabin of the car or truck. Presently the technology is so advanced that vehicles may transport things on chosen routes without the activity of drivers. First of the real used autonomous trucks were presented in United States within the mines (Pauvre, 2016), and some of them can be legally used on chosen routes with some of the states (Kostecka, 2016). Such examples can be also found within the Europe, such as convoy of autonomous truck within the European platooning challenge held in 2016 (Budzeń, 2016). Every of the experimental routes granted positive outcomes in way of: greater safety, lesser usage of fuel, faster and more efficient performing of transport processes. Safety of the driver and transported goods is a crucial thing, when it comes to the fact of providing the resources in right place on the right time, and in right quality. Some studies show that 90% of accidents are caused by the human mistakes. When it comes to the autonomous trucks, they have better reaction time, and many algorithms which adjust the steering of the vehicle for the weather conditions, by steering the vehicle smarter and safer than humans, and eliminating the fatigue (Bosch-Studie, 2012). Usage of the autonomous driving cars may also reduce the number of vehicles on the roads which can affect the lesser negative influence on the environment. In addition, the more efficient steering of the vehicles is characterized by lower fuel consumption, which stands for less cost and less negative impact on environment (Kückelhaus, 2014). Better performance of the autonomous vehicles in comparison to the "regular" ones may be achieved by the system of internal communication between them,

what allows them to avoid the congested roads, and to adjust the speed within the convoys. Such actions indicate the savings of around 15%. Additional barrier is the work time of the drivers, which could be eliminated by usage of autonomous vehicles, adding the savings to the overall level of 40% (Kückelhaus, 2014). It is also worth of mention that in case of autonomous vehicle the driver becomes the passenger, who is involved in steering only in some parts of the journey, and for the rest of the time he or she can do something else. Such examples of benefits make one to reflect, and point out the positive implications for logistics, as a way of providing the resources in accord to the 5R rule.

Usage of the autonomous transport system does not need to be limited only for the long roads. Such technology may be also used for the improvement of internal transportation of enterprises. Usage of advanced sensors and specifically programmed algorithms of GPS for the warehouse devices. Vehicles which are used in warehouses, based on autonomous system are good not only for the transportation of materials but also for loading, unloading and completion of orders. These systems influence on the improvement of safety and efficiency of warehouse processes. Many of devices can move within the warehouses, causing no danger for working people and predicting their routes to be faster and more efficient. Such example could be the Knapp cart vehicle (*KNAPP Logistics Automation Open Shuttle AGV*, 2013). It is of course one of many examples, and the others are adjusted to the size of warehouse and other needs. The popular forklifts were also upgraded with autonomous technology (balyo.com). From autonomous palette carts up to system overlays, which are meant not only to move the goods from point A to B but also automatically identify pallets or goods, for the work within the warehouse to be made faster, more efficient and safer, without any goods damage. Such improvements allowed the creation of special devices which automatically collect the specified goods and transport them or even unload at the chosen point. In a large scale, such devices make all the warehouse operations easier and allow for them to be conducted faster. These examples were proven and effects of use are: better safety within the warehouse and improvements in making such processes. Autonomous vehicles can improve also the outdoor warehouse processes. They are used within the yards, airports or harbors. Many of the vehicles in such places are a threat for people working there. Autonomous technology used in these places proven more level of safety, less damaged cargos and faster conducted processes of loading and unloading (Kerner). In the airports or harbors, special vehicles were used for the transportation of containers, which can be exemplified by the container terminal in Altenwerder in Germany. Container movement in this place is almost whole automatic, conducted by 87 driverless vehicles. Such solution granted faster movement of cargos, and improvement of effectiveness of container terminal (*SCA – Preventive maintenance at the world's largest container terminal*, 2009). Like this, there are also vehicles used in big airports granting similar improvements. When it comes to the improvement of loading and unloading processes, it is essential not to forget about long distance road transportation. Road transport is one of the most popular transport branches, which are used because of its high availability, well developed infrastructure and big level of flexibility. This is one of the biggest part

of transport when autonomous technology may be used for improvements. Such system can affect the safety of the drivers, the cargo and the whole time of transportation. Right now, the usage of fully driver-less vehicles is not allowed, but in many places, there were made tests in which driver was present only in the first truck of convoy. Such actions were limited to the driving on the highways and expressways, both in the USA and Europe. Used technologies allowed to get results, such as reduction of the crashes, reduction of the fuel consumption of 5–10% which relates to the costs of transport services (Green Car Congress, 2014). As the final stage of providing the right resource for the client in accordance of 5R rule, is the stage called “last-mile transport”, which is delivering the goods or resources directly to the client or enterprise. Plans are to develop new system which aims to help the delivery for people. Such system is planned to have vehicles which are used for delivery services and will inform about the need of another loading or, these vehicles will do such thing automatically. Collection stations are now also popular. They are based on autonomous technology. It is possible to grant Polish example which is “Paczkomaty”, which allow us to collect our goods at the right place and time for us. The plan is, then in the future such parcels will be small enough to move from place to place, when someone wants to receive the goods. Such thoughts are to provide faster and more efficient process of providing the right resources along with the right price (Kückelhaus, 2014).

Given examples are the real source of possible benefits of using the autonomous transport vehicles. Right now, we have so many improvements for logistics, and positive effects of using such technology, despite technological and law limitations. In the future, it is very likely that we will have first routes which will be meant only for the autonomous transport, making the services for 24 hours in every day, to provide the right resources per the 5R rule.

## Conclusions

The autonomous vehicles will be the part of another industry revolution in the future. Usage of the autonomous transport, and in the future the automatic transport will change the outlook and functioning of many human aspect of life. For sure it can be stated that this form of modern transport will affect logistics. Right now, we can only ask questions “when” the autonomous vehicles will be commonly used. Autonomous transport as a part of logistics support system is very important part of logistics services. Providing the right resources according to the 5R rule, when using autonomous transport may be done faster, more effective, without any worries about the cargo, and without any mistakes during the loading process, at exact moment of demand. Autonomous vehicles are also connected with less costs for the service, what allows the enterprises for further development to be able to provide goods and services. Among many benefits of autonomous transport within the logistics service, it cannot be forgotten about some problems of moral and law issues. If such vehicles are ought to function without driver participation, who or what will be responsible in case of any crash. There are many dilemmas

about safety on the road when it comes to the autonomous vehicles, even despite the fact of testing and researches proving better safety on the roads. The moral and law responsibility can be the cause to write another article. Right now, usage of autonomous vehicles results in only positive effects, and improves the logistic services.

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