

## TRENDS IN AUTOMATIC LOGISTIC SYSTEMS AND LOGISTIC MARKET IN SLOVAKIA

### Augustín Stareček

Institute of Industrial Engineering and Management, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Jána Bottu 25, 917 24 Trnava, Slovak republic, [augustin.starecek@stuba.sk](mailto:augustin.starecek@stuba.sk)

### Milan Bachár

Institute of Industrial Engineering and Management, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Jána Bottu 25, 917 24 Trnava, Slovak republic, [milan.bachar@stuba.sk](mailto:milan.bachar@stuba.sk)

### Natália Horňáková

Institute of Industrial Engineering and Management, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Jána Bottu 25, 917 24 Trnava, Slovak republic, [natalia.hornakova@stuba.sk](mailto:natalia.hornakova@stuba.sk)  
(corresponding author)

### Dagmar Cagánová

Institute of Industrial Engineering and Management, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Jána Bottu 25, 917 24 Trnava, Slovak republic, [dagmar.caganova@stuba.sk](mailto:dagmar.caganova@stuba.sk)

### Helena Makyšová

Institute of Industrial Engineering and Management, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Jána Bottu 25, 917 24 Trnava, Slovak republic, [helena.makysova@stuba.sk](mailto:helena.makysova@stuba.sk)

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**Abstract:** The paper focuses on innovation in the field of automated logistics systems oriented on increasing the efficiency, safety and performance of industrial enterprises in Slovakia. Majority of new trends in logistics are based on the Industry 4.0 concept, which is focused on increasing the competitiveness of industrial enterprises. The development of the industry in Slovak republic resulted to the increased demand for warehouse space. Dynamic development of the industrial sphere in Slovakia also leads to the increased demand for qualified labour. The authors of the paper analysed new trends in automated logistics systems such as autonomous vehicles, AGV systems and hybrid modules for AHV vehicle. Mentioned facts are also evident by the analysis of logistics warehousing development and the need for the logistics workforce in Slovak republic.

## 1 Introduction

Logistics belongs to the basic every day and most important activities of each industrial enterprise. The main role of logistics is to move material or different products from point A to point B with the aim to make relocation the most efficient [1]. If enterprises want the individual relocation activities to be as effective as possible, the enterprises must ensure that selected activities will have the shortest possible time, right quality and, last but not least, the lowest cost [2]. The effort to implement advanced, stockless production systems, such as Just in Time, place increased demands on logistics. Based on the mentioned reasons, the importance of shortening the time of shipment, keeping the schedule of loading and unloading is increasing. It means higher demands on the volume of goods transport between Slovakia and abroad [3].

The warehouse logistics is characterized by the fact that its implementation is connected to considerable financial resources of the enterprise. At present, it is necessary to innovate the production process and one of the possibilities of the innovation is the concept Industry 4.0. This concept Industry 4.0 can be considered as an instrument of competitiveness. The biggest issue in the maintaining of

the production process is the skilled labour. According the mentioned reasons, it is necessary to address the implementation of innovative methods into the business's practice with the regard to the personnel assurance of the production process [4].

## 2 Analysis of the current state of labour force and logistic market in Slovakia

Due to major demographic changes, longer average life and lower birth rates, the European labour force will be with higher age average in the next years. Older labour force presents up to 35 % of the working-age population in many European countries. In the next decade, the European Union will increase the share of older labour force in industry by up to 15 % [5]. Industry in Slovakia constantly develops with constant demand for a qualified labour force. In the next three years, the Slovak industry will need more than 45,000 employees [6].

The Slovak secondary schools and universities provide a number of graduates, as much as labour market needs, but the structure of graduates does not correspond to the requirements of the enterprises. In the automotive industry, there is currently lack of 14,000 employees with the

required qualification. That is the reason why the automation and the support for intelligent/smart technologies in enterprises in Slovakia is more than necessary to keep enterprises competitive [6].

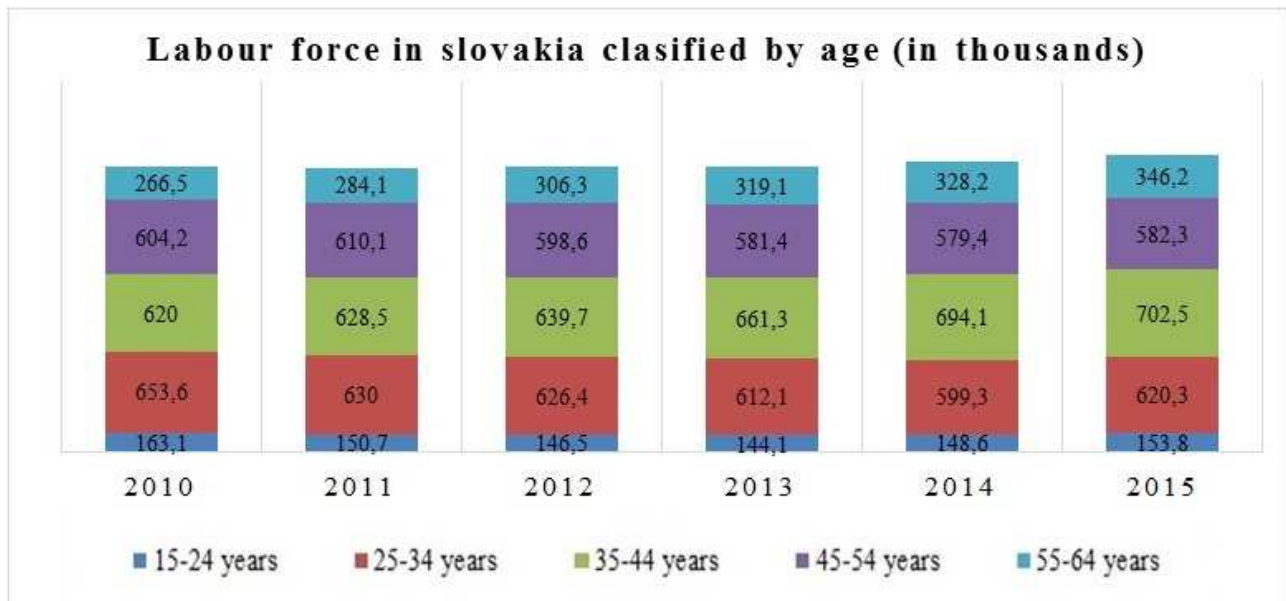


Figure 1 Labour force in Slovakia clasified by age [7]

Figure 1 shows an increase in the number of men and women employed in Slovakia. To compare the year 2010 and 2015, in 2015 more than 79,000 women and men aged 55 to 64 were employed. The group of employees (aged 55 to 64) will be in retirement age over the next ten years. Within the European Union, as a result of the aging of the population, 15 % of the labour force will be in the age of 55 to 64. It will be up to 21 % in Slovakia. According the above mentioned, the employers should already think about the creating the right conditions for the work of an aging population [7]. The implementation of concept Industry 4.0 into industrial practice will not reduce the need for skilled labour force. Enterprises also have to start to analyse the age structure of their employees. The awareness of the Slovak industrial enterprises about active aging of the population is low and is often misinterpreted [8].

### 2.1 The analysis of the logistics market in Slovakia

According to CBRE (advisory group), the development of warehouse space in 2016 helped to provide another 147,685 m<sup>2</sup> of logistics and warehouse space in the total Slovak stock at 1.67 million m<sup>2</sup>. In the last quarter of 2016, four warehouses with space of over 52,000 m<sup>2</sup> were built in the market, the largest one was built for Volkswagen Slovakia, a.s.. The Figure 2 shows the offer versus demand in the logistics market in Slovakia over the reference period [1].

From the Figure 2 results it is evident that there is an increased demand for warehouse spaces in Slovakia in recent years. The mentioned fact was caused primarily by

the development of industry in the industrial areas of Western Slovakia. In addition to a compacted network of industrial enterprises, it can be stated that demand is also affected by a good road network connected to Austria, Hungary and the Czech republic. The drop in demand and offer of warehouse space was recorded mainly during the economic crisis (year 2009). Nowadays the demand for warehouse spaces is almost two times higher than the offer [10].

Automotive manufacturing company Volkswagen Slovakia, a.s. with developers Prologis and CTP are the largest warehouse companies in the Slovak market. The mentioned trio owns almost half of all Slovak warehouses, especially in the surrounding areas as Lozorno, Senica, Nitra, Trnava and Devínska Nová Ves, where it is currently the largest potential in development not only in the industrial area, but also in the field of warehouse logistics. Almost 400,000 m<sup>2</sup> of land contracted by the tenants, up to 2/3 of the area was formed by the new enterprises. The largest transaction according to CBRE was the rent of the land to Faurecia in Lozorno. The entry of Jaguar Land Rover to Nitra, with a planned start of production in 2018, caused that it is necessarily needed to build a large number of logistics warehouses for subcontractors of Jaguar Land Rover. In addition to the development of industrial areas around the Volkswagen Slovakia, a.s. in Bratislava and Jaguar in Nitra, the new industrial properties will be added to Dubnica nad Váhom, where the developer wants to build 70,000 m<sup>2</sup> of warehouse space. Across the Slovak Republic, the number of projects with a total volume of 130,000 m<sup>2</sup> is expected, of which most of them are already contracted. The estimates of warehouse occupancy from

the years 2016 and 2017 are that the newly built warehouse areas will be fully occupied and the demand for new warehouse areas will be still high. The implementation of

new trends in logistics made the warehouse management more efficient (examples: reduction of the extensive travel time or increased picking productivity) [9].

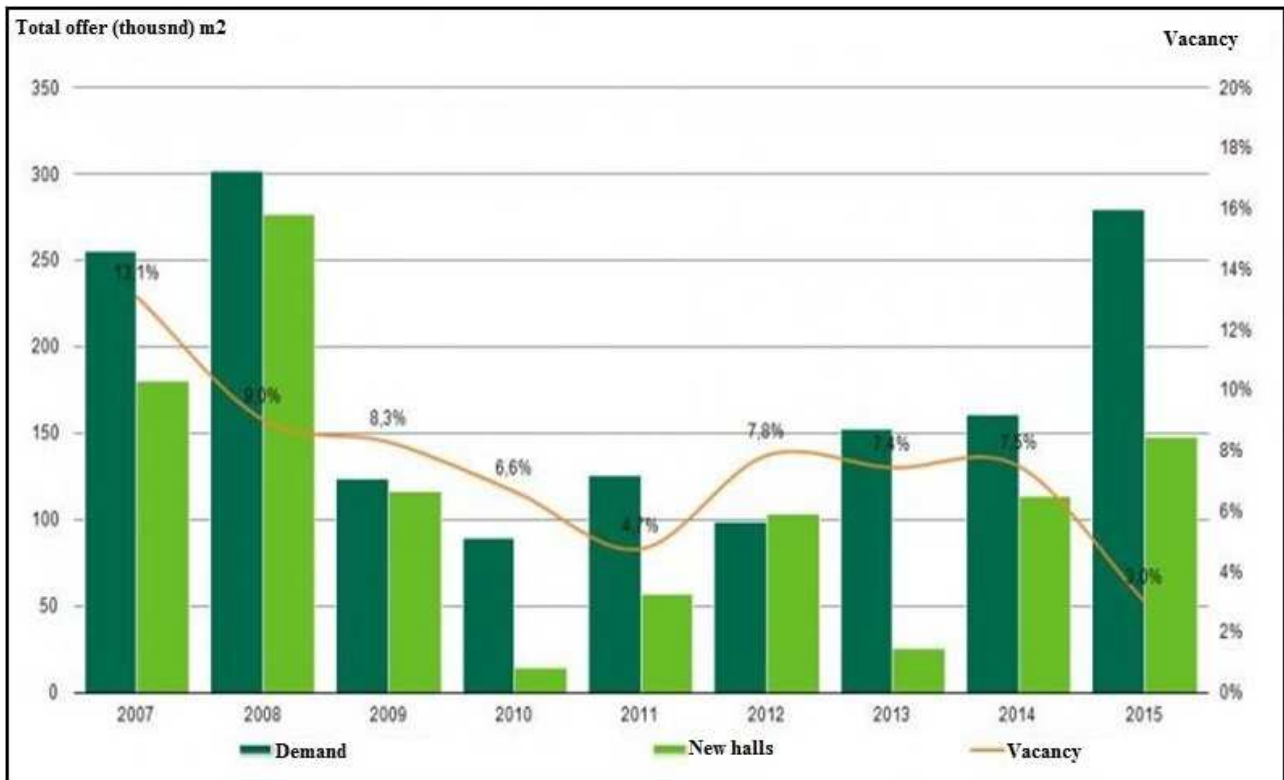


Figure 2 Offer versus demand in logistics market [9]

### 3 Trends of automatic logistic systems

Great competition on the global market, including Slovak republic, pushes the enterprises to constantly increase the performance and achieve the best competitive position against the rivals. International cooperation in industrial sectors is conditioned by the quality of logistics and the ability to import components and distribute the products from the production and warehouses. Currently, the trend of rapid reduction of input costs, i.e. increase of the profit plays a key role in the Slovak and Czech enterprises [11]. Supply logistics management is unsystematic, inefficient, ordering of material is intuitive in many Slovak and Czech enterprises.

The mentioned current characteristics of the supply logistics is linked with other issues in production. The main issue of supply logistics is to set the level of the inventory in order to meet the two opposing requirements - prompt fulfilment of customer requirements and associated increase in inventories and costs and the minimizing the value of input warehouses. The implementation of right management system will allow to achieve cost reductions, increase utilization of machines and employees, improve production planning and management system, increase productivity, and thus to have better economic indicators of the enterprise [12].

#### 3.1 Automatic logistics system in the context of Industry 4.0

In the literature, there are several definitions that describe the term Industry 4.0. The concept can be also described as a revolution, whose main task is the informatisation of production and logistics technologies within the machine-machine data exchange. The result of the 4th industrial revolution are smart factories that will be flexible, reconfigurable, efficient, ergonomic and directly linked to the customer, including subcontractors. In general, the 4th industrial revolution is characterized by the following six creative principles [11]:

- Interoperability: the ability of cyber-physical systems to interact with each other and the possibilities for mutual communication of people and intelligent factories through the Internet of Things and the Internet of Services,
- Virtualization: the building of a virtual form of intelligent factory by collecting and connecting data from sensors,
- Decentralization: the ability of cybernetic-physical systems to decide about the own proceeding within the intelligent factory,
- Real-Time: ability to aggregate and evaluate information in real time and provide immediate outputs / solutions,

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- Service orientation: the providing services via Internet of Services,
- Modularity: the flexibility of intelligent factories to changing requirements by replacing or expanding the individual parts/modules.

All above mentioned six principles of concept Industry 4.0 were considered in designing Automated Guided Vehicles (AGVs). The role of an automated logistics system is to deliver the required material in the correct quantity and quality to a predetermined location at a given time. The logistics process puts the emphasis on

management of logistics processes and limitation of human factor faultiness [11].

There are complex solutions consisting of multiple modules for automatic supply of workplaces and production lines. The AGV automatic logistics system consists of a vehicle and various types of peripherals, such as automatic roller conveyors, e-frames, gravity wagons and a control system. Thanks to the wide modularity of AGV vehicles and their peripherals, the AGV system offers several levels of automation [11].

(1) The first level of automation means simple replacement of manually driven vehicles for the AGV vehicles with accessory (Figure 3).



Figure 3: The first level of automation [11]

(2) The second level of automation means replacement of the manually driven vehicles for the AGV vehicles + peripherals (Figure 4).



Figure 4: The second level of automation [11]

(3) The third level of automation represents replacement of manually driven vehicles for AGV vehicles + peripherals + control system (Figure 5).



Figure 5: The third level of automation [11]

The market offers a wide range of complex modular solutions for automated supply of production lines. As a basis for automated supply of production lines with material, enterprises can apply the AGV logistics system, which consists as mentioned above of an autonomous logistic vehicles and various additional peripherals such as a hydraulic module, automatic roller conveyors, gravity wagons and etc.. By using the technical devices automation in logistics does not end. For greater complexity, the industrial enterprises can also use other automated devices such as a lifting - rotation device or a handling device (example: devices for handling the pallets) [12].

The combination of the above mentioned technical solutions and devices allows to create an efficient and efficient automated logistics system that reflects the trends of an already existing the 4th industrial revolution. These types of innovations in logistics, as well as in the manufacturing area, bring time and cost savings but also the ergonomic solutions for handling the loads [13]. The advantage of autonomous technical and technological solutions is the modularity which increases the flexibility in the implementation of logistics systems to the conditions of industrial enterprises.

### 3.2 Innovation of AGV system for automation of industry logistics

In order to consider technical system as competitive, it must meet several basic parameters such as [15]: meet customer requirements, be affordable and reliable. The AGV Automatic Logistics System offers a comprehensive solution for the automation of logistics processes in industrial enterprises by using the automated drawing of the wagon with material on pre-defined route by autonomous logistic vehicles in industrial halls. The mentioned system results in increased automation and productivity while lowering the logistics costs and

ensuring increased security provided by sensors and cameras. In order to supply robotic and automated workplaces by automated supply system, it is necessary to create a modular system with easier adaptation to manufacturing, robotic workplaces or assembly line [14].

A comprehensive modular solution is capable to provide various levels of automation, according to customer needs [13]. CEIT Company offers a wide range of different modules that are able to adapt to demanding customer requirements at a high level of robotization of workplaces. The individual solutions and modularity options of offered technical solutions are shown in Figure 6.



Figure 6 Addition modules for AGV vehicles [13]

One of the main advantages of the AGV system is its modularity, which constantly develops and transcends its entire structure. Elements of a modular system such as a vehicle, a peripheral and a control system are just basics. In developing each of the three basic building blocks, it is important to keep the idea of modularity as much as possible. To keep the main idea of modularity, AGV can be used in any industry sector. The AGV are limited only by meeting the company's operational parameters. The vehicle as a basic part of the modular system has several additional modules and modifications serving for various

ways of connecting the cargo within the logistics flow during the production process [13].

### 3.3 Importance of AGV vehicles in logistics

An autonomous logistic vehicle is a device that meets the function of transport motor vehicle without operating personnel to transport the material by wagons or various transport modules. Vehicles are driven by electrical energy and most often driven by a magnetic tape located on the floor. Based on RFID (Radio Frequency Identification) tags, the vehicle can determine the route, speed, stop, or

communicate with the control system to manage the autonomous system. The role of the system is to manage complex situations, junctions, preference in driving and etc. [14].

The automatic plug-in and disconnect module with the reverse module (Figure 8) extends the operational capabilities of each compatible logistics trailer. The combination of these two features allows the trailer to change the direction of move by retrieving data from the RFID tag and automatically connect load located outside the direct route and consequent automatic disconnecting. Reversing in the designated areas can be used not only to connect the load, clear the route, but also to automatically connect the logistics trailer to the docking station. The automatic connection and disconnection module has the following features [15]:

- Automatic connection and disconnection of wagons based on RFID tag information,
- Module providing reverse mode at the designed areas to maintain the highest possible level of the health protection of the employees and material,
- Connections which are proceed outside the direct route. It is needed to reverse to the place which is allowed by the additional reverse module,
- Safety during the reverse process is provided by crash strips,
- Maximum reverse speed is limited to 0.25 m / s.



Figure 8 Hydraulic module of logistics trailer [13]

The hydraulic module has the following features [13]:

- The possibility of connecting the peripherals that require connection of hydraulic circuits,
- Control of connection or disconnection commands using the RFID tags or manually one,
- Possibility to connect single-acting or double-acting hydraulic systems,
- Hydraulic system connection using a quick joints,
- Possibility to connect up to 4 peripherals.

The modular system of autonomous logistics trailers allows customers to use the logistics system exactly with regard to their needs and to the degree of required



Figure 7 Automatic plug-in and disconnecting module with reverse module [13]

Another option to extend the automation of logistics trailers is a hydraulic module that enables the trailer to control various types of peripherals with a hydraulic system. The logistics trailer equipped with the hydraulic module (Figure 8) fulfils the function of an autonomous trailer capable to pull the wagons and mobile conveyors equipped with a hydraulic system. To ensure the mentioned operations, the trailer must be equipped with a hydraulic unit, the relevant software and connections for interconnecting the hydraulic system with peripherals. Peripheral control is performed automatically by data retrieved from the RFID tag on the trailer track. It is also possible to manually operate the peripheral directly from the display on the trailer [13].

automation. Autonomous logistic trailers and their modules, such as automatic connection and disconnection with the reverse module or hydraulic module are successfully implemented in several enterprises where the automation and efficiency of logistics processes is successfully increased [15].

#### 4 Conclusion

The interest of warehouses and logistics halls increases in Central Europe. Ten years ago, investors could choose only from 4.6 m<sup>2</sup> of warehouses and logistics halls in Central Europe, today it is almost 18 million. In 2014, more

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than 1.4 million m<sup>2</sup> of logistics areas were built in the region, which is slightly above the average of the decade and slightly more than the total amount of industrial area in Slovakia at the present. The Figure 9 shows vacancy rate of warehouse spaces in middle Europe. It is clear that demand grows and the vacancy of warehouse spaces decline significantly [16].

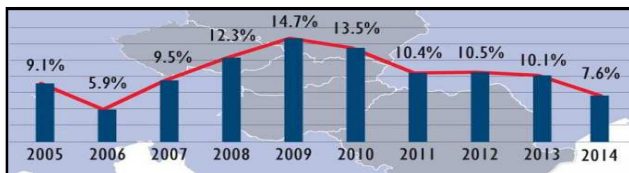


Figure 9 Vacancy rate of warehouse spaces (average of middle Europe) [7]

It can be stated that in Slovakia the vacancy rate is up to 4 %, the average of Central Europe is twice as high. The level of vacancies has decreased compared to previous periods [17].

Intelligent/smart technology in industry and logistics in context of the concept Industry 4.0 is a relatively new concept that entered the market in the last few years. The options, as well as the possibilities of using the technologies, are still partially limited. The lack of skilled labour force and the financial difficulty of implementation into corporate practice are the main limitations [7]. The impact of new trends on the logistics market in Slovakia is evident. In the last two decades many industrial enterprises and warehouse spaces were developed. Despite the fact that industrial enterprises try to eliminate stocks of materials and finished products, production without stock is still not possible. The implementation of new technologies into the warehouse management along with the development of the economy allows the construction and efficient use of warehouse areas. Automated logistics technologies in the field of storage result in the elimination of human element in storage processes.

One of the negatives in implementing the concept Industry 4.0 is the fact that there is lack of qualified labour force. Another negative factor is the aging population and the issue of resolving the aging labour force when it is necessary to involve the personnel assurance of the production systems to solve the situation [18]. The analysis shows that the demand for warehouse areas still increases. The mentioned fact is caused by efficient use of warehouses not only for their primary storage function but also for the consolidation activities. Production and crossdocking warehouses create the main space for implementation of automated logistics systems.

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