This is sample of how the thesis should be my topic is "Indian companies Sustainability by green logistics initiatives"

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Master's Thesis

The importance of packaging management in the automotive industry

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Preface

The automotive industry is one of the sectors most frequently surveyed by logisticians. It's not without reason. Although logistics as a science began in the military, where war strategies were closely linked to logistics planning, it was the automotive industry that developed it in the industrial sector. The Toyota Production System based on such a popular Just-In-Time concept, Kanban cards or minimising losses, waste or variability is one of the best known techniques and methods for improving logistics processes. It can certainly be said that most, if not all, companies apply at least one of the components of its system. The automotive industry is a very interesting research area also due to its complex structure. One car consists of several thousand parts, so several hundred suppliers must provide them. In order to eliminate unnecessary connections in the supply chain, many management strategies have been developed, such as concentrating suppliers in one industrial park or pulling semi-finished products as finished components, which already consist of several other parts. A car is a very expensive product, so the customer requires it to be adapted for him or her. In order to achieve that, possibilities need to be expanded by the company. This generates additional stock in components and further costs related to the transport of them. It also generates larger production range. The automotive industry has found strategies and methods such as Build-to-Order. Car and component factories have to deal with many contradictory objectives such as minimizing stock without any possibility of production downtime. Line downtime is a huge cost that other industries do not have to deal with. Time itself is extremely important in this area, which is why logistics plays such a huge role in this particular sector.

Packaging, in turn, is a much undervalued area of logistics. Although packing materials are known to be an integral part of logistics, in practice they are often overlooked or their role is undermined. They are very often treated only as an ancillary measure that is not necessary for the production of the product. This is true, however, packaging is just as important element as any component that comes into the final product. Although the product will not be created without raw material, it will also not leave the plant without packaging. Containers, pallets or cartons are both a means of protection and an element that enables its transport. In the case of packaging in the industrial sector, the flow of packaging is systematised and standardised. Very often their change to another is a means to improve the efficiency of the flow or the transport, storage or production process. The juxtaposition of slightly underestimated packaging in

logistics with the automotive industry, which is one of the most popular research topics, is an interesting comparison that can prove the importance of packaging in logistic.

This work aims to show the importance of packaging by presenting how many logistical processes are related to it. This will be presented through a description of the processes taking place in the XYZ plant as well as through the scope of responsibilities and the way of performing the tasks entrusted to the packaging specialist. This will allow the reader to trace the role of packaging and its impact on the company's current processes and costs.

In the first part, the scientific basis is presented in the form of a definition of packaging and its classification, as it provides a groundwork for delving deeper into the further stages of the work. The same chapter also describes the importance of packaging in logistics and directly in the automotive industry. The second part of the work presents the specificity of the automotive industry and the current condition of it in Poland and worldwide. This will allow to present to the reader the largest automotive concerns, their share and importance on the market. The most important suppliers in the industry will also be presented. In the same chapter will be presented solutions and logistics concepts in the automotive industry that enable the efficient flow of components, products and cars. The third subchapter will describe Japanese methods supporting production and logistics processes, which help to support the efficiency of flows and processes within each companies.

The practical part was developed on the basis of research and direct interviews with employees of automotive companies who wanted to remain anonymous. The first chapter of this part of the work describes the importance of packaging in logistics processes on the basis of an example of a company contractually named XYZ. The first part of this chapter is to present the type of packaging in the industry. The second subchapter presents the label as an element of packaging and its importance in logistics processes. The third subchapter allows to understand the role of internal packaging in the logistics processes of the company. The last chapter presents the roles and responsibilities of the person who is responsible for packaging management in XYZ Company. The main elements of this person's work are the preparation of packaging proposals, packaging instructions and many other activities related to the introduction of a new product into production, which is described in the first subsection. One of the most important, if not the most important task is to ensure that the company keeps an adequate level of packaging stock. The manner and description of the activity is presented in subsection two. The last part of the work describes how packaging cost is calculated, which significantly affects the profits of the production plant during the project.

1. Characteristics of packaging

Packaging may be seen in many different ways. Most see them as an aid to transport and production. Supply logistics sees it as one of the components, production as the last element added to the final product, the warehouse in turn sees it as its main product because it hardly ever sees the final product itself. As is well known, the packaging is an element that protects the final product from damage and allows for its further manipulation and transport. Although the essence of packaging can be presented in a few sentences, there are many definitions, and the classification method is very extensive. The chapter below attempts to present the most important theoretical points regarding packaging - their definitions and divisions, which will form the basis for further parts of the work.

1.1. Definition of packaging and its classification

The first, one of the most important definitions that can be presented is the one found in Polish law. The Packaging and Packaging Waste Management Act of 13 June 2013 defines packaging as a product, including a non-returnable product, made of any material, intended for storage, protection, transport, delivery or presentation of products from raw materials to processed goods.[1] Packaging is not always presented as an object. Some call it the whole coordinated system in which a product is prepared, where the main purpose is to ensure its safety but also to create the possibility of effective transfer, transport, distribution or subsequent retailing, recovery and subsequent reuse or disposal.[2] The traditional approach can be seen in the definition coming from the Polish law, but many people now understand the package as a tool to help encourage the customer to buy the product and achieve greater satisfaction with the goods.[3] Packages can be marketing tools now, and they are no longer merely seen as a protective material.

The definitions show the essence of packaging, but they describe it in a very general way, which is why it is so important to classify it because it completes the definitions themselves. In Tomasz Jałowiec's book can be found the division of packaging as below:

[1] http://www.przepisy.gofin.pl/przepisyno,2377,94857,42,42,20160101,2,1.html (access on: 12.12.2019)
[2] T. Jałowiec, *Towaroznawstwo dla logistyki wybrane problemy.* Difin, Warszawa 2011, p. 129
[3] M. Löfgren, L. Nilsson, *Kano's Theory of Attractive Quality and Packaging in the Quality,* „Quality Management Journal" 2005, Vol. 12, No. 3, p. 9

Table 1 Method of packaging division according to selected criteria

Division criterion	Types of packaging
Function	• Transport • Bulk • Unit
Material	• Paper and cardboard • Glass • Metal • Wood • Plastics • Textile • Ceramics • Composite packaging
Construction form	• Unit packaging (partially or completely) covering the product • Transport (partially or completely) covering the product
Form of trading	• Packaging sold • Packaging rented
Method of use	• Disposable packaging • Reusable packaging
Property criterion	• Own packaging • Foreign packaging • Leased packaging
Forming methods	• Packaging formed directly for production • Packaging formed before the product is placed in it
Means of contact with the contents	• Direct packaging • Indirect packaging
Possibility of environmental protection	• Packaging that degrades naturally • Packaging that does not degrade naturally

Source: Own elaboration based on T. Jałowiec op. cit. p. 129

The most important thing in the case of packaging is its functions and as it was defined above we can divide it into transport, bulk and unit. This also represents the three-stage packaging scale, because the unit packaging in which the product is directly placed could be packaged in bulk packaging. It in turn can be placed in or on transport packaging e. g. pallets.[4]

Another criterion of division is the material of which the packaging is made. These can be natural resources such as wood, paper or ceramics. Not very popular types of packaging are those made of fabric. Very common in turn are multi-material packaging made of at least 2 different materials. The connection between them must be durable enough that they cannot be separated by hand or by simple mechanical methods.[5] As early as the 1990s, it was said that the most popular packaging material was plastics made from various types of polymers. They

[4] A.M. Jeszka, *Rola opakowań w technologiach logistycznych*. In: J. Długosz (ed.), *Nowoczesne technologie w logistyce*, PWE, Warszawa 2009, p. 232.

[5] https://www.ekocykl.org/aktualnosci/437-najnowsze-interpretacje-dotyczace-opakowan-wielomaterialowych (access on: 12.12.2019 r.)

replace those made of metal or glass. Their main advantages, which prevail over other materials, are their lightness, cleanliness, shock resistance, total sealing capability, and many other features.[6]

Packaging is also divided into disposable and reusable packaging. The first type is cartons and pallets produced by the company concerned or purchased from the supplier. Reusable packaging is a container or pallet that may belong to a particular company, customer or supplier or be hired from a logistics operator. This also represents another way of dividing category - by ownership. Today there are many ways to manage packaging. Some people stick to the disposable packaging system because it is very easy to manage (though also very expensive), others buy the perfect packaging for their needs. Many companies also use the open-pooling system, which is rental of packaging tailored to the manufacturer's needs. The best-known operators who can provide such a system include EPS, IFCO, CHEP, CC, and many others.[7]

Packaging has different functions for different business areas. Based on that, packages are selected and evaluated. Bearing in mind the 3 main aspects - logistics, marketing as well as the environment - it is worthwhile to present these most important ones:

Figure 1 Basic aspects and functions of packaging

Source: Own elaboration based on G. Jönson, *Packaging Technology for the Logistician. 2nd Ed,* Packaging Logistics, Lund University, Sweden 2000, p. 68

As shown in the figure, one of the most important logistical functions is simply to distribute and transport the product itself. Protecting this product is also very important. Plastic

[6] S. Solovyov, A. Goldman, *Mass Transport & Reactive Barriers in Packaging. Theory, Applications &Design,* DEStech Publications, 2008, p.2-3
[7] M. Tokarczyk, *Systemy zarządzania opakowaniami zwrotnymi,* https://www.log24.pl/news/systemy-zarzadzania-opakowaniami-zwrotnymi/. Date of publication: 15.10.2010

bags, cartons or plastic packaging create a protective wall that prevents environmental impact on the product. This action may be active (external factors penetrate the product) or inactive (the quality of the product is not damaged by contact with external factors).[8] The diagram also indicates that it is the environment - people, the environment, animals - that must be protected from the negative impact of the product. This is particularly important for corrosive or toxic products as well as for explosive cargo. Hence, the many markings and information on the packaging itself and the label. From a logistical point of view, it is mainly about information about the producer, production date or distribution and transport information. From the marketing side, information, colours, symbols are to attract the customer's attention and create a kind of advertisement and present what a given company is. Not infrequently, the packaging itself is a factor that determines the purchase of a given product.[9]

1.2. The importance of packaging in logistics

In order to analyse in depth the importance of packaging in logistics, it is worth to start by defining and explaining what logistics itself is. It has been present in human life since ancient times. Transport planning or inventory management are processes familiar to companies, the military or ordinary people. One of the definitions of logistics was presented by Martin Christopher in his book - „*Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the costs-effective fulfilment of orders.*"[10]

Currently, the market is very dynamic and the competition is very fierce, so companies compete with each other on every level. The product has to be better and cheaper, and the costs of the company's operations are getting lower. This is where the role of logistics comes in, because a very large part of the costs are transport and storage, as well as the duration of the production process. All these processes are influenced by good or bad logistics management.[11]In many plants, although logistics is regarded as an essential element of a company's functioning, it is mainly seen as a support for production, as it is the only area that

[8] R. Cierpiszewski, *Opakowania aktywne i inteligentne*, EUP, Poznań 2016, p. 9
[9] A. Maryniak, *Nowe trendy w opakowalnictwie artykułów spożywczych w kontekście logistycznych funkcji opakowań,* „Logistyka" 2012, No. 4, p. 1117
[10] M. Christopher, *Logistics and supply chain management IV Edition,* Pearson Education Limited, Great Britain 2011, p. 2
[11] M. Kilibarda, M. Andrejić, V. Popović, *Creating and measuring logistics value*, 1st Logistics International Conference in Belgrade, Serbia, 28-30 November 2013, p.197-198
http://logic.sf.bg.ac.rs/wp-content/uploads/Papers/ID-36.pdf (access on: 22.01.2020)

creates measurable value. In recent years, however, there has been a tendency to see logistics as a department that also generates this value in the form of adapting to the customer's requirements, i. e. delivering the product to the customer in the amount, time and quality that he wants and at the same time minimizing the costs of the entire supply chain.[12] The way of choosing packaging, i. e. choosing between returnable and non-returnable packaging, increasing packing density, changing the palletization, increasing the efficiency of management of rented packaging are often used to save logistic costs.

Many scientists call management of the packaging *the packaging logistics*. One of these people is Chris Dominic, defining that as an approach whose main goal is to develop packaging and packaging systems to support and improve the logistics process. The really important point of this approach is meeting customer and user requirements.[13] Starting from the basic assumptions and definitions of packaging and logistics, another definition can be created. Logistics is all about planning, implementation and control. Packaging, on the other hand, means protecting, securing, promoting the product and containing information about it. It is also, in a way, a source of further profits (if an appropriate margin is imposed on it). Based on these assumptions, packaging logistics according to Saghira[14] is "the process of planning, implementing and controlling the coordinated packaging system of preparing goods for safe, secure, efficient and effective handling, transport, distribution, storage, retailing, consumption and recovery, reuse or disposal and related information combined with maximizing consumer value, sales and hence profit."

The main pillars of packaging logistics are also defined: defining technical and aesthetic requirements, adapting the coordinated structure of the appearance and shape of the packaging to the new products, and adopting a system for assessing the impact of all packaging on aspects such as customer assessment, global costs, sales or environmental impact.[15]

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[12] S. Rutner, J. Jr. Langley, *Logistics Value: Definition, Process and Measurement*, "The international journal of Logistics Management" 2000, Vol. 11, No. 2, p. 78

[13] C. Dominic, *Packaging Logistics Performance and How to Evaluate the Packaging Performance by Applying the Tool Packaperforma*. Conference: 17th IAPRI World Conference on Packaging 2010, p. 245 https://www.researchgate.net/publication/269141021_Packaging_Logistics_Performance_and_How_to_Evaluate_the_Packaging_Performance_by_Applying_the_Tool_Packaperforma/link/5495a3d70cf2ec13375b2ade/download (access on: 22.01.2020)

[14] M. Amorim, C. Ferreira, M. Vieira, *Engineering Systems and Networks. The Way Ahead for Industrial Engineering and Operations Management*, Springer International Publishing, Switzerland 2017, p. 140

[15] J. Garcia-Arca, P. Prado, A. T. Gonzalez-Portela Garrido, *"Packaging Logistics": Promoting sustainable efficiency in supply chains*, "International Journal of Physical Distribution & Logistics Management" 2014 , Vol. 44, No. 4, p.30

The most important function of packaging is to be able to transport the product in the safest way for it. Adequate protection, which the construction of the product requires, is the basic criterion for the choice of packaging materials. The company sending the goods can always insure them in case of an accident or damage, but if there is any loss and the packaging was not suitable or the packaging could not protect against the loss, the insurer will not refund the money lost. As stated in the ICC, it is the insured person who is responsible for the proper and safe packaging of the cargo.[16]

However, in a modern logistic approach, the packaging is no longer considered as an auxiliary element, which is only needed to safely send the product to the customer or pick up the component from the supplier. The choice of the type of packaging has a significant impact on logistics costs, which, as previously written, make a large contribution to the price of the product itself. In addition, environmental requirements make defining a container or box no longer a quick and insignificant decision and begin to turn into a planning process that requires strategic thinking.[17] Interestingly, many packaging engineers or specialists do not know all the costs associated with the packaging or deliberately ignore them, which means that the price of the product does not include all expenses incurred by the company.[18] It is difficult to include the price of a polyester tape or an ordinary adhesive tape in the price of a product because it is necessary to determine its quantity per product. Many specialists assume that if a given tape does not cost even 5 PLN, the lack of its addition will not affect the calculations. However, taking into account the expenses of the whole year for this polyester tape through the whole production plant, it may be an amount of over several thousand zlotys and such a cost is already significant. Apart from the cost aspect itself, the choice of packaging affects the efficiency of both logistics and production processes - its speed and ergonomics. The packaging should be designed or selected by a given company in such a way that it best fits into the processes of the packaging itself, it's delivery to the customer, any kind of handling, storage or transport.[19]

The following links can also be mentioned between the change of packaging conditions and logistical activities:

[16] M. Klopott, *Problematyka dotycząca opakowania i przygotowania ładunku do przewozu w instytutowych klauzulach ładunkowych,* „Logistyka" 2003, No. 5, p. 1045
[17] A. Lockamy, *A Conceptual Framework For Assessing Strategic Packaging Decisions*, "International Journal of Logistics Management" 1995, Vol. 6 No. 1 p. 55
[18] D. Twede, *The process of logistical packaging innovation*. "Journal of Business Logistics" 1992, No. 13, p. 72
[19] D. Hellstrom, M. Saghir, *Packaging and Logistics Interactions in Retail Supply Chains,* "Packaging Technology and Science" 2007, Vol. 20, No. 3, p. 201-202

Table 2 Logistics activities related to packaging and their benefits

Logistics activity	Trade-offs
Transportation	
Increased package information	Decreases shipment delays; increased package information decreases tracking of lost shipments
Increased package protection	Decreases damage and theft in transit, but increases package weight and transport costs.
Increased standardisation	Decreases handling costs, vehicle waiting time for loading and unloading; increased standardisation; increases modal choices for shipper and decreases need for specialised transport equipment
Inventory	
Increased product protection	Decreased theft, damage, insurance; increases product availability (sales); increases product value and carrying costs
Warehousing	
Increased package information	Decreases order filling time, labour cost.
Increased product protection	Increases cube utilisation (stacking), but decreases cube utilisation by increasing the size of the product dimensions.
Increased standardisation	Decreases material handling equipment costs.
Communications	
Increased package information	Decreases other communications about the product such as telephone calls to track down lost shipments.

Source: Own elaboration based on D.M.Lambert, J.R.Stock, L.M. Ellram, *Fundamentals of Logistics Management*, McGraw-Hill, Singapore 1998, p. 246

For transport and storage, the most important things are information and to secure the product in such a way that it can be handled without any concerns. Standardisation is equally important because it significantly reduces costs by, among other things, not requiring special equipment to operate it. In the inventories, the author of the table listed the strengthening of product protection because it can protect against the risk of theft and extend the life of such cargo. However, when thinking about annual inventories, it would be worth adding an information point, because improving the quality of information placed on packaging can shorten the time of the whole inventory process.

1.3. Modern packaging logistics solutions in various industries

The most important and cost-effective solution for modern packaging logistics is implementing the returnable (reusable) packaging. Most often these are packages made of plastic or metal. They are suitable for pallets that are also manoeuvrable, usually with Euro dimensions (1200x800) or industrial dimensions (1200x1000). The implementing of such a

solution creates a closed loop between the company and its supplier or its customer. The use of plastic or metal packaging ensures greater safety of goods during transport and storage. The possibility to stack pallets in the warehouse and during transport is significantly increased. Packaging made of plastic or metal has the possibility of stacking from 3 to even 5 pallets on top of each other, while cartons usually do not have this possibility or it reaches 2 pallets on top of each other. The best solutions to the returnable packaging are these that can be foldable. They save space in the warehouse and significantly reduce transport costs, as folding packages usually take up to 3 times less space.[20] Apart from the financial aspect, they are a much greener approach. Flow designs using returnable packaging can be considered a fully sustainable approach that enables reverse logistics. This reduces direct and indirect pollution. This approach also reduces the use of wood and paper. In addition, plastic packaging can be processed into pellets and reused to produce containers.[21]

Active packaging, also known as intelligent packaging is one of the latest and most interesting solutions on the market. Mainly because they are constantly being developed. Their main role is to facilitate communication in the logistics supply chain by providing information on the status of the product. Continuous monitoring of the quality of goods allows to improve their value in the eyes of the customer. Intelligent packaging is not only about packaging materials, but also about systems, packaging machines and modern labels that allow the use of innovative systems that accelerate the identification and receipt of goods in warehouses.[22] Automatic Data Capture (ADC) is a solution for automatic identification and storage of data such as using barcodes. In combination with intelligent packaging, they enable much faster logistics processes. ADC is based on GS1 systems, a set of international standards which aim to facilitate logistics management by identifying packaging and companies.[23] Another equally helpful technology combined with packaging is RFID. It is a system in which I identify a given product through radio waves, which significantly accelerates logistic processes - reception, release, control. His work is based on readers, computer system and chips, which are on the label of a given commodity.[24] This technology can be used not only to identify and track goods.

[20] *Opakowania wielokrotnego użytku dla logistyki*.
https://www.logistyka.net.pl/aktualnosci/item/8298. Date of publication: 19.03.2013
[21] D. Silva, G. Reno, G. Sevegnani, T. Devegnani, *Comparison of disposable and returnable packaging: A case study of reverse logistics in Brazil*, "Journal of Cleaner Production" 2013, No. 47, p. 380
[22] K. L. Yam, P. Takhistov, J. Miltz, *Intelligent packaging: Concepts and Applications*, "Journal of Food Science" 2005, Vol. 70, No. 1, p. R5
[23] A. Kawa, *Systemy automatycznej identyfikacji*, In: J. Długosz (ed.), *Nowoczesne technologie w logistyce*, PWE, Warszawa 2009, p. 76
[24] K. Kocot, O. Łazarowicz, P. Witkowski, *Wykorzystywanie technologii RFID w budowaniu przewagi konkurencyjnej*, „Logistyka" 2012, p. 1057

Many companies also use it to locate and track reusable packaging in the supply chain. This helps in their management because it does not allow containers or pallets that can cost several to several hundred Euros to get lost.[25]

Focusing on specific industries, one of the most interesting areas in terms of packaging is food. It is this part of the market that has forced innovation in packaging and this is the area that most intelligent packaging techniques are used. There are many reasons for that. This is not just a basic measure to protect the product. Many scientists combine inappropriate packaging with food wastage, which is one of the biggest problems in the modern world. The current approach is therefore to create packaging that will reduce such waste. The main points are to create packaging in the way that the food portion is not too large and does not force the consumer to throw it away. The second is to create packaging that will extend the quality of the product for as long as possible.[26] As it is known, food is a product that spoils very quickly so it is required to be properly packaged, transported and stored under certain conditions.[27] MAP (Modified Atmosphere Packaging) technology allows for longer product storage. The effect of an atmosphere usually consisting of carbon dioxide or a mixture of oxygen and nitrogen is used. It allows to slow down the metabolism of aerobic microorganisms. They are responsible for the food decomposition process. The atmosphere in the package can be measured by testing the CO2 concentration. This allows to estimate the freshness of the product and the tightness of the packaging.[28]

An interesting example will be medical devices, which are one of the most sensitive products. Their safety during transport and storage affects the subsequent treatment of many people. If drugs, syringes and other medical products are not properly transported and stored, this can even endanger the life and health of patients. In their case, the requirements for packaging are very strict - the wrapping must be tight, insensitive to temperature, the packaging must be flame retardant, often resistant to pressure, shocks. The ease of identification as well as the susceptibility to create pallet units is also important.[29] Medical packaging is divided into 2 categories. One concerns their sterility because the packaging can be sterile or non-sterile.

[25] R. Angeles, *RFID Technologies: Supply-Chain Applications and Implementation Issues*, "Information Systems Management" 2005, No. 22, p. 52
[26] H. Williams, F. Wikstrom, T. Otterbring, M. Lofgren, A. Gustafsson, *Reasons for household food waste with special attention to packaging*, "Journal of Cleaner Production" 2012, Vol. 24, p.142
[27] A. L. Brody, E. R. Strupinsky, L. R. Kline, *Active Packaging for Food Applications*, CRC Press, Boca Raton 2001, p. 5
[28] M. Cichoń, T. Lesiów, *Zasada działania innowacyjnych opakowań inteligentnych w przemyśle żywnościowym*. „Nauki inżynierskie i technologie – engineering sciences and technologies" 2013, No. 2(9) p. 12
[29] T. Prystacki, *Opakowania dla produktów medycznych*, „Logistyka" 2003, No. 5, p. 34

The second category concerns whether they are reusable or nonetheless disposable. The unit packaging used for individual drugs or medical instruments will therefore usually be sterile and disposable. The most common packages are trays (a combination of PET and medical paper) pouches (made of plastic, highly airtight and sterile) and header bags (packages closed with medical paper, allow for more accurate product description).[30] A packaging that will contain several or more sterile wrappers may already be unsterile and reusable - for example, a plastic container or pallet.

From an ecological point of view, the greatest innovations can be found in a manufacturer who creates packaging with the environment in mind. So Dell is a prime example. He was the first in the technology industry to start using the packaging that is made from plastic waste that is taken out of oceans, rivers and canals and collected on beaches. The company processes the waste and makes packaging for 2in1 Dell XPS 12. The company estimated that in 2017, thanks to them, more than 7 tons of plastic did not reach the oceans.[31] As it is known, creating a sustainable supply chain is one of the most important points of modern logistics management. From a financial point of view, such an enterprise also reduces expenditure on the material needed for packaging. As mentioned earlier, plastic packaging can be converted to granulate so it creates a closed plastic circuit again, which has a positive impact on the environment.

[30] J. Blocher, *The effect of relative humidity on the microbial barrier properties of porous packaging materials used in the medical device industry,* Proquest, Umi Dissertation Publishing, 2012, p 14-18
[31] Dell wprowadza ekologiczne opakowania z odzyskanego plastiku.
https://www.logistyka.net.pl/aktualnosci/item/87980. Date of publication: 10.03.2017

2. Analysis of the automotive industry

As it was mentioned earlier, the automotive industry is a source of ideas and logistical concepts. The well-known Just-In-Time principle in logistics forces parts manufacturers as well as automotive companies themselves to continuously improve their processes to protect them from mistakes, delays or unnecessary costs. The automotive industry itself is so dynamic that a temporary stagnation or any inactivity in market activities threatens to result in huge losses or to fall out of business. All these features make the automotive industry one of the most interesting to observe and describe.

2.1. Characteristics of the automotive industry in Poland and in the world

The automotive industry is a huge area that is very often mistakenly narrowed down only to automotive concerns. However, it is not only made up of car factories but also of suppliers of components and accessories for vehicles. Also, there is the trade area and the automotive services sector. However, the most important area of this industry is the logistics chain, which aims to produce and deliver the car to the customer. The supply chain often starts with a 2 or even 3-degree supplier, which produces the basic part, which can be a metal engine component or car window. Then, after one or more stages, the semi-finished product goes to the direct supplier of the car factory (OEM - Original Equipment Manufacturer), which is the central part of the automotive industry. The finished car goes to the international storehouse where it is collected by the local importer or distributor. In the last stage, the car goes to a network of car dealers where it is picked up by the customer.[32]

Following the chronology from the beginning of the supply chain, it is worthwhile analysing the market of automotive parts suppliers in Poland and worldwide. A car is a product consisting of several to several thousand components, so it is logical to assume that several hundred suppliers are needed to make it. At the moment, the biggest car parts manufacturers in the world are[33]:

[32] R. Przybylski, *Charakterystyka i delimitacja branży motoryzacyjnej w Polsce*. In: M. Łuszczak, Ł. Małys (ed.) *Współczesne koncepcje i trendy w branży motoryzacyjnej*, Advertiva. Poznań 2016, p. 37

[33] http://www.egospodarka.pl/art/galeria/50769,Najwieksi-producenci-czesci-samochodowych-na-swiecie,2,56,1.html; https://www.visteon.com/; https://www.zf.com/; http://www.magna.com; http://www.lear.pl; https://pl.bosch-automotive.com/pl/; http://www.densom.pl; https://www.delphi.com/;http://www.faurecia.com; http://www.johnsoncontrols.com/pl; http://www.valeo-poland.com (access on:12.12.2020)

- **Delphi (now Aptiv and Delphi Technologies)** which deals with powertrain and fuel systems, air conditioning, steering and suspension, advanced diagnostic equipment and modern intelligent car systems solutions
- **ZF Friedrichshafen AG** is a manufacturer of power transmission, chassis and active and passive safety systems
- **Bosch** is a manufacturer of brakes, batteries, spark plugs, filters, wipers, starters and alternators, drive belts, sensors and start/stop systems.
- J**ohnson Controls** focuses on batteries, but has a daughter company that manufactures seats and interior fittings for cars
- **Valeo** specializes in power transmission, cooling systems, wipers, car optics and braking systems
- **Magna** producing driver assistance systems and electronic components
- **Visteon** producing mainly automotive electronics such as audio systems and controllers
- **Denso** active in the manufacture of filters, air-conditioning and heaters, starters and alternators, engine management systems (EMS), ignition systems and wipers
- **Faurecia** focusing on car seats and metal seat structures
- **Lear** manufacturing car seats and electrical systems

In Poland, the largest manufacturers of car parts are[34]:

1. **Boryszew** (revenue of PLN 5,64 billion) which deals with production of wires and accessories, production of plastic elements of interiors and visual elements of cars
2. **Bridgestone** (revenue of PLN 2,05 billion) focusing on tyre production
3. **Denso Thermal Systems Polska** (revenue of PLN 1,18 billion) producing cockpits and interior heating elements
4. **Delfo Polska** (revenue of PLN 1,13 billion) producing extrusions and welded elements as well as providing painting services
5. **Exide Technologies** (revenue of PLN 1,10 billion) focusing its activity on car batteries.

[34] *Raport KMPG w Polsce z inicjatywy Polskiego Związku Przemysłu Motoryzacyjnego. Stan branży motoryzacyjnej oraz jej rola w polskiej gospodarce,*
http://www.pzpm.org.pl/Publikacje/Raporty/Stan-branzy-motoryzacyjnej-oraz-jej-rola-w-polskiej-gospodarce3.
Date of publication: 10.11.2017

Important players on the Polish car market are also Federal-Mogul Gorzyce (pistons for engines), Firma Oponiarska Dębica (tyres), Gestamp Polska (body parts), Gkn Driveline Polska (half-shafts) and Brembo Poland Group (discs and brake systems).

What is interesting is that international groups producing car parts have many types of products in their offer. This can be caused by many factors. The most important of these will be many requirements from car manufacturers - continuous pressure to reduce prices, improve quality while producing an environmentally friendly product.[35] The producers are therefore looking for an area where they can stay as long as possible and get as much as possible. They also ensure that if they fail in one area, they always stay on the market. Another reason may be the fact that suppliers very often become more or less involved in designing the car as well as the car production process itself so that the flow is as safe as possible (no risk of stopping production due to lack of a component) and as cost-effective as much as possible (adjustment of the production process, transport, storage between the customer and the supplier to minimise costs on both sides).[36] Thanks to this, the automotive industry is one of the most "friendly" because even though the customers, i. e. automotive concerns, are very demanding towards their suppliers, the cooperation between them is of a partnership character, not dominant one.[37]

Moving on to the pillar of the automotive industry, i. e. automotive corporations with car factories (OEM), it is worth mentioning at the very beginning that every continent or country will have completely different requirements and preferences for cars, therefore the rankings of the most popular cars will be different in the USA and completely different in Japan. Moving from the largest area (global) to the smallest area (Poland), the rankings will look as follows:

[35] D. Johnson, M.A. Johnson, J. Sun, *Integrating multiple manufacturing initiatives: Challenge for automotive suppliers*, „Measuring Business Excellence" 2007 , Vol. 11, No. 3, p. 50-53
[36] J. K. Liker, R. R. Kamath, S. Nazli Wasti, *Supplier involvement in design: A comparative survey of automotive suppliers in the USA, UK and Japan*. „International Journal of Quality Science" 1998, Vol. 3, No. 3, p. 214-220
[37] M. Kruczek, Z. Żebrucki, *Charakterystyka współpracy przedsiębiorstw w łańcuchach dostaw wybranych branż,* „Logistyka" 2011, No. 2, p. 365

Table 3 Ranking of the most popular automotive companies by number of new cars registered.

Miejsce	Globalnie	Europa	Polska
1	**Toyota** - 6 467 781 szt.	**Volkswagen Group** - 3 733 427 szt.	**Volkswagen Group** - 144 523 szt.
2	**Volkswagen Group** – 5 222 428 szt.	**PSA Group** - 2 499 522 szt.	**PSA Group** - 63 300 szt.
3	**Ford** - 4 197 136 szt.	**Renault** – 1 641 156 szt.	**Toyota** - 60 176 szt.
4	**Nissan** - 3 731 626 szt.	**BMW** – 1 033 221 szt.	**Renault** - 51 180 szt.
5	**Honda** - 3 708 195 szt.	**FCA Group** – 1 021 311 szt.	**Ford** - 31 612 szt.
6	**Hyundai** - 3 270 302 szt.	**Ford** – 994 397 szt.	**Kia** - 24 708 szt.
7	**Chevrolet** - 3 035 912 szt.	**Daimler** – 970 187 szt.	**Hyundai** - 22 800 szt.
8	**Kia** - 2 154 452 szt.	**Toyota** – 760 069	**Daimler** - 21 444 szt.
9	**Daimler** - 1 939 664 szt.	**Hyundai** – 543 292 szt.	**FCA Group** - 18 753 szt.
10	**Renault** - 1 933 603 szt.	**Kia** – 494 304 szt.	**BMW** - 17 600 szt.

Source: Own elaboration based on https: //www.pzpm.org.pl/Publikacje/Raporty/Raport-branzy-motoryzacyjnej-2019-2020 (access on: 12.02.2020 r.) . and https://www.auto-swiat.pl/top10-najchetniej-kupowane-samochody-swiata/gc3fewq (access on: 12.02.2020 r.).

It is clear that the largest automotive concern, which is important not only in Europe but also worldwide, is Volkswagen. The concern includes brands such as Volkswagen, Skoda, Audi, Seat and Porsche. In Poland and Europe, the PSA concern is also very important, consisting of Peugeot, Opel/Vauxhall, Citroen and DS. The acquisition of Opel in 2017, which significantly increased its market share, was very important for this concern. At the end of 2019, FCA and PSA announced the merger of the two companies, which will also very significantly increase their market share across Europe.

The success of automotive companies can also be measured by the popularity of models from individual brands. In 2018, the most frequently registered model was the Skoda Octavia (over 21,000 registered cars). In second place was Skoda Fabia (19.6 thousand cars). The third place no longer belonged to the Volkswagen group, but to PSA, because the third most popular model in Poland was the Opel Astra (15.3 thousand units). Then Volkswagen Golf was fourth (14.2 thousand) and Toyota Yaris fifth. The next five are opened by Toyota Auris, followed by Ford Focus, Dacia Duster, Skoda Rapid and Volkswagen Passat. Analysing the entire list of the most popular car models in Poland, undoubtedly Volkswagen is again of the greatest importance on the market - 5 of the 10 most popular models belong to this group.[38]

[38] Raport branży motoryzacyjnej 2019/2020, https://www.pzpm.org.pl/Publikacje/Raporty/Raport-branzy-motoryzacyjnej-2019-2020. Date of publication: 09.08.2019

2.2. Logistics solutions and concepts in the automotive industry

Cars like any product have to be adapted to customers. Initially, when the automotive industry was spreading its wings, the number of equipment variants was small. Companies built their inventories based on forecasts and long-term orders. This supply chain management concept has been called *Build-to-Stock* (also called *Push* strategy). These stocks generated a freezing of money and companies were looking for savings in a lean approach.[39] Currently, there are several to several dozen possibilities to adapt each element of the car to customer expectations. A good example is the number of combinations of equipment options in the Mercedes brand, which is around 6,635,000,000,000.[40] The production of such a number of variants, even for a few cars, is impossible and would create huge inventory costs. Thus, most automotive companies have decided to switch from *Build-to-Stock* to *Build-to-Order* strategy. When moving to a new style of management, companies had to carry out a number of analyses which enabled them to determine the optimal number of product variants which, on the one hand, meet customer's needs and, on the other hand, do not make a company activities unprofitable. This choice had to be made on the basis of a thorough cost analysis (variant pricing), which in turn did not contain any lack of information. Following this analysis and the introduction of a sufficient number of variants in the portfolio, the principle of "cleansing" had to be introduced in order to avoid product cannibalism.[41] The transition to a *Build-to-Order* system has primarily enabled technological development, which has created opportunities to build systems that manage the entire supply chain. For example, BMW spent $55 million on its online ordering system to cut order times by an average of 20 days.[42]

Custom production generates a lot of time and extends the range of components ordered by companies. A good example is the Volkswagen Beetle, where its first versions consisted of 4,893 parts at a time when the latest models already contained around 12,000 of them.[43] For this reason, automotive companies are putting as many components as possible on the standardization and modularization. This means that parts brought to a car factory are not made from individual elements but from whole product assemblies, such as a ready engine or whole

[39] M. Holweg, F. Pil, *Successful Build-to-Order Strategies: Start with the Customer*, „MIT Sloan Management Review" 2001, No 43, p. 74

[40] P. Łuka, H. Woźniak, *Współczesne problemy zarządzania logistyką w przemyśle motoryzacyjnym (cz.1),* „Logistyka" 2012. No. 1. p. 16

[41] A. Szmelter-Jarosz, *Supplier parks and agent-based technologies as efficient solutions for complexity management in automotive industry*, „Transport Economics and Logistics", 2019, *Vol. 78, p.113.132*

[42] H. Meyr, *Supply chain planning in the German automotive industry*, In. H. Günther, H. Meyr (ed.), *Supply chain planning: Quantitative decision support and advanced planning solutions*, Springer, Berlin 2009, p. 346

[43] P. Łuka, H. Woźniak, *Współczesne problemy zarządzania logistyką w przemyśle motoryzacyjnym (cz.2),* „Logistyka" 2012. No 2, p. 16

seats. As far as standardisation is concerned, it is important that as many parts as possible are common to different car models, e. g. hoses, gaskets and other semi-finished products that are not visible on the surface for customer.[44] One step ahead of other car manufacturers, Toyota has created a new TNGA (Toyota New Global Architecture) production philosophy that encompasses the design and manufacture of cars based on a common design for several models. In the future, Toyota plans to launch 5 platforms of different sizes on which it will build the next generations of all its models.[45]

One of the most important objectives of comprehensive logistics management is to create a flexible supply chain. Flexibility can be applied to process, product or volume. In the case of a process, this includes all processes present in the logistics chain, including the supply network. If flexibility is to apply to the product, its adaptation to the customer's expectations must be as close as possible to the end of the whole process, and thus to the customer himself. Volume flexibility is based on negotiations with suppliers to adapt orders to needs rather than full capacity.[46]

One of the ways to achieve the greatest possible flexibility of the system is to create supplier parks or logistics centres. They must be located as close as possible to OEM plants, i. e. car assembly plants. They create the possibility of faster flow of information and goods.[47] This idea was born in the 1990s. of the 20th century. The essence of this concept is to create a certain kind of supplier association that supports its customers (car manufacturers) within a radius of 400 km of the park. This is also called an "intelligent" structure with several to several dozen supplier factories.[48] Creating supplier parks is popular in many industries, not only automotive. For example, Dell, located in Ireland, has this kind of park. Delivery of the finished product to the recipient takes up to 7 days from receipt of the production order. Dell maintains an average stock of 4 hours of continuous operation, and orders are received every 15 minutes on average.[49]

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[44] D. Bennet, F. Klug, *Logistics supplier integration in the automotive industry,* „International Journal of Operations & Production Management" 2012, No. 32, p. 1294

[45] https://www.motofakty.pl/artykul/toyota-nowa-globalna-platforma-tnga-1.html (access on: 24.02.2020)

[46] M. Howard, J. Miemczyk, A. Graves, *Automotive supplier parks: An imperative for build-to-order?,* „ Journal of Purchasing and Supply Management" 2006, Vol. 12, No. 2, p. 92,93,98

[47] J. Miklińska, *Centra logistyczne a logistyka w przemyśle motoryzacyjnym*, „Logistyka", 2012. No 6, p. 879 (CD no. 1).

[48] W. Sihn, K. Schmitz, *Extended Multi-Customer Supplier Parks in the Automotive Industry,* „CIRP Annals - Manufacturing Technology" 2007, No. 56, p. 480

[49] C. Davis, *Inside Dell's manufacturing facility,* „Supply Chain Europe" 2005, No. 14, p. 34

In the case of the automotive sector, Emden, which is dedicated to the Volkswagen factory, is a model example of a supplier park. Good examples are also Audi parks (located in Ingolstadt and Neckarsulm), BMW (located in Leipzig and Wackersdorf), Ford (in Genk, Cologne and Valencia) and Jaguar (Halewood). An interesting facility is the supplier park belonging simultaneously to BMW, Ford, Fiat and Nissan, which is located in Pretoria in South Africa.[50]

Creating supplier parks is a way to improve material flow. However, there is the second most important element in logistics - information. Fast and efficient data flow would not have been possible without such rapid technological development over the last dozen years. Currently, companies would not be able to function without electronic data interchange (EDI). Creating virtual information flows enables software and hardware, which often costs companies a lot, but the savings resulting from the use of this type of technology and the convenience of its application compensate for the costs incurred at the beginning. A fast and flawless flow of information between the manufacturer and its suppliers and customers is essential nowadays.[51] EDI is not the only technological element that enables companies to communicate with their suppliers. Web applications, eBusiness technology and the creation of special websites – automotive portals where the company can contact its customers and suppliers - are some of the most important tools used by car manufacturers. This type of technology enables the combination of purchasing, production, marketing systems and flexible customer service in one place.[52]

The most important tool on which companies base all their work and all processes taking place in the company are ERP systems. More than 3,000 companies in the automotive industry worldwide operate on the basis of the most popular system of this type - SAP. Such systems enable planning, coordinating, supervising the flow of cargo, finances and information throughout the supply chain.[53] Interestingly, these systems never stay the same as when they were implemented in the company. They are constantly adapted, new functions and reports are created so that a specific company and the people working in it can use them as effectively as possible. The only disadvantage of such systems is their lack of mobility. Working in logistics is very often considered to be a 24-hour job because the logistics specialist should be on the

[50] J. Miklińska, op. cit., p. 883 - 888
[51] H. K. C. Pfeiffer, *The Diffusion of Electronic Data Interchange*, Springer, Berlin 1992, p. 104, 105
[52] S. K. Majumdar, M. P. Gupta, *E-Business Strategy of Car Industry : SAP-LAP Analysis of Select Case Studies*, „Global Journal of Flexible Systems Management" 2001, Vol. 2, No. 3, p 25
[53] A. K. Lorenc, M. Szkoda, *Zastosowanie systemu SAP ERP do obsługi dostaw Just-in-Time oraz Just-in-Sequence w branży motoryzacyjnej,* „Logistyka" 2015, No. 3, p. 2884-2886 (CD no 1)

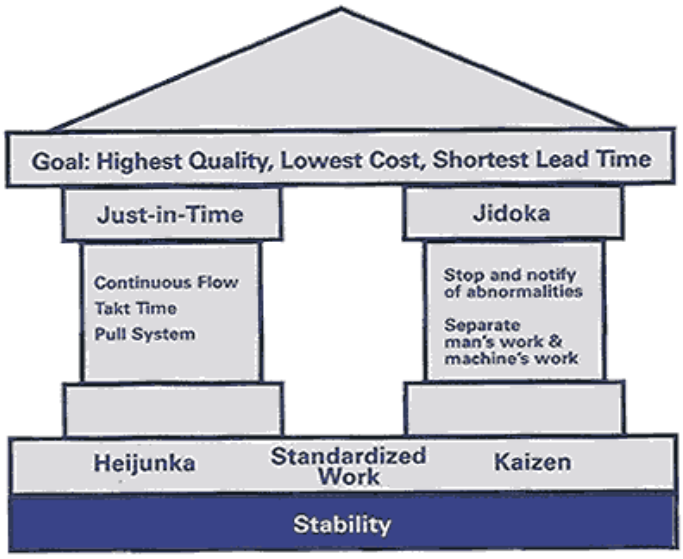
call almost all the time. It would be extremely helpful if the SAP system could operate as an application on the phone, then specialists could solve also system problems without being physically in the office or at the computer.[54] Despite minor shortcomings, without SAP-type systems, nowadays companies with several hundred to several thousand employees would not be able to operate.

3.2. Japanese methods supporting production and logistics processes

Toyota is one of the most powerful - if not the most powerful - automotive company in the world. Their exceptional success is based on a set of principles and concepts which were created in the 1980s. The Toyota Production System is a complex of unique rules that most companies in the market currently apply - not only those in the automotive industry. Interestingly enough, even Toyota's competitors such as GM, Ford or Chrysler quickly started to build on its foundations. However, not everyone managed to implement it in an effective way immediately. Originally, the success of TPS implementation was attributed to the unique cultural characteristics of the Japanese people, but in the end, everyone realized that in order to effectively implement this system, it is necessary to know exactly its fundamentals, principles and reasons for using it, as well as to adjust it and gradually implement it in a given enterprise.[55]

The most common graphic model that shows its scope is the so-called *house*.

Figure 2 Toyota Production System *House*



Source: https://leanmanufacturingpdf.com/lean-production-definition/ (access on: 01.01.2020)

[54] M. Kulisz, *Evaluation of SAP System Implementation in an enterprise of the automotive industry – case study*, „Applied Computer Science" 2018, Vol. 14, No. 4, p. 91

[55] S. Spear, H.K. Bowen, *Decoding the DNA of the Toyota Production System*, „Harvard Business Review". September/October 1999, p. 97

Undoubtedly the most important and best known concept is Just-In-Time. The essence of it is to manage the flow of materials or products in such a way that they are placed at their destination exactly when they are needed, while eliminating unnecessary stocks.[56] JIT is based on several principles that allow for the greatest savings[57]:

o Continuous improvement of quality, thus striving for complete elimination of errors
o To keep stocks only at the level necessary for production or dispatch
o Reduction of lead times by reducing start-up time, queuing length and batch sizes
o Gradual improvement of production operations
o Reducing the cost of compliance with the above mentioned rules

The previously presented drawing of the so-called *house* also shows the objectives of TPS activities. The highest process quality, in the shortest time at the lowest process costs. This is in turn related to the 3M concept, which consists of 3M:

- *Muda* (waste)
- *Mura* (variability, irregularity)
- *Muri* (overload)

Most companies focus on eliminating the first point, i. e. Muda according to a leaning production approach. Taiichi Ohno - the author of the Toyota Production System has indicated its 7 categories. Overproduction will be the first of them and it leads to the second one, which is too much stock. The third is unnecessary traffic, which can generate too long transport, which is the fourth category. This one in turn can generate a fifth which is too long wait. There is also waste in the form of deficiencies and their repair and unnecessary processing which is the last of the seven types of loss.[58]

Currently, the eighth type of waste, i. e. underutilisation of employee's potential, is very often mentioned. The most common example of this is ignoring ideas of workers and not using their knowledge and possibilities. This kind of waste is clearly visible in one of the styles of employee management, namely instructor management, where the employee does not know the meaning or purpose of the task. He has to perform it according to the precise instructions and

[56] Y. Monden, *Toyota Production System. As Integrated Approach to Just-In-Time. , IV Edition*, CRC Press, Boca Raton 2012, p.8
[57] A. Wąsowicz, *Logistyka produkcji na etapie projektowania samochodów*, „Logistyka" 2014. No 3, p. 6621. (CD no. 1).
[58] T. Ohno, *Toyota Production System. Beyond Large-Scale Production*, Productivity Press . Portland, Oregon 1988, p.21

methods of his superior. In theory, the best solution is to direct through objectives, which consists in setting a goal by the head of a given department without methods or information on how to perform a given task. However, the choice of management method should not be permanent or imposed in advance by the policy of the company. Selection of an appropriate management style should be based, among other things, on the competence of employees and managers or based on the nature, scope and importance of performed tasks. Time constraints are also important.[59]

In order to exclude *Muda*, which is a waste resulting in some way also from high stock levels, it is often necessary to order small batches, which generates the second of 3M - *Mura*. It is an irregularity and variability, which is precisely the result of constant rearming and changes in a particular position. Orders in the automotive industry are irregular and difficult to predict so *Mura* cannot be avoided. However, it can be minimized by variability reduction techniques, experiment design (DOE) or even production levelling by production planners. [60]However, it can also be removed but only in the individual activities of operators or specialists by 5S standardisation or it can also be named 5S terminology, which consists of following the 5 principles[61]:

- Sort (Seiri) - Eliminate what is not needed and keep what is needed.
- Straighten (Seiton) - Position things in such a way that they can be easily reached whenever they are needed.
- Shine (Seiso) - Keep things clean and tidy; no refuse or dirt in the work area.
- Standardize (Seiketsu) - Maintain cleanliness and order
- Sustain (Shitsuke) - Develop a commitment and pride in keeping to standards

Muri is the last of the 3M. It means overloading people and machines. It is somehow a result of the 2 previous ones: *Mura* and *Muda*, because the need to correct mistakes or too many unnecessary actions leads to the aforementioned overload. Too fast a pace of work, overtime, excessive bureaucracy or overuse of machines are some of the many reasons that can be mentioned. Like the two previous ones, *Muri* can also be eliminated, but first specialist

[59] P. Sadowski, *Warunki określające kierowanie systemem logistycznym przez cele zadaniowe lub instruktażowe*, „Logistyka" 2014, No. 3, p. 5587-5588. (CD no. 1).
[60] C. Fritze, *The Toyota Production System. The Key Elements and the Role of Kaizen within the System*, p. 6 https://www.researchgate.net/publication/289519018_The_Toyota_Production_System_-_The_Key_Elements_and_the_Role_of_Kaizen_within_the_System. Date of publication January 2016
[61] A. M. Muhmound, *Just in Time (JIT), Lean, and Toyota Production System (TPS)*, Industrial Engineering Branch Department of Production Engineering and Metallurgy University of Technology, Baghdad – Iraq 2014-2015. p 14

responsible for that must carefully observe the work of a person or machine, identify and analyse each of their processes. The analysis can be carried out on production capacity or the manufacturing process itself. In the case of employees, ergonomics, elements of work, working methods or standardization of the work process can be examined. In the case of machines, it is possible to analyse their work in terms of time and movement.[62]

As it was mentioned earlier, *Muda*, *Muda* and *Muri* are closely connected, so focusing on only one of them is the wrong approach. Liquidating one of the 3M will not eliminate the problem but only temporarily extinguishes it. However, this does not change the fact that when someone is looking for a solution to current problems of the company it is worth to start with *Muda* because although the source of complications may be in each of the 3Ms, in most cases it is in waste. In addition, identification of unnecessary processes, work stocks is the easiest way to do it.[63]

It was shown on the *House* picture that one of the two pillars of TPS is Jidohka. This is the possibility that the production line will be stopped by the machine or in the employee when a production problem arises. A golden mean to detect errors before they generate losses is to equip machines and workers with equipment as well as relevant information. The most popular tools that make this possible are Poka Yoke, i. e. techniques and solutions that eliminate the possibility of errors, and Andon, which is a visual way of communication by means of light signals.[64]

Also worth mentioning is the concept of *Genchi / Genba genbutsu* which means "Go and observe". This is the most practical cognitive method because it requires specialists or managers to appear at the scene of the process and observe how it goes. The TPS system or concept was developed by Taiichi Ohno himself, who used this method to train newly employed professionals. They were to observe the process of machines and people, paying attention to all details.[65] It allows any specialist or manager to understand what is happening during the process, what are the flaws in the process, where it can be improved.

Another tool that helps improving the logistics process is *Kanban*. It can be seen as a system or understood as a card accessory. The main task of this system is to control the flow of

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[62] H. Rabakavi, H. Ramakrishna, S. Baligar, *Thorough Elimination Of Muri, Mura And Muda To Achieve Customer Satisfaction,* „International Journal of Innovative Reaserch & Development" 2016, p. 1459.
[63] M. Imai, *Gemba Kaizen, A Common-sense Approach to a Continuous Improvement Strategy. Ed.2,* McGraw-Hill, New York 2012, p. 126.
[64] R. Kumar, R.K. Dwivedi, A. Verma, *Poka-Yoke Technique, Methodology & Design*, „Indian Journal of Engineering" 2016, p. 363-365
[65] M. Jedlińska, Wybrane zagadnienia związane z zarządzaniem przedsiębiorstwem w branży motoryzacyjnej – case studies, In: M. Łuszczak, Ł. Małys (ed.) *Współczesne koncepcje i trendy w branży motoryzacyjnej*, Advertiva, Poznań 2016, p. 187.

materials in such a way as to adjust to the Just-in-Time principle in the most efficient way. The cards mentioned above are a tool that generates a signal to order the flow of products in order to replenish stock levels on the production line. The principle of operation of cards is based on the *Pull* system, which is designed to eliminate shortages, delays, stocks, inactivity, queues, unnecessary control or technological operations and unnecessary movements.[66] In practice, these cards are in the form of a rigid sheet of paper, which is designed to transport the newly created material from one production area to the next in the process. These cards can also be used in cooperation with suppliers. Two types can be distinguished: production cards, where the data needed to start the next stage of production of a given material are available, and transport cards, which give the possibility to move one container, which contains a standard number of components between consecutive production stations. The aim of these cards is to minimize the preparation and completion time of the production process and to standardize the size of a single production batch in order to optimize it.[67]

[66] J. Walasek, *Kanban w branży motoryzacyjnej*,
https://www.log24.pl/artykuly/kanban-w-branzy-motoryzacyjnej,3904. Date of publication 6.11.2013
[67] M. Pałęga, E. Staniewska, Zastosowanie kart Kanban w przedsiębiorstwie przemysłowym, „Logistyka" 2012, No. 6, p. 545-546, (CD no. 1),

3. The importance of packaging in logistics processes based on the XYZ enterprise.

Packaging, although in theory treated as part of logistics, is often neglected in practice. This is due to the fact that it is mainly an auxiliary material for production and not a direct component needed to create a finished product. In order to send the goods to the customer we need the product first of all, but we are not able to transport them if they are not properly secured. Based on a direct interview with employees of the *XYZ* automotive plant, the role and ways of packaging management in the company and in the logistics chain of the company was described. However, the company's employees want to remain anonymous due to the lack of official permission from the production plant to make this data available.

In the case of industrial plants, there are mainly bulk shipments consisting of one or more pallets. Based on this assumption, the most basic product – in case of enterprise *XYZ* the tube - will have to be packed in a cardboard box or a plastic container. If required by the customer, it must also be packaged in a plastic bag to ensure it is clean during transport. The aforementioned cardboard or container must be transported on a pallet that is sharpened or secured with polyester tape. In addition, there may also be corners or a collecting lid if the container is open. In summary, 3 to 5 packaging materials will be needed to secure the product properly.

Figure 3 Sample packaging materials for 1 finished product

Source: https://e-gtp.pl/; https://www.chep.com/ (access on: 12.12.2019)

3.1. Types of packaging in the automotive industry.

Packaging can be divided into two types - returnable (usually made of plastic, metal or wood) and non-returnable, disposable (cartons, plastic bags, and disposable pallets). Returnable packaging is the cheapest solution for most projects if it is assumed that cooperation will last several years. The first solution for reusable packaging is to use the packaging that the customer

has in his portfolio. Corporations such as BMW and Volkswagen have their own containers. Each of these manufacturers has several or more types, which differ in size and material.

Figure 4 Examples of packaging of Volkswagen Group

Source: http://www.1logistics.com.pl/fr/product.xml?category_id=1334253 (access on: 12.12.2019)

At the start of a new project, car manufacturers check whether they have the necessary amount of packaging on the basis of the fixed quantity in the container and the forecast annual demand for the product. If not, they buy the missing quantity. When they make their packaging available, they do so for a fee to the components manufacturers. Suppliers must pay rent for the packaging if it stays more than the number of days specified in the contract. The assumption is that the packaging should only be used for shipping goods - not for storage. This is most often not coincide by the actual use of packaging because every parts supplier has to protect himself in case of fluctuations in order quantities.

Packaging owned by customers is also divided into two types. The first is the packaging supplied on the basis of direct orders from the parts supplier. The person ordering the containers enters the order on the customer portal or does so via e-mail. The second type of packaging is the one delivered to the supplier automatically. The customer provides his supplier with packaging based on his orders. The disadvantage of the first solution is the full responsibility of the supplier for the availability of the containers on site. The disadvantage of the second solution is that it is not possible to do the safety stock and in this case there is a possibility of lack of packaging or excess of packaging in case of last-minute order changes by the customer. Theoretically, it's the client's fault, but in practice it's hard to agree and prove after all.

The second option is for the supplier to purchase part of the packaging for the project. The supplier knows best under what conditions and in what packaging their product should be stored and transported. After designing or selecting the packaging available on the market, the amount of packaging needed for a given project is calculated. To do this supplier needs data such as quantity of products in the package, forecast annual quantity, transport time to the customer, accepted stock in days. The purchase costs of these packages are included in the price

of the product that will go to the producer so that the cost incurred for the containers will be refunded during the project.

The third option is to use the services of logistics operators who make their packaging available for a fee. The most popular suppliers of such packaging are CHEP (dedicated packaging supplier for Opel or Ford) and GEFCO (dedicated supplier for PSA and Jaguar).

Figure 5 Examples of CHEP's packaging

Source: http://www.chep.com (access on: 12.12.2019)

Figure 6 Examples of Gefco's packaging.

Source: pl.gefco.net (access on: 12.12.2019)

These suppliers have small packaging (e. g. 400x300x150 mm) boxes, metal or plastic containers, as well as pallets and lids. Their portfolio is huge, which enables the supplier and the customer to have different possibilities. The cost of packaging is incurred in the form of rental – Both the supplier and the customer pays it. Rental is calculated after the number of days specified in the contract (usually between 3 and 5 days). The amount of rental costs is related to the price of each package, e. g. in case of KLT 600x400x280 packaging it will be about 0. 3 Euro per 1 day, while for a plastic container with dimensions 1200x1000x480 the rental will be 1 Euro per day.

The choice of the type of packaging - whether it is customer's, supplier's or logistics operator's packaging is usually decided by the customer like VW, PSA etc. Selecting the package size, packaging trials and determining the quantity is already a common process.

In addition to returnable packaging, there are also non-returnable, disposable packaging. These are mainly cartons and disposable pallets. They are used when:

- The supplier and customer do not have returnable packaging that they could use
- The supplier and the customer do not have contracts with logistics operators for various reasons, e. g. for a small annual volume
- The flow between supplier and customer is multi-stage, i. e. passes through various types of logistics centres, external warehouses, wholesalers. There is then a small possibility of monitoring the flow of packages, which may result in their loss. An example of this is the supply of spare parts. The products initially go to a car manufacturer, but the target customer is a garage. Repackaging the products in this case would be a waste of both time and money. The use of returnable packaging along the entire supply chain would also not be possible due to the huge number of customers in the form of garages.
- The distance between the customer and the supplier is too long and the transit time too long. Renting packaging or buying it for a project is no longer profitable. An example in this case is sea shipments where the transit time is about one month. It must also be assumed that this is not only the transport of finished products to the customer but also the transport of empty packaging to the supplier. The amount of "frozen"; packaging in transport makes the rental extremely expensive and buying the necessary amount of containers for the project would be much more than using cardboard packaging. In addition, a very high cost of transporting empty packaging to the supplier has to be added.

The next type of packaging will be disposable packaging. It won't just be a box or a pallet. Disposable packaging will also include auxiliary packaging materials. Their use is no longer dependent on costs. This is usually required by specific transport conditions, the requirements of the product itself or the customer's requirements (e. g. cleanliness). Corners are an example of additional packaging measures. They can be used to strengthen the whole structure

Figure 7 Additional packaging materials - corners.

Source: https://askartony.com/zabezpieczenia-transportowe/; https://opakowania24.eu/produkt/naroznik-ochronny-16-a-1000.html?gclid=EAIaIQobChMIp_Tg8Lrl5QIVjIGyCh2dAglAEAQYCSABEgLQ-vD_BwE (access on: 12.12.2019)

Another example of packaging aids will be plastic bags. This is a very important aspect of packaging. Especially for packaging in the automotive zone. Their use is not entirely obvious, as in most cases they are not dependent on transport requirements or the product itself. They depend on specific customer requirements. For example, the entire Volkswagen group requires them because of their specific cleanliness requirements. BMW only requires them for spare parts. PSA uses them only occasionally - in this case their requirement depends on the specifics of the product.

The label will also be an additional material. Here too, they can be divided into several types, because one label is placed on the part (usually having only its number and date of production) or on individual plastic bags in which one piece is packed (here also usually there is only information about its number and date of production) or a shipping label (this one usually appears on the wrapping, i. e. a box or container and on a pallet).

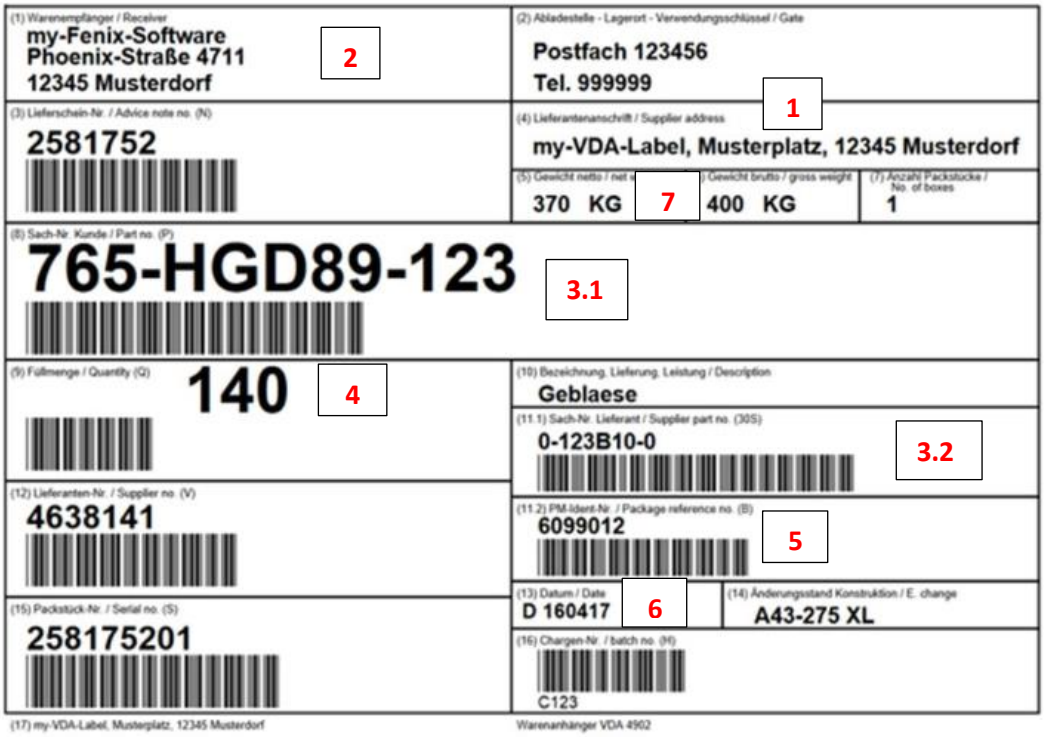
3.2. The label as an element of packaging and its significance in logistics processes.

The label is treated as part of the packaging and therefore the person responsible for packaging management is often also responsible for the labels. Nowadays it is very rare for a label to be handwritten. The vast majority of them are generated by the system of a given company after the box is packed or the whole pallet is completed. The label contains basic information such as:

- Name of the manufacturer (1)
- Name and address of recipient (2)

- Number and/or name of the product - usually two numbers. One corresponds to the internal number of the manufacturer, the other corresponds to the product number of the recipient (3)
- Number of units per package (4)
- Type of packaging (5)
- Date of manufacture (box) and date of dispatch (pallet) (6)
- Weight of box/pallet (7)

Figure 8 Sample shipping label.



Source: https://www.pid-labelling.co.uk/label-products/delivery-labels/odette-labels/ (access on: 20.12.2019)

Each customer chooses the different format of the label. The appearance of such a label differs in size, data distribution, different barcodes or QR codes. Automotive customers take a very restrictive approach to the type of labels and data on them. Failure to comply with its requirements (bad label format, bad data or lack of certain information) results in an immediate reaction in the form of a complaint often combined with a financial burden. There's a reason why their reaction is so rigorous. The receipt of goods in the case of car manufacturers is automatic, so a problem with scanning the barcode on the label stops the receipt of goods in the warehouse. Manufacturers operate on a just-in-time basis and a slight delay may cause the line to stop.

The first label for a box is created on the production line. It is printed by the operator or leader of the area or line concerned. The person responsible for this shall use the appropriate option in SAP or any other system used by the company. To do this he only needs the product number and the number of pieces in the package. He usually does so on the basis of the packaging instructions that contain such data. The box marked as such goes to the warehouse where it is waiting for shipment. When generating documents related to shipping, i. e. CMR, WZ and others, shipping labels are automatically created. The duties of the warehouse include replacing the labels that were created on production with those that were created during the creation of documents.

Production labels are not suitable for shipment because they do not contain all information. First of all, they lack the date and the delivery number on which the goods go. Secondly, the name of the specific factory where the goods are to go is missing. Usually one type of product does not go only to one customer's factory, but goes to several. Which box or pallet will be delivered to be decided when the goods are already in stock.

Labels in the automotive industry are extremely important. They enable the identification of a product, the system placement of a given box or pallet at a specific storage location or the shipment of a given product. Because of this, a very important moment is the process of printing the label itself. An error during this activity causes so-called mislabelling - this is nothing more than an incorrect product designation. In the automotive industry, it is extremely dangerous due to the Just-In-Time principle and the minimisation of stocks. If the box with wrong parts is already on the car production line and operator realizes that he has the wrong product, it may be too late for any reaction, because for example, the transit time will be more than several days. Such a mistake very often leads to a stoppage of the production line, which involves losses of several hundred thousandths or even millions of euros.

Mislabelling is not one kind, but a whole group of possibilities connected with wrong identification. They may be:

- Mixed product types in one container or box
- Wrong number of parts on the label
- No label or marking on 1 part
- No label on the container
- Mixing of wrapping on a pallet
- Incorrect product number on product, container or pallet label

Each of these errors will lead to a different negative event for the customer. Mixing up the products will lead to the situation that the box will not be allowed to be used on production and in that case customer will not pay for all or for several parts that into this box. Lack of any label will lead to the goods being retained already at the customer's warehouse. Wrong number of parts on the label can also lead to stopping the line, as the operator may be missing several pieces to complete production.

However, the most dangerous and common mistake is the wrong product number on the label. It is the most dangerous option because until the very end, i. e. until the product is delivered to the car production line, it is very difficult to detect. The reason for this particular kind of mislabelling is most often:

- Incorrect label printed out by the production operator or production leader – mistake happens when entering the product number
- Mistake during replacement of label from production to shipping one by warehouse operators

It can also happen that labels fall out during transport or removal from storage racks and are wrongly placed again. The labels can also be confused if the products go through the final quality control after printing the label on a given box, and they are incorrectly repositioned during this control.

In each of these cases, however, it is usually human fault, so the main action against this type of errors is to automate the process or reduce the role of man and introduce *Poka Yoke* type systems to prevent all that kind of mistakes.

3.3. Internal packaging and its role in the company's logistics processes

Internal packaging, as the name suggests, is used to store and transport raw materials, semi-finished products, finished products, tools or waste within the company. However, it is most important for logistics to use them for the first three elements, as they are the main logistics actors. The inner packaging can be made of different materials. However, the most effective will be those that are reusable, i. e. usually metal or plastic packaging. Those made of glass or ceramics are definitely too brittle to risk being used during the process. The inner packaging can therefore be a plastic box or plastic big container, a net container, a specific hanger that allows the product to be hung and then transported on it, or a pallet on which containers used inside the company are transported.

Figure 9 Examples of internal packaging.

Source: http://fach-pak.pl/ (access on: 20.12.2019)

At first glance, these packages are not much different from those that can be sent to the customer or used to bring in components. These packages are undoubtedly similar - they should be made of durable material, they should be adapted to the product being stored and they should have space for a label. The difference, however, lies in three characteristics - first, the inner packaging can be semi-open or open, i. e. the product or semi-finished product does not have to be covered on all sides. An example is the openwork packaging shown in the third photo. This is due to the fact that during internal transport or storage of products in the company they are not threatened by moisture, rain, low temperature, dust or other internal factors. Although additional protection in the form of foil bags or sleeves is sometimes used, this is due to the specific requirements of the customer for the manufacturing process.

It is the manufacturing process that generates the second difference between the packaging used for off-site transport and that used internally. The internal containers must be adapted to the process. For example, if the product was washed, openwork packaging should be used so that the remaining water escapes from the container and does not generate unnecessary moisture, which may destroy the intermediate product. Another example will be the previously mentioned hanger, which significantly shortens the production process if the operator does not have to pack a long metal object into a box but only hang it for later processing.

There is another difference between the inner and outer packaging - the freedom of choice and the possibility to buy them at any time during the project. The containers used for shipping or delivery are selected at the beginning of each contract and the quantity needed is accurately estimated, so it is difficult to buy or change packaging during the subsequent several years of cooperation. Firstly, it will affect the transport, storage or even production process, and secondly, it is more difficult to agree on the costs of new packaging. In the case of internal packaging, this is not a problem because it is obvious who bears the cost of purchasing them, and there is no need to adapt the logistics process in several stages to the new containers.

Additionally, the choice of packaging supplier is also left to one company. This particular enterprise can decide which supplier it wants, what the quality or price of these packages will be. Most often this is done on the basis of inquiries to several companies and choosing the most reliable with the best price offer.

The possibility of buying packaging at any stage of the process from any supplier is a great convenience and facilitation, however, causes that they are skipped when designing the production process when a new project is launched. This can have many negative effects such as:

- Lack of acceptance of packaging or the method of packaging or storage by one of the company's departments - production, quality, engineering or warehouse
- Unsuitable space for storage of packaging on the nests or production lines or in the warehouse
- Packaging size is not adjusted to medium production batches - the result will be too many small packages, which generates unnecessary time for the operator to pick up the container or inefficient use of too large packages
- Lack of packaging during periods where demand may be greater. This forces the use of disposable packaging until the next batch of containers arrives
- Buying packaging in a very short period of time because of its unforeseen lack makes it impossible to find the most advantageous offer and negotiate the appropriate terms and purchase price.

In order to avoid the negative effects mentioned above, it is therefore necessary to select packaging before the production of certain products. So the package should be:

- Adapted to the length, shape and material of the raw material, intermediate or finished product
- Adapted to the production and storage process
- Adapted to the size of production batches
- Adapted to the size of the storage and production sites or should be adapted to the size of the packaging
- Adapted to health and safety requirements, i. e. full packaging should not exceed the permitted lifting standards for men and/or women
- Accepted by all process stakeholders - engineering, quality, logistics and production
- The most attractive price while maintaining appropriate technical and quality parameters

If a company decides to introduce internal packaging accordingly, the issue of standardisation of the packaging process for semi-finished products arises. In theory, creating packaging instructions and instructing production staff to always pack a specific semi-finished product in a specific quantity into a selected container is the safest and most effective solution because:

- ✓ this facilitates production planning
- ✓ it enables efficient use of packaging
- ✓ it gives the possibility of assigning specific locations in the warehouse for specific references, which in turn makes it easier to locate the products in the internal warehouses
- ✓ eliminates the risk that the label will show the wrong product number and incorrect quantity because the operator will have to follow the packaging instructions
- ✓ eliminates the risk that the operator will pack the product incorrectly, i. e. it will damage the product during packing, exceed the permitted lifting standard or the product will protrude above the container, thus preventing its safe storage

Although standardisation of the packaging process seems to be ideal and the only solution, it generates one of the most valuable things for logistics - time. An operator who does not have specific packaging conditions takes an available, matching container in the area and packs the product in full. However, if a packing instruction exists, the employee needs time to locate it in the documentation, order containers from the warehouse or just find a specific container as well as focus on the proper way of packing the given intermediate product. As it is known, the time of a given operator costs money, so it is impossible to introduce standardisation during a given project unless the company concerned wants to cover the additional costs resulting from the additional processes itself, which is highly doubtful. Therefore, the best solution is to introduce standardization before the start of a given production and include additional process costs in the price of a finished product

4. The role and tasks of the person responsible for packaging management at XYZ Company

Logistics is certainly a vast issue, which consists of many aspects and elements. The importance of supply logistics is indisputable - without components, the product will not come into being. The importance of production logistics is also known - without a production plan the production process will not start. The impact of distribution logistics is obvious - without it the goods will not reach the customer. Transport and storage do not even need to be described to know how important it is for each company. Packaging logistics, however, are often overlooked due to their isolated and seemingly narrower nature. However, based on company XYZ it will be demonstrated what kind of role and tasks has a packaging and the person who is responsible for it management.

4.1. Packaging logistics as an element of launching production of new products

The start of production of each new car model in corporations such as PSA, Volkswagen or Daimler is connected with launching new production at selected suppliers. Usually one car model means several or several dozen new parts at the component manufacturer. They are launched as a new project that has its individual stages. The first phase is the prototype phase, where engineers specify the appearance of the part. The next phase is the pre-serial stage, i. e. the time when all details of a given part, the conditions of the whole cooperation, including logistic conditions and the final costs of the product, are specified.

As the automotive industry is known for its planning and standardization – it is no different with packaging. It is not possible to plan transport or warehouse space efficiently without standardized packaging for each product sent out. At the beginning of each project to implement the production of a new part, one of the basic steps is to establish the number of units of the product in the basic packaging unit, which is usually a container or box. After establishing such a quantity, MOQ (Minimal Order Quantity) is set. This allows to agree with the customer the smallest quantity that can be in the order. This quantity may correspond to one container, one layer of packaging on a pallet or a full pallet of products. The best option for the supplier is the last option due to transport savings (effective filling of the car, less transport) as well as storage savings (effective filling of the storage space) and savings resulting from less rearming on production lines. For the customer of a given product it is also important to use transport efficiently, however, the priority is to keep the smallest stock, with adequate

production security, so usually the customer presses for a reduction and the supplier for an increase in MOQ.

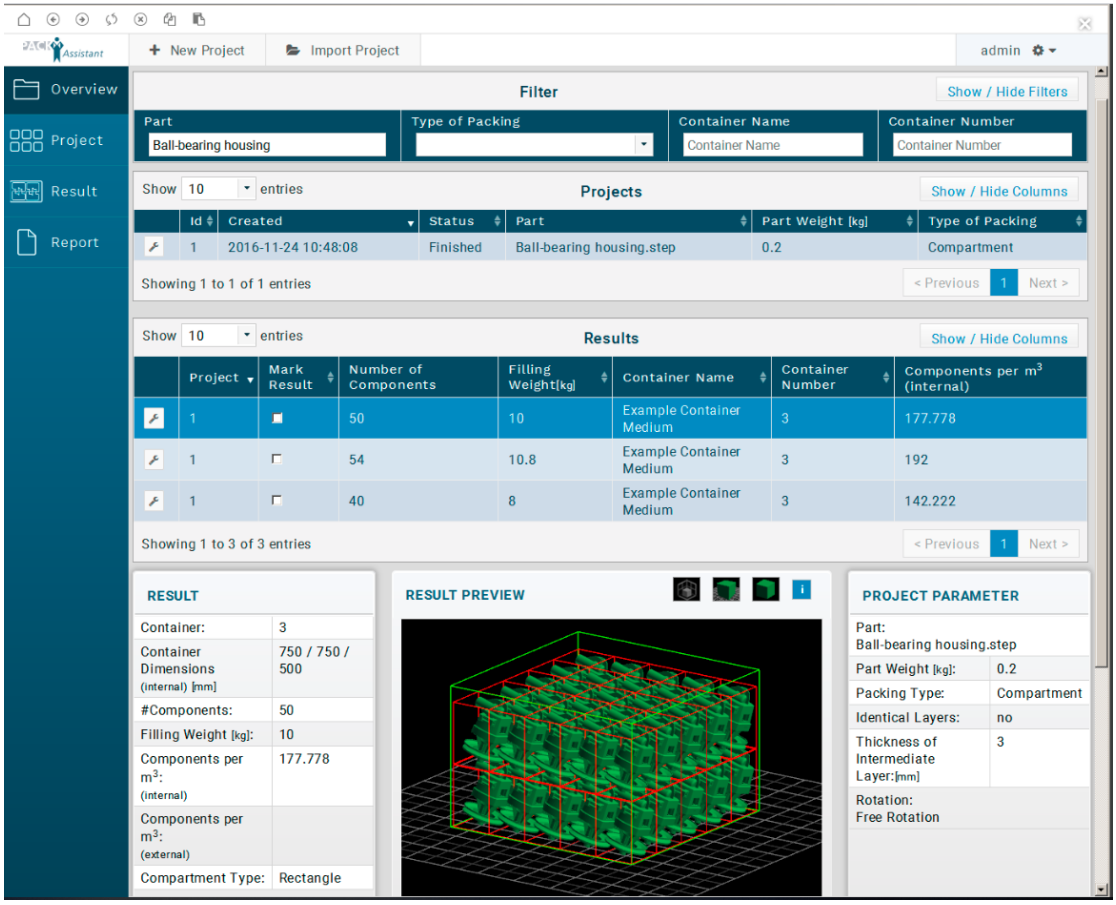
Usually, customers have clearly defined types of packaging for serial and spare parts in their manuals. For serial parts, this is usually a returnable packaging. Their types were already described earlier in this work. The exceptions, however, are projects that involve shipments by sea or rail. Transportation in this case takes several weeks to several months and investing in returnable packaging would be unprofitable, so both the customer and the supplier choose the cardboard boxes. In the case of sea shipments, it is necessary to use special reinforced cardboard boxes - minimum 7 layers or use cardboard covers so that the packaging is not damaged due to moisture. Another reason is to stack loads. Ordinary cartons are very rarely able to be stacked 2 pallets up, not to mention 3 pallets up, which is possible with plastic or metal packaging. Cartons with the appropriate reinforcement are already able to withstand such stacking.

Packaging for spare parts is usually disposable. The most common practice is to use unit packaging, i. e. a bag or a small cardboard box for one item with the appropriate identification. A common technique is to use labels in the form of small stickers with part number together with a barcode or QR. Parts packaged in unit packages go into bulk packages such as cartons or Gitterboxes.

Regardless of whether the packaging is determined for serial parts or for spare parts, during the pressure phase the person responsible for packaging must agree with the customer which specific packaging should be used and how many parts will be in a particular container, carton or bag. Sometimes the sentences are consistent, but sometimes they differ due to the size of the production or storage space allocated to the container. Although the supplier may argue his choice, the customer still has the decisive vote.

The proposal of suitable packaging and the quantity in the box usually results from packaging trials, although there are also situations when there are not enough parts in the initial pre-serial phase, so a computer program is used for this purpose, which calculates and shows the position of the parts in the packaging.

Figure 10 Example of the PackAssistant program presenting data of product packaging



Source: https://www.packassistant.de/en/product.html (access on: 20.01.2019)

However, the final physical testing of packaging must take place during the pre-serial phase, even if these are the last days of that phase. After receiving the customer's consent, the work documentation for the production operator is created on its basis. Packaging instructions are usually also a document showing how to palletize, so they are used by the customer's logistics to organize transport and the warehouse to prepare the shipment. In this type of document the most important information is:

- Product number (supplier and customer), product description, weight and picture
- Type of packaging, photo, internal name, dimensions, palletisation
- The quantity in the package, the description of the packaging, the arrangement and one or more pictures showing the packaging process

There should also be data such as:

- Method of applying the label, type of labels used
- Alternative (another acceptable) type of packaging in case of lack the serial one

- Document numbers, dates of issue, persons approving the document (usually the logistics manager, the quality specialist and the production manager

Once the packing instruction is created, it is taken to the appropriate production section, then the operators working there are trained how to use the packaging instruction.

The last element of preparing packaging processes for the project is to set up appropriate labels in the system according to customer expectations. In SAP or in another company's system, fixed data shall be entered, which must be on the label for a given part, i. e. the packaging number, the quantity in the box, the quantity on the pallet and the type of label (the way the data on the pallet are arranged). The last element is to order the first batch of packaging for the start-up of the project.

4.2. The problem of minimal packaging inventory with the need to ensure constant access to packaging for the enterprise

As mentioned earlier, there are 2 main types of packaging - returnable and non-returnable. Returnable packaging can belong to supplier, the logistics operator or to customer. Each of them has a specific style of packaging management. One will deliver his packages of 100 pieces a day when he receives his goods. Another one will do it once every 2 weeks bringing his supplier a full trailer of packaging. Suppliers must adapt to this style and manage their packaging in such a way that it is never lacking for production and that stocks are kept as small as possible.

Logistics is not only the numbers on which a given specialist has to work, it is also the knowledge of the aforementioned style, defects that the client has, but also the people with whom the specialist has to work. One customer may have a very friendly delivery system, for example, delivery every day, in small batches exactly according to the supplier's order, but from time to time he will have problems with delivering the packages to the agreed unloading window and instead of delivering the packages between 6:00 and 8:00, he will deliver them at 22:00. When calculating daily demand, a few hours can make a big difference.

Each packaging supplier or customer is an individual case and their packaging is managed in an individual way, so here is one specific example to describe how to proceed and calculate the demand:

- Packaging supplier - logistics operator X
- Packaging is delivered every day, according to the demand made on the portal.
- The minimum order value is 75 pallets of boxes.
- Lead time is 5 working days - packages ordered on Friday will be delivered on Friday next week
- Packaging is ordered for a customer whose order value may fall or increase by 20% to 3 days before the goods are collected
- The operator is sometimes 1 day late with delivery
- The operator delivers 3 types of packages - packages A - 10 pieces per pallet, packages B - 15 pieces per pallet, packages C - 30 pieces per pallet.

One of the most convenient ways of ordering packages is presented above because it is known when and in what quantity the packages will arrive. Lead time of 5 days is also very short waiting time. However, the whole situation is complicated by the fact that the customer can change orders much shorter than the lead time of packaging orders. In addition, it is known that the supplier may be late, which also makes it necessary to keep a much larger safety stock on site. The minimum order value is 75 pallets, which may also make it difficult to maintain a minimum stock.

In order to properly manage such packaging, priorities and alternative outputs must be established. The priority is to order 5 days in advance each day and order 75 pallets as otherwise they will not be delivered. In order to never stop production, alternative packaging is agreed with the customer, which is usually a carton corresponding to the dimensions of plastic packaging. However, this does not change the fact that the company should do everything to ensure that the returnable packaging is used, because using cartons even for 1 day of production is a huge cost that neither the logistics operator, nor the supplier, nor the customer himself will want to pay.

In summary, there are priorities and there are alternatives, so it is worthwhile to set a minimum stock value. In fact, if the supplier of goods keeps additional stock around 1 day, this eliminates the negative consequences for both the logistics operator and the customer.

The following is an example of how to calculate the demand and usage of boxes:

Table 4 Calculation of the appropriate stock level

Type of packaging	Current stock (pcs)	Monday				Tuesday			
		Demand	Delivery (pcs)	Delivery (pallets)	Stock	Demand	Delivery (pcs)	Delivery (pallets)	Stock
Type A	250	345	400	40	305	428	500	50	377
Type B	150	245	225	15	130	140	225	15	215
Type C	300	347	600	20	553	529	300	10	324
			Sum:	75			Sum:	75	

Source: Own elaboration based on information from employees from XYZ company

The most important thing in calculation is to focus on the stock that will be left in the end of the day. For example in case of Monday, stock that will be left on that day will be from simple mathematical operation = Current stock (Sunday) – Demand + Delivery (pcs). In the same time there must be another operation that will be counting the sum of the pallets to fill the whole truck (75 pallets).

Only 2 days have been provided to facilitate the calculation. As it can be saw above, it is practically impossible to keep the right stock in the same condition because in every day there is a different demand for a particular type of packaging. The most effective way is to calculate the daily requirement, however, in a week's perspective, when we see that we need to minimize stock due to a production stoppage or changeover, or increase stock because the customer's orders increase significantly over several days.

Non-returnable packaging is managed in a very similar way. The person responsible for ordering them must maintain a minimum stock with 100% assurance that they will not be missing for production. The calculation method is also very similar to that for returnable packaging. The rules of orders and deliveries are also established at the very beginning of cooperation. However, the basic principles are different. First of all, in the case of returnable packaging, the transport cost is in 90% of cases covered by whoever provides the packaging, i. e. the customer or logistics operator. In the case of cartons and pallets, this is specified in the contract between the supplier of non-returnable packaging and the company that purchases the packaging. Thus, if transport is on the side of the ordering party, the person responsible for packaging must also focus on minimising transport costs and ordering transport-efficient lots.

Another difference is the already mentioned 100% certainty that there will be no shortage of cardboard packaging and pallets because cardboard packaging very rarely has its counterparts, the so-called alternative packaging. Pallets are theoretically easy to replace with

others because companies usually have 2 types of pallets of the same size each - industrial pallets and phytosanitary pallets. However, replacement works only one way. The industrial pallet can be replaced by the phytosanitary pallet, but phytosanitary cannot be replace by industrial pallet. It works differently with cartons. Ordering boxes of the same dimensions is a completely meaningless solution. It is impossible to keep an alternative supplier because each component supplier must be contracted and committed to ordering the contracted annual lot. Therefore, keeping a safe stockpile is necessary.

The problem is theoretically solved by consignment stock. The definition defines this state as „Goods in possession of a party that is not the goods' owner or titleholder. From the accounting point of view, such goods have neither been sold nor are a part of their owner's inventory"[68]. Consignment stock is the last of the 3 main differences between return and disposable packaging management. In the case of such stock, the supplier undertakes to deliver the goods - in this case the packaging - to the place concerned. The goods belong to the supplier as long as they are not consumed by the production. This is a very common way of cooperation for industrial companies. If the packaging is not used, it may return to its owner, the supplier. The customer himself is responsible for the goods, but he pays for them only when they are used up.[69] This means that packaging can be delivered very quickly for production even though its costs will only be covered when it is actually needed and the money will never be frozen in stock. However, what the person responsible for this type of packaging should focus on is the storage space. Although such stocks theoretically cost nothing, in practice they take up space that costs a certain amount of money.

4.3. The method of calculating the packaging cost and its share in the cost of the product.

Regardless of the type of packaging, each one costs the company that uses it for production. No company can afford to incur costs without a guarantee of reimbursement when selling its product. That's the case with packaging. The cost of packaging is usually a separate part of the price, i. e. in contracts, i. e. so-called trade orders, the cost of the product itself and packaging is determined separately. There are also packaging conditions and MOQ.

[68] http://www.businessdictionary.com/definition/consignment-stock.html (access on: 20.01.2019)
[69] https://www.inventoryops.com/ConsignmentInventory.htm (access on: 20.01.2019)

The method of calculating the cost of packaging depends on its type. The easiest to calculate is the non-returnable packaging. By accepting the conditions below, a packaging cost calculation is presented.

1. A single part is packed in a 400x350 mm plastic sack - price 0,5 Euro per piece

2. The unit packaging is a 600x400x200 mm cardboard box. There are 30 pieces in one box. – The price of 1 cardboard box is 1. 5 Euro per piece.

3. An industrial pallet with dimensions 1200x1000x150 mm is used for transport. There can be a maximum of 15 cartons on one pallet - price 5 Euro per piece.

4. Everything is strapped with polyester tape. It is assumed that the cost of its consumption per pallet is fixed at 0.02 Euro.

5. Additionally, there is a label on each box. It is assumed that the cost per label is about 0.1 Euro.

A very important piece of information will be MOQ, i. e. how much minimum can be ordered by the customer. As described earlier, this is usually a multiple of the unit packaging, in this case a box. So it can be assumed that in this case it will be one layer of cartons - 5 cartons per pallet or 150 pieces.

The method of calculation of packaging costs can be presented as follows:

Table 5 The method of calculating the packaging cost per item

Type of packaging	Packaging price	Number of units per package	Cost of packaging per item
Plastic sack	0,50 €	1	0,500 €
Carton	1,50 €	30	0,050 €
Wooden pallet	5,00 €	150	0,033 €
Polyester tape	0,02 €	150	0,000 €
Label	0,10 €	30	0,003 €
		Total cost of packaging per 1 piece	0,587 €

Source: Own elaboration based on information from employees from XYZ company

In case of using returnable packaging that is subject to rental charges, much more data is needed. In addition to MOQ, there is a need of knowledge of a forecast annual volume, a forecast stock on a given product (in days), its transport time, time in external warehouses and, of course, conditions and rates for rent. When calculating such costs, logistic matrixes are most

often needed - excel files containing several to several dozen bookmarks that contain several hundred data.

If a product is packed 5 pieces per package and the expected annual volume is very large, then the rental costs must certainly be recalculated and added, because it is known that the number of packages on the market will be huge and therefore the monthly rental costs for packages will be significant. However, if the product in question is packaged in more than 100 units, then regardless of the annual volume per unit, the cost is likely to be less than 1 euro cent, so it will not be entirely possible to add it to the product price. However, it is worthwhile to consider each product individually and verify its expected costs, which will be incurred for the rental of packaging. In theory, these calculations cover all the expenses that the company will incur during the project. Practice, as is common knowledge, often differs from theory. The reason for not returning all packaging costs in piece price might be special safety stocks (causing the packaging to “freeze" in stock), incorrect data on portals or monthly reports (deliveries/shipments are systemically delayed by one day and the company pays for packaging that is not physically present) or even production delays (that “freeze" packaging in the process). Therefore, each company should impose a mark-up on packaging costs or round them up to 1 euro cent even if they are smaller, as this prevents it from losing uncovered costs in the price of the product.

The cost of the packaging process, i. e. the activities performed by the production operator and the cost of processes performed in the warehouse is determined by the process engineer. A packaging specialist or packaging engineer is only involved in this process if the packaging conditions are specific e. g. if additional activities such as bag welding, printing and applying a specific customer label and the like are needed. In this case, the production or storage worker shall be informed of the specific operations to be carried out when packing this product. In the presence of a packaging specialist and a process engineer, the time of the activities is measured. After checking the time, the cost of additional activities is calculated on the basis of the average rate per minute or hour worked by such an employee.

Such a cost is also added to the price of the product, since every material and every employee's work must be priced and must be paid for in the price of the product. The aim of each company is to profit from its activities, so the appropriate margin - ranging from 5% to even 50% - is also added to the aforementioned materials or activities.

Summary:

The above work describes the theory and practice related to packaging. The automotive industry is an ideal area to present in logistics research. Its main objectives are to increase quality, reduce process time at the lowest possible cost. Choosing the right packaging can definitely help with that. But every company and every industry is different - it has different processes and different goals. However, regardless of that, it can certainly be said that packaging is necessary, if only for the basic reason that the product will not leave the factory if there is no packaging. It might be even said that the product will not even be made if the company has no internal packaging.

The aim of this work was to prove the importance of packaging in the automotive industry based initially on packaging theory and in the practical part on XYZ's processes and responsibilities as a packaging specialist. This aim was achieved trought theoretical sources and practice. Already in the theoretical part, it has been presented that more often logistics specialists perceive the choice of packaging as a strategic element to reduce costs, speed up the process or encourage customers to buy the product. For this reason, more and more companies are opting for a specialist in the logistics whose role will be broadly defined as packaging management. In the case of the automotive industry, which is famous for its standardization and systematization, this role can be taken over by one or even several people, because the number of packaging tasks is enormous. Starting with the management itself - ordering, flow checking, annual stock - the person has to make sure that the stock is always correct, that the packaging is always available and the rental costs are as low as possible.

There are two main types of packaging - disposable and returnable. Reusable packaging can be divided into packages belonging to the customer, supplier or logistics operator. One customer can have several types of packaging. Suppliers of disposable packaging also very often supply several, if not several dozen types of cartons, spacers, bags or pallets. So, as can be seen, there are many types of packaging, and each has a different management style, a different type of storage and a different way of accounting for costs. Packaging can therefore primarily be classified as procurement logistics.

Very often the person responsible for the packaging has to choose the packaging that the company will deal with throughout the project. Although disposable packaging is easier to manage, it is much more expensive and less safe for goods, so this choice is not easy. Companies also have a choice of internal packaging, which is essential for the process when introducing new designs. If not selected properly, it can jeopardize the semi-finished products and reduce the efficiency of the process, but designing the right packaging for the product and the process can significantly reduce operator's activity time, increase their work ergonomics and reduce the cost of the whole process. To sum it up, the packaging is therefore also an element of project and process management of the entire company.

Cost calculation is another part of the work of packaging logistics. If a company deals with disposable packaging, it has a price. If the company chooses return packaging, the rental will cost a certain amount per day. Each of these costs must be added to the product price. This is also very often the role of the person responsible for packaging because he or she knows when to add costs and when not. The packaging specialist also has information about rental prices, in particular prices of cartons, pallets and even plastic bags. Packaging is, therefore, an important element in determining the price of the product itself, it can represent up to a dozen or so percent of the price if the product is very sensitive to external conditions or the customer's requirements are very restrictive.

After a long process of choosing the right packaging, testing it and calculating the costs of using a particular container or box, appropriate packaging instructions should be made and production operators should be trained. It is often the responsibility of the packaging specialist to create the correct settings in the system that will generate labels for products. The role of the label in automotive logistics processes is particularly important due to the Just-In-Time system, which eliminates stocks that can secure the operation of a production line if the data on the label is incorrect. Incorrect marking is one of the most dangerous phenomena and every production plant tries to eliminate it. The label is an element of packaging, which is why the packaging specialist often associates with such activities and supports projects that prevent mislabelling.

In the above short summary of the whole work, most of the packaging specialist's duties and processes in the company XYZ related to packaging are presented. As mentioned, packaging is an element of supply logistics, an important point in the design of material flow processes and an element that has a large share in the product price. It is also closely linked to labels, which are key to logistics processes. This shows the extensive role of the packaging itself and its importance in managing logistics processes in the automotive industry.

Bibliography:

1. Amorim M., Ferreira C., Vieira M., *Engineering Systems and Networks. The Way Ahead for Industrial Engineering and Operations Management*, Springer International Publishing, Switzerland 2017.
2. Angeles R., *RFID Technologies: Supply-Chain Applications and Implementation Issues*, "Information Systems Management" 2005, No. 22.
3. Bennet D., Klug F., *Logistics supplier integration in the automotive industry*, „International Journal of Operations & Production Management" 2012, No. 32.
4. Blocher J., *The effect of relative humidity on the microbial barrier properties of porous packaging materials used in the medical device industry*, Proquest, Umi Dissertation Publishing, 2012.
5. Brody A. L., Strupinsky E. R., Kline L. R., *Active Packaging for Food Applications*, CRC Press, Boca Raton 2001.
6. Christopher M., *Logistics and supply chain management. IV Edition*, Pearson Education Limited, Great Britain 2011.
7. Cichoń M., Lesiów T., *Zasada działania innowacyjnych opakowań inteligentnych w przemyśle żywnościowym*, „Nauki inżynierskie i technologie – engineering sciences and technologies" 2013, No. 2(9) .
8. Cierpiszewski R., *Opakowania aktywne i inteligentne*, EUP, Poznań 2016.
9. Davis C., *Inside Dell's manufacturing facility*, „Supply Chain Europe" 2005, No. 14.
10. *Dell wprowadza ekologiczne opakowania z odzyskanego plastiku*. (No author's name) https://www.logistyka.net.pl/aktualnosci/item/87980 Date of publication: 10.03.2017.
11. Dominic C., *Packaging Logistics Performance and How to Evaluate the Packaging Performance by Applying the Tool Packaperforma*. Conference: 17th IAPRI World Conference on Packaging 2010. https://www.researchgate.net/publication/269141021_Packaging_Logistics_Performance_and_How_to_Evaluate_the_Packaging_Performance_by_Applying_the_Tool_Packaperforma/link/5495a3d70cf2ec13375b2ade/download (access on: 22.01.2020)
12. Fritze C., *The Toyota Production System. The Key Elements and the Role of Kaizen within the System,* https://www.researchgate.net/publication/289519018_The_Toyota_Production_System_-_The_Key_Elements_and_the_Role_of_Kaizen_within_the_System, Date of publication: January 2016.

13. Garcia-Arca J., Prado P., Gonzalez-Portela Garrido A. T., *"Packaging Logistics": Promoting sustainable efficiency in supply chains,* „International Journal of Physical Distribution & Logistics Management" 2014 , Vol. 44, No. 4.
14. Hellstrom D., Saghir M., *Packaging and Logistics Interactions in Retail Supply Chains,* „Packaging Technology and Science" 2007, Vol. 20, No. 3.
15. Holweg M., Pil F., *Successful Build-to-Order Strategies: Start with the Customer*, „MIT Sloan Management Review" 2001, No 43.
16. Howard M., Miemczyk J., Graves A., *Automotive supplier parks: An imperative for build-to-order?*, „ Journal of Purchasing and Supply Management" 2006, Vol. 12, No. 2.
17. Imai M., Gemba Kaizen, *A Common-sense Approach to a Continuous Improvement Strategy. Ed.2,* McGraw-Hill, New York 2012.
18. Jałowiec T., *Towaroznawstwo dla logistyki wybrane problemy*, Difin, Warszawa 2011,
19. Jedlińska M., *Wybrane zagadnienia związane z zarządzaniem przedsiębiorstwem w branży motoryzacyjnej – case studies*, In: M. Łuszczak, Ł. Małys (ed.) *Współczesne koncepcje i trendy w branży motoryzacyjnej*, Advertiva, Poznań 2016.
20. Jeszka A.M., *Rola opakowań w technologiach logistycznych*. In: J. Długosz (ed.), *Nowoczesne technologie w logistyce*, PWE, Warszawa 2009.
21. Johnson D., Johnson M.A., Sun J., *Integrating multiple manufacturing initiatives: Challenge for automotive suppliers*, „Measuring Business Excellence" 2007 , Vol. 11, No. 3.
22. Jönson G., *Packaging Technology for the Logistician. 2nd Ed,* Packaging Logistics, Lund University, Sweden 2000.
23. Kawa A., *Systemy automatycznej identyfikacji*, In: J. Długosz (ed.), *Nowoczesne technologie w logistyce*, PWE, Warszawa 2009.
24. Kilibarda M., Andrejić M., Popović V. , *Creating and measuring logistics value*, 1st Logistics International Conference in Belgrade, Serbia, 28-30 November 2013. http://logic.sf.bg.ac.rs/wp-content/uploads/Papers/ID-36.pdf (access on: 22.01.2020)
25. Klopott M., *Problematyka dotycząca opakowania i przygotowania ładunku do przewozu w instytutowych klauzulach ładunkowych*, „Logistyka" 2003, No. 5.
26. Kocot K., Łazarowicz O., Witkowski P., *Wykorzystywanie technologii RFID w budowaniu przewagi konkurencyjnej*, „Logistyka" 2012.
27. Kruczek M., Żebrucki Z., *Charakterystyka współpracy przedsiębiorstw w łańcuchach dostaw wybranych branż*, „Logistyka" 2011, No. 2.

28. Kulisz M., *Evaluation of SAP System Implementation in an enterprise of the automotive industry – case study*, „Applied Computer Science" 2018, Vol. 14, No. 4.
29. Kumar R., Dwivedi R.K., Verma A., *Poka-Yoke Technique, Methodology & Design*, „Indian Journal of Engineering" 2016.
30. Lambert D.M., Stock J.R., Ellram L.M., *Fundamentals of Logistics Management*, McGraw-Hill, Singapore 1998.
31. Liker J. K., Kamath R. R., Nazli Wasti S., *Supplier involvement in design: A comparative survey of automotive suppliers in the USA, UK and Japan*. „International Journal of Quality Science" 1998, Vol. 3, No. 3.
32. Lockamy A., *A Conceptual Framework For Assessing Strategic Packaging Decisions*, "International Journal of Logistics Management" 1995, Vol. 6 No. 1.
33. Löfgren M., Nilsson L., *Kano's Theory of Attractive Quality and Packaging in the Quality*, „Quality Management Journal" 2005, Vol. 12, No. 3.
34. Lorenc A. K., Szkoda M., *Zastosowanie systemu SAP ERP do obsługi dostaw Just-in-Time oraz Just-in-Sequence w branży motoryzacyjnej*, „Logistyka" 2015, No. 3.
35. Łuka P., Woźniak H., *Współczesne problemy zarządzania logistyką w przemyśle motoryzacyjnym (cz.1),* „Logistyka" 2012. No. 1.
36. Łuka P., Woźniak H., *Współczesne problemy zarządzania logistyką w przemyśle motoryzacyjnym (cz.2),* „Logistyka" 2012. No 2.
37. Majumdar S. K., Gupta M. P., *E-Business Strategy of Car Industry : SAP-LAP Analysis of Select Case Studies*, „Global Journal of Flexible Systems Management" 2001, Vol. 2, No. 3.
38. Maryniak A., *Nowe trendy w opakowalnictwie artykułów spożywczych w kontekście logistycznych funkcji opakowań*, „Logistyka" 2012.
39. Meyr H., *Supply chain planning in the German automotive industry*, In. H. Günther (ed.), *Supply chain planning: Quantitative decision support and advanced planning solutions,* Springer, Berlin 2009.
40. Miklińska J., *Centra logistyczne a logistyka w przemyśle motoryzacyjnym*, „Logistyka", 2012. No 6.
41. Monden Y., *Toyota Production System. As Integrated Approach to Just-In-Time,* IV Edition, CRC Press, Boca Raton 2012.
42. Muhmound A. M., *Just in Time (JIT), Lean, and Toyota Production System (TPS)*, Industrial Engineering Branch Department of Production Engineering and Metallurgy University of Technology, Baghdad – Iraq 2014-2015.

43. Ohno T., *Toyota Production System. Beyond Large-Scale Production*, Productivity Press . Portland, Oregon 1988.
44. *Opakowania wielokrotnego użytku dla logistyki*. (No author's name) https://www.logistyka.net.pl/aktualnosci/item/8298 Date of publication: 19.03.2013.
45. Pałęga M., Staniewska E., *Zastosowanie kart Kanban w przedsiębiorstwie przemysłowym,* „Logistyka" 2012, No. 6.
46. Pfeiffer H. K. C., *The Diffusion of Electronic Data Interchange*, Springer, Berlin 1992.
47. Prystacki T., *Opakowania dla produktów medycznych*, „Logistyka" 2003, No. 5.
48. Przybylski R., *Charakterystyka i delimitacja branży motoryzacyjnej w Polsce*. In: M. Łuszczak, Ł. Małys (ed.) *Współczesne koncepcje i trendy w branży motoryzacyjnej*, Advertiva. Poznań 2016.
49. Rabakavi H., Ramakrishna H., Baligar S., *Thorough Elimination Of Muri, Mura And Muda To Achieve Customer Satisfaction*, „International Journal of Innovative Reaserch & Development" 2016.
50. *Raport branży motoryzacyjnej 2019/2020*. https://www.pzpm.org.pl/Publikacje/Raporty/Raport-branzy-motoryzacyjnej-2019-2020, Date of publication: 09.08.2019.
51. *Raport KMPG w Polsce z inicjatywy Polskiego Związku Przemysłu Motoryzacyjnego. Stan branży motoryzacyjnej oraz jej rola w polskiej gospodarce*. http://www.pzpm.org.pl/Publikacje/Raporty/Stan-branzy-motoryzacyjnej-oraz-jej-rola-w-polskiej-gospodarce3, Date of publication: 10.11.2017.
52. Rutner S., Langley J. Jr., *Logistics Value: Definition, Process and Measurement*, "The international journal of Logistics Management" 2000, Vol. 11, No. 2.
53. Sadowski P., *Warunki określające kierowanie systemem logistycznym przez cele zadaniowe lub instruktażowe*, „Logistyka" 2014, No. 3.
54. Sihn W., Schmitz K., *Extended Multi-Customer Supplier Parks in the Automotive Industry*, „CIRP Annals - Manufacturing Technology" 2007, No. 56.
55. Silva D., Reno G., Sevegnani G., Devegnani T., *Comparison of disposable and returnable packaging: A case study of reverse logistics in Brazil*, "Journal of Cleaner Production" 2013, No. 47.
56. Solovyov S., Goldman A., *Mass Transport & Reactive Barriers in Packaging. Theory, Applications &Design*, DEStech Publications, 2008.
57. Spear S., Bowen H.K., *Decoding the DNA of the Toyota Production System*, „Harvard Business Review". September/October 1999.

58. Szmelter-Jarosz A., *Supplier parks and agent-based technologies as efficient solutions for complexity management in automotive industry*, „Transport Economics and Logistics", 2019, Vol. 78.
59. Tokarczyk M., *Systemy zarządzania opakowaniami zwrotnymi*, https://www.log24.pl/news/systemy-zarzadzania-opakowaniami-zwrotnymi/ Date of publication: 15.10.2010.
60. Twede D., *The process of logistical packaging innovation*. "Journal of Business Logistics" 1992 , No. 13.
61. Walasek J., *Kanban w branży motoryzacyjnej*, https://www.log24.pl/artykuly/kanban-w-branzy-motoryzacyjnej,3904, Date of publication 6.11.2013.
62. Wąsowicz A., *Logistyka produkcji na etapie projektowania samochodów*, „Logistyka" 2014. No 3.
63. Williams H., Wikstrom F., Otterbring T., Lofgren M., Gustafsson A., *Reasons for household food waste with special attention to packaging*, "Journal of Cleaner Production" 2012, Vol. 24.
64. Yam K. L., Takhistov P., Miltz J., *Intelligent packaging: Concepts and Applications*, "Journal of Food Science" 2005, Vol. 70, No. 1.

List of websites:

- http://www.przepisy.gofin.pl/przepisyno,2377,94857,42,42,20160101,2,1.html
- http://www.egospodarka.pl/art/galeria/50769,Najwieksi-producenci-czesci-samochodowych-na-swiecie,2,56,1
- https://www.visteon.com/;
- https://www.zf.com/;
- http://www.magna.com;
- http://www.lear.pl;
- https://pl.bosch-automotive.com/
- http://www.denso-am.pl;
- http://www.johnsoncontrols.com/pl;
- https://www.delphi.com/;
- http://www.faurecia.com;
- http://www.valeo-poland.com

- https://www.pzpm.org.pl/Publikacje/Raporty/Raport-branzy-motoryzacyjnej-2019-2020
- https://www.auto-swiat.pl/top10-najchetniej-kupowane-samochody-swiata/gc3fewq
- https://www.motofakty.pl/artykul/toyota-nowa-globalna-platforma-tnga-1.html
- https://leanmanufacturingpdf.com/lean-production-definition/
- https://e-gtp.pl/
- https://www.chep.com/
- http://www.1logistics.com.pl/fr/product.xml?category_id=1334253
- http://www.chep.com
- pl.gefco.net
- https://askartony.com/zabezpieczenia-transportowe/
- https://opakowania24.eu/produkt/naroznik-ochronny-16-a-1000.html?gclid=EAIaIQobChMIp_Tg8Lrl5QIVjIGyCh2dAglAEAQYCSABEgLQ-vD_BwE
- https://www.pid-labelling.co.uk/label-products/delivery-labels/odette-labels/
- http://fach-pak.pl/
- https://www.packassistant.de/en/product.html
- http://www.businessdictionary.com/definition/consignment-stock.html
- https://www.inventoryops.com/ConsignmentInventory.htm
- https://www.ekocykl.org/aktualnosci/437-najnowsze-interpretacje-dotyczace-opakowan-wielomaterialowych

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