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Industry 4.0 in Cosmetic Companies

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Abstract

The cosmetics industry is one of the Polish economy's largest and most promising branches. As per the data retrieved since 2021, there are about 400 cosmetics manufacturers in Poland and the largest number of start-ups in the cosmetics sector in Europe. The Industry 4.0 concept in this area assumes that cosmetic companies are implementing intelligent solutions and an effective supply chain of ecological raw materials. In the future, they will be referred to as the Smart Factories. The article aims to present visible trends in cosmetics companies in Industry 4.0. The paper describes the genesis and concept of Industry 4.0. Then, the most critical technologies that shape the development of the fourth industrial revolution in the cosmetics industry are presented and characterized. Also, the research conclusions and further studies on Industry 5.0 and 6.0 have been presented. Along with this, the research problem regarding the ignorance, part of cosmetic companies regarding modern technological solutions, and the lack of qualified staff who could implement the new ICT solution have been focused on in this paper.

Keywords: Industry 4.0, Industry 5.0, Industry 6.0, Digital technology, Cosmetics industry, ICT

1. Introduction

Industry 4.0 is a comprehensive concept indicating the integration of intelligent machines and systems and the introduction of changes in production processes to increase production. The use of modern robots in production processes that help integrate man and machine work is a crucial aspect of the proper functioning of the organization in the economic market. Production and industrial plants that use new, more advanced technological devices and IT systems increase the efficiency of their operations, improve energy efficiency, reduce production costs, and increase customer satisfaction. In the industry history, you can also specify Industry 1.0, 2.0, and 3.0.

The first revolution was Industry 1.0 – mechanization. In 1807 the steam engine was invented and implemented, bringing production into the industrialization era. According to Vaidya, S., Ambad, P., & Bhosle, S. (2018), the steam drive contributed to the mechanization of production and thus increased the efficiency of manufactured products. It also had a revolutionary impact on the development of the means of transport

(railroads and steamboats).

The second industrial revolution (Industry 2.0 – electrification) occurred in the second half of the nineteenth and early twentieth centuries. Electricity replaced steam engines, and hence production lines within companies were able to produce products in large batches. According to Woźniak, J., Budzik, G., & Zimon, D. (2018), the new work organization in enterprises significantly influenced the price, quality, and availability of products offered on the market in the 20-to 30s of the 20th century. The rapid growth in industrial production has mainly affected South America and Western Europe. Thanks to the development of electrification, one of the most famous production lines were created by H. Ford in 1913.

The third industrial revolution is the scientific and technological revolution that began after the Second World War and continues today. Industry 3.0 - digitization: characterized by increasingly powerful computers and data processing systems that allow machines to be controlled by software. As suggested by Stadnicka D., Zielecki W., Sęp J., (2017), machines gained greater efficiency, flexibility, and precision thanks to new software. Moreover, the digitization process contributed to achieving higher and higher degrees of automation. As a result of Industry 3.0, planning and control systems began to appear to coordinate activities within production processes.

According to Trzop, A. (2020), the year 2013 is considered to be the start of the fourth industrial revolution (Industry 4.0). The name was used for the first time in 2011 during the international trade fair Hannover Messe. Industry 4.0 - means system integration and networking: it integrates people and digitally controlled machines with the Internet and information technologies. The materials that have been produced or used in production can be identified and also have the ability to communicate independently with each other. The information flows vertically- from the individual components of the IT department of the organization and from the IT department to the components. The second direction of the flow information flow is carried out horizontally and is conducted between the machines involved in the production process and the company's production system. Industry 4.0 generally comprises many complex components and has broad applications in numerous industrial sectors.

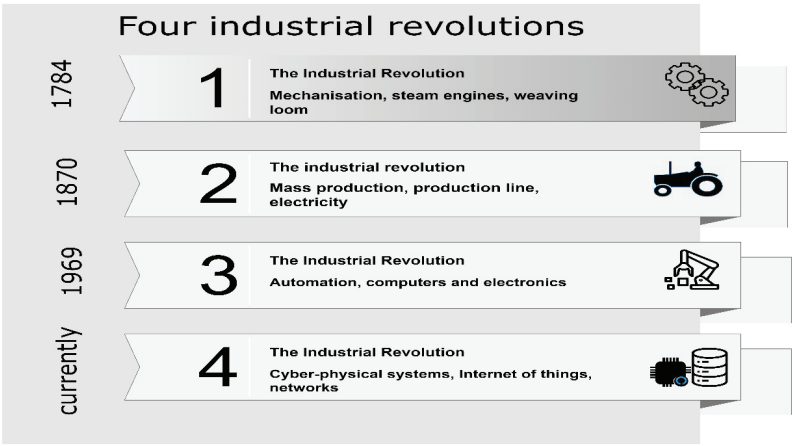

Fig. 1. Four industrial revolutions, Source: own study based on: Kiraga, K. (2016).

Additionally, to better illustrate the concept of Industry 4.0, the genesis of the industrial revolution in the world is presented below (Figure 1).

2. Industry 4.0 and Relevant Technologies

According to the literature the general meaning of production organized in a global network means that the production process can flexibly and freely adapt to all customer requirements and the activities of additional supply chain participants and the rapidly changing economic market.

The term Industry 4.0 has been recognized as a global achievement in technology. A 2016 PWC study defined three main areas that affect the development of all companies operating in different industries: the integration and digitization of horizontal and vertical value chains, the digitization of products and services, and the shaping of the digital business model and customer relationships. The connected new technologies are shown in Figure. 2.

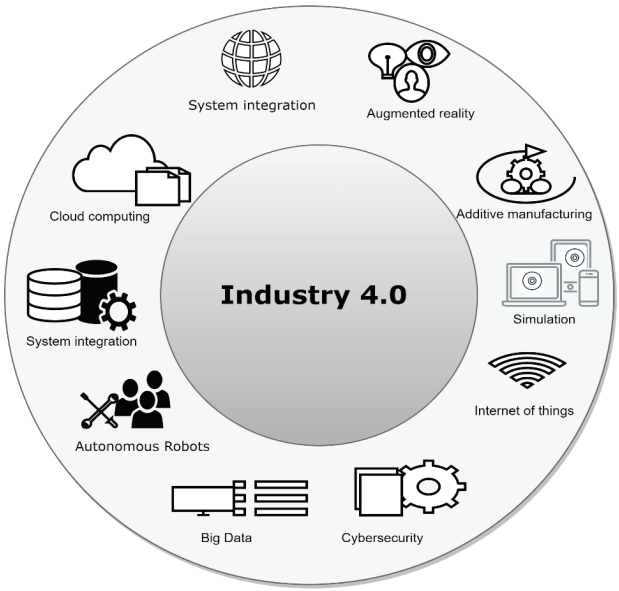

Fig. 2. The leading technologies of Industry 4.0, Source: own study based on: Special Report (2020).

3. Review of the Literature

According to Gubán, M., & Kovács, G. (2017), the digitization of the production process and Artificial Intelligence (AI) are the needs of today's industry and modern factories. The development of civilization and global technological progress has forced enterprises to constantly adapt to changing environmental conditions, which contributed to the development of the fourth industrial revolution. In the industry's history so far, the first three revolutions have been implemented over the centuries. According to Spałek, S. (2017), the three industrial revolutions have been defined as ex-post, and the fourth

industrial revolution is already defined as ex-ante. While according to research authors Sanghavi, D., Parikh, S., & Raj, S. A. (2019), Industry 4.0 is described as the epitome of the digitalization of production in this revolution. This revolution refers to the accumulation of technology in successive generations of advanced tools and techniques. Olsen, T. L., & Tomlin, B. (2020), in their research, show that the technologies underlying the concept of Industry 4.0, both individually and collectively, hold the promise of promise to reduce costs, increasing flexibility, accelerating and improving quality, but not only that, Industry 4.0 offers an opportunity to mitigate the tensions between these key operational priorities. According to the next author, James, M., et al. (2015) report estimated that by 2025 the economic impact of the IoT (Internet of Things) would be in the trillions of dollars, with the majority of this impact attributed to operations applications in the areas of inventory, maintenance, worker productivity, and optimization opportunities. IoT is considered by Xu, L. D., Xu, E. L., & Li, L. (2018) a key enabler for developing the next generation of advanced manufacturing.

Additionally, IoT can enable the creation of virtual networks to support an intelligent factory as part of the Industrial Revolution 4.0. A different view is that of Maroušek, R., & Novotný, P. (2016) that in Industry 4.0, the importance of project management in companies will increase even more. With the above in mind, it can be concluded that the hybrid approach in project management will grow. On the one hand, it is characterized as rigid on the other hand; it integrates agile methodologies into the overall project management process.

At present, one of the challenges we face is to use cutting-edge ICT and engineering technology to make Industry 4.0 successful (Mosterman, P. J., & Zander, J., 2016). Additionally, Cloud-based manufacturing is a technology that can contribute significantly to the realization of Industry 4.0 (Thames, L., & Schaefer, D., 2016). Like cloud computing, Cloud manufacturing uses a network of resources in a highly distributed way. Manufacturing-as-a-Service (MaaS) has been gaining attraction in the manufacturing industry.

In work suggested by Gajdzik, B., & Grabowska, S. (2018), as a concept of increasing the competitive economy, the German government supported the idea by announcing that Industry 4.0 would become an integral part of the country's development program, whose primary goal is to achieve global leadership in the field of innovative technologies. Industry 4.0 was also used in the German government's technology development strategy project as "High-Tech Strategy 2020." Work on developing the Industry 4.0 implementation concept was carried out by a platform created by three industry associations: the German Association of Digital Technology Bitkom, the Association of the Mechanical Industry VDMA, and the Association of Producers of the Electrical and Electronic Industry ZVEI. The developed document became the beginning of the birth of a new idea of Industry 4.0 and the leading topic in the development of enterprises, products, services, business models, modern society, and urban planning.

Based on the literature review, analysis of current research, practical experience of the authors, and visible trends in the development of the Industry 4.0 concept in cosmetic companies, research on the use of modern ICT solutions is justified. The main problem in Industry 4.0 is the lack of good scientific studies and model solutions and recommendations that can be directly applied in reality. Entrepreneurs often

have problems making the appropriate decision regarding implementing technologies such as the Internet of Things, Artificial Intelligence, Big Data, Business Intelligence, or Cloud Computing, which can positively impact building Smart Factories.

The article describes the industrial revolution 4.0 in cosmetic companies, defined as the phenomenon of the information, IT, and digital revolution, digitization, and the civilization of knowledge. Accordingly, the second goal is to interview two selected companies and familiarize them with key technological solutions, concepts, and tools used in the fourth industrial revolution. The article is based on a literature review on implementing industry 4.0 technologies in cosmetic companies.

4. Research Methodology

The idea of research related to Industry 4.0 in cosmetic companies has appeared because two Lower Silesian companies can analyze state of the art and discuss it with top managers. Those companies deal with receiving, storing, and preparing orders for individual customers and distributing cosmetics to other companies. One of the companies employs fifty people, the other one hundred and eighty people in various positions. They employ specialists, engineers, warehouse workers, and blue-collar workers in their staff. Selected companies have not yet implemented the assumptions of Industry 4.0 in their processes.

The study was conducted through interviews and surveys with senior managers in cosmetic companies. The interview was conducted concisely and pragmatically, and the researcher asked questions about technological capabilities and employees and their competencies. The interview was designed to explore the technological infrastructure of the company and the automation of production and quality processes. The next stage of the research was a questionnaire, which aimed to indicate the technological solutions of Industry 4.0 that the company could use.

One company declared its willingness to participate further in the survey. In contrast, the other company withdrew from further participation, and the survey with the senior manager was discontinued at the stage of completing the survey. A cosmetics company near Wrocław, employing 150 people in various positions, was selected to participate in the study. The warehouse area is 39,550 m^3 and is filled with equipment and storage racks that include items for sale. The company conducts warehousing and logistics processes for one of the leading cosmetics companies, which owns a chain of perfumeries specializing in selling original perfumes and cosmetics for men and women.

As mentioned earlier, the interview and questionnaire were conducted in two companies. Company A, located near Wrocław, employs 150 people. Company B, located in Wrocław, employs 180 people. Company B withdrew from further research after completing the questionnaire. The interview and questionnaire were completed by senior managers who managed all the processes in the company and reported the data to the company's director and board.

The purpose of the interview was to examine companies' level of technological involvement in their development. On the other hand, the questionnaire aimed to investigate what solutions in the field of Industry 4.0 are needed for companies to start implementing them.

The interview questions were prepared from the perspective of the technology used in the company and the managerial competence.

The survey and interview questions for the two companies are presented below.

Table 1. Interview with company A and B (Questions about technology), Source: own elaboration

Interview Part 1
Questions on technology
1. Which ERP/warehouse system is used for the company's operational processes?
2. Does the company have an automated sector with modern machinery/equipment?
3. How are operational data monitored per department?
4. What applications do they use to control operational processes, business management, and contacts with clients and contractors?
5. What tools do they use to make decisions and strategies?
6. How do they look after their products?
7. How do they secure/protect their sensitive data?

Table 2. Interview with company A and B (Competence-related questions), Source: own elaboration

Interview Part 2
Competence-related questions
1. Is the concept of Industry 4.0 known?
2. What competencies influence business decision-making?
3. What difficulties do you encounter in performing your daily duties?
4. Is the company developing?
5. Is it easy to introduce new solutions in the company?
6. What technological solutions does the company lack?
7. Whotakesstrategicdecisions?
8. Is the company investing in information technology?
9. Is the company able to implement Industry 4.0?

In the survey, managers had to answer questions about whether they would like to implement Industry 4.0. If so, which area would be most necessary for the development of their company and whether the company has a budget for the implementation of new solutions.

Table 3. Model survey on Industry 4.0 (for companies A and B), Source: own elaboration

Survey on Industry 4.0 Please complete the survey, which will be used for scientific research. The questionnaire will be used to verify the companies' approach toward technological solutions for Industry 4.0 Answers: Mark with a cross in the empty field under YES or NO.

Questions	Yes	No
1. Would I like to introduce Industry 4.0 into my company?		
2. Does the company have a budget for implementing Industry 4.0?		
3. Select the solutions that are needed in your company. Insert a dedicated percentage for each item, e.g., 10%		
Internet of Things		
Integration of systems (IT and OT)		
Digital twin		
Robotics and Automatics		
Big Data		
3D Printing		
Cloud Computing		
AI and Machine Learning		
Cybersecurity		
4. Is the company interested in learning about modern solutions for Industry 4.0?		
Metrics		
Name and surname		
Company name		
Position		

5. Results

The research has shown that the cosmetics company "A" is interested in learning about the functionality and use of the new concept and showed approval for further cooperation and contact with the researcher to confirm the desire to implement Industry 4.0. After completing the questionnaire, as previously mentioned, Company B resigned from further research. Proposals for implementing and presenting new solutions were presented only for company A.

Moving on to the interpretation of the results, the subjective feelings of the authors were taken into account. Analysis of the research showed that company A gave the following answers from the first type of interview, which indicate a fairly well automated company, but at a basic level, without much IT capability. Data is processed and presented inefficiently, without the possibility to use application/software providers for modern data visualization, e.g., BI (SAS, IBM, Oracle) or visualisation.org.

Below is the response from company A.

Table 4. Answers in respect of technology (For company A) (Source: own research)

Answers to questions about the company's technology Responses from company A
1. Mecalux WMS warehouse system, SAP system, SSP dedicated client system
2. Yes - flow racks, high bay racking, cosmetics packaging line, motorized roller conveyors, sorter for sorting already prepared customer orders, electric forklifts, pallet trucks, laser barcode scanners, data collectors
3. Data is downloaded from WMS and SAP and analyzed by managers. Reports are prepared in an EXCEL spreadsheet and e-mailed to the relevant management groups.
4. GOOGLE applications, Microsoft applications, HeySpace by TimeCamp
5. SQL database, SAP system, management meetings on TEAMS platform, Outlook mail
6. The quality department ensures constant control of products on the slope and during the preparation of orders. The expiry date and storage method are also checked during delivery—the quality department checks incoming goods for damage.
7. Traditional form - folders, sheets, and on company computers and servers, protected by individual logins and passwords of authorized persons. Data should be more protected, and we do not have the tools for this process.

The analysis of company B showed a similar range of technological functionality as company A. It is more innovative in implementing applications, and it uses more systems and tools than company A. An additional advantage is the technological equipment solutions such as belts, roller conveyors, and pick towers.

Below is the response from company B.

Table 5. Answers in respect of technology (For company B), Source: own elaboration

Answers to questions about the company's technology Responses from company B
1. Warehouse system LoMag is also connected to the online shop - Click Shop. CRM system Enova 365, Asana Work Graph program
2. Yes - push-back racks, high and low racks, pick tower, conveyor belt for transporting individual items, manual packaging stations, roller conveyor for transporting finished customer orders, forklift trucks, pallet trucks, and handheld laser, LED barcode scanners.
3. The data is analyzed in LoMag and the CRM system and then compared with individual rates. All data is entered into the Microsoft SharePoint platform, to which only authorized managers of the organization have access.
4. GOOGLE applications, Microsoft applications, applications ZOOM

5. The company uses ASANA software, which plans, organizes, and manages all the projects and tasks to be performed. The Sharepoint platform is used to analyze the most important decisions in the company.
6. The company has a separate quality department that monitors individual incoming articles and customer orders. In addition, cyclic stock inventories are carried out to prevent the distribution of articles after their expiry date.
7. Data is saved and stored in the warehouse system and on company servers and is protected by individual logins and access passwords. This is not good data security, and it can be easily stolen.

The following analysis of the study, which was an interview on the scope of competence of managers, showed a similar approach of companies to Industry 4.0. All factors of the development of companies focus on the incurred costs of implementing tools and solutions for processes in companies. The scope of competence of managers is very similar, and they know about Industry 4.0 but are aware that companies do not have enough knowledge about new solutions. Both managers also indicated which tools and equipment were missing in their companies and the degree of difficulty in implementing new solutions.

The following is a comparative analysis of responses from two companies.

Table 6. Questions and answers on managerial competence (For companies A and B), Source: own elaboration

Interview Part 2
Questions and answers on managerial competence
1. Questions: Are you familiar with the term Industry 4.0? **Responses:** **Company A:** The topic is known **Company B:** Yes, I am familiar with Industry 4.0 solutions
2. Questions: What competencies influence business decision-making? **Responses:** **Company A:** Soft skills: coping with stress and time pressure, creativity, high personal culture, leadership **Company B:** Conflict resolution skills, interpersonal skills, punctuality, commitment to tasks assigned
3. Questions: What difficulties do you encounter in carrying out your daily duties? **Responses:** **Company A:** Lack of appropriate management decisions, lack of time to deal with all the issues of the day, lack of appropriate people in post **Company B:** Lack of qualified workers

4. Questions: Is the company developing and investing in IT? **Responses:** **Company A:** In some subjects, yes, but in most subjects, the company does not want to invest in the development **Company B:** Yes, it tries to introduce new tools and solutions, but they are not at a high technological level
5. Questions: Is it easy to introduce new solutions in the company? **Responses:** **Company A:** It depends on the team of the area. People usually want new process solutions, but the company does not implement them often. **Company B:** Not always; not everyone wants to learn new things and take the time to do it
6. Questions: What technology solutions does the company lack? **Responses:** **Company A:** Integration of data in one system, access to this data is limited, lack of applications in solving warehouse and business management problems **Company B:** Warehouse equipment, new generation printers, and scanners, informatics solutions for data capture and processing
7. Questions: Does the company have the capacity to implement Industry 4.0? **Responses:** **Company A:** I do not know, I think so, but they are afraid of the high costs of implementing Industry 4.0 technological solutions **Company B**: The company has great potential and is in favor of implementing modern management methods, but there are no decision-makers in the company

The survey analysis shows that managers from both companies said they would like to implement Industry 4.0 tools in the future and decided to choose appropriate technological solutions, marking each point with a percentage. In the questionnaire, the companies marked the percentage of their preferred concepts of Industry 4.0. The second issue, which was also key, was whether the companies had a sufficient budget to implement new technological solutions. Both companies indicated that they did not have such a budget and were afraid of new solutions.

Company A felt that the best solution would be to introduce new automation or robotics solutions in warehouse and logistics processes, indicating a 50% importance rating. The least essential solution was artificial intelligence (AI) and machine learning at 5%.

Company B had similar sentiments for which the most important and effective solution was also robotics and automation at 45%, and the least important solution would be Cyber Security at 15%.

Analysis of the data shows that the two companies' needs, which operate on a similar level in the same industry, are similar. This data is presented in the table below

(Table 7) and illustrated in a pie chart (Figures 3 and 4).

Table 7. A tool for Industry 4.0, Source: own elaboration

Proposed tools for Industry 4.0		
Industry 4.0	Company A	Company B
Internet of Things	10%	10%
Systems integration	10%	
Digital Twin		
Robots and Automatics	50%	45%
Big Data		
3D Printing		
Cloud Computing	25%	30%
AI and machine learning	5%	
Cyber security		15%

The data are presented in graphs to give a more detailed picture of the concepts chosen by the two companies.

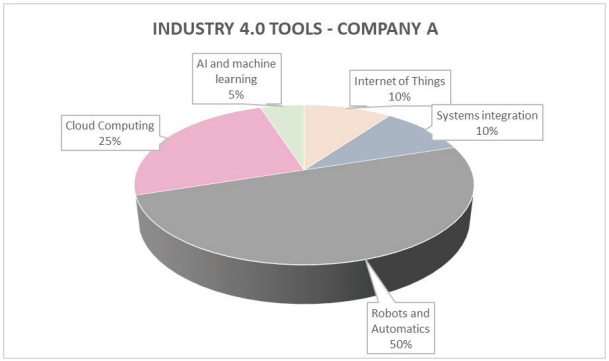

Fig. 3. Graph of Industry 4.0 concept for Company A, Source: own elaboration

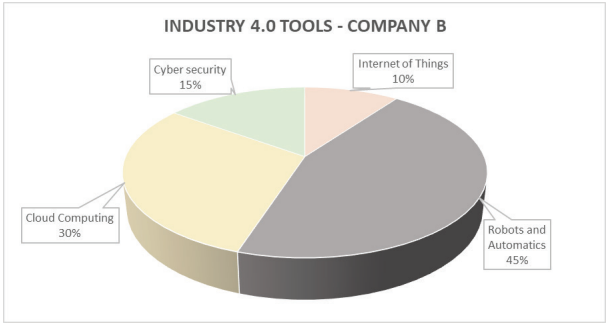

Fig. 4. Graph of Industry 4.0 concept for Company B, Source: own elaboration

The research showed that the new model of Industry 4.0 assumes mass personalization and close cooperation of both groups. In the analysis, attention was taken into account to threats and difficulties resulting from technological solutions in cosmetic enterprises in Lower Silesia. The research aimed to present and characterize advanced production technology and new business solutions in Industry 4.0. The researched companies do not have the strategic financial basis to fully use business solutions to increase flexibility and competitiveness in the Polish industrial market. The surveyed cosmetic companies have been aware of not having adequate IT infrastructure and warehouse automation. An additional barrier is the adequate competencies and training of the management and engineering staff in terms of implementation processes and maintenance of the latest technologies. The best solution for cosmetic companies would be to train their employees to implement and use new solutions of Industry 4.0.

Additionally, training companies organize training in investment management and calculations concerning optimizing particular processes. Another factor influencing the company's fears related to the implementation of Industry 4.0 is the impossibility of introducing new technological solutions due to the resistance of the management and, consequently, the lack of financial resources for the implementation of specific process improvements. The analysis of needed solutions shows that both companies need automated tools and Cloud Computing to manage business processes more efficiently. The least desired tools in both companies are AI and machine learning and the Internet of things.

The analysis of the cosmetic companies surveyed has shown that the fears and barriers of small and medium-sized enterprises before implementing Industry 4.0 are entirely understandable. However, numerous benefits should be kept in mind, including increased production efficiency and process management effectiveness, the possibility of optimizing warehousing costs, and flexible response to changing business trends. It is worth noting that the road to realizing these plans is not fast, and a fully digital enterprise is unlikely to emerge before 2030, even though many modern technologies for creating and using digital manufacturing are already available. On the other hand, digitization is necessary and cosmetic companies should gradually implement solutions in this regard and take business steps to add value for customers and remain competitive in the market.

6. Recommendations of Industry 4.0 for the Cosmetics Industry

In the following research stage, new technological solutions from Industry 4.0 were presented only to company A, as company B was not interested in further cooperation. After analyzing the interview and completing the questionnaires, the researcher presented the selected cosmetic company with solutions from Industry 4.0.

The analysis of the questionnaire showed that company A is 50% interested in new solutions in the field of Robotics and automation, so the new concept is to implement a new automatic sorting machine and the introduction of a robot in the warehouse processes as well as a software vision system for better and faster quality control at the packing stations, where they pack articles for shipping. The first example consisted of identifying production solutions for a selected cosmetics company, which are one of the most important factors influencing the company's condition and improving the

efficiency of the flow of packages prepared for shipping.

In order to better understand the operation of the conveyor line and the sorter, the construction of the individual devices is described.

• Sorting system - sorter

A sorting line consists of a mechanical and control layer whose task is to separate a stream of goods according to the parameters set by the sorting tables while maintaining the agreed technical parameters of the line. The sorter consists of the following parts:

- Transport line (transport subsystem)
- Identification-weighing-measuring device (identification subsystem)
- Sorting device (sorting subsystem)

• Sorting equipment

Sorting unit, Interroll sorter, sorter

A unit supplied by Interroll with its control system.

A sorting unit consists of:

- A system that corrects the position of the parcel in front of the sorter
- Vertical Cross Belt Sorter ST6130
- Dumpers

An integral part of the sorting line.

• Identification, weighing, and measuring device

Dimensioning-Weighing-Measuring-System (DWMS), identification gate, identification-weighing-measuring gate.

The measuring device is responsible for identifying, weighing, and measuring packages on the sorter, and it forms an integral part of the sorting line.

• Conveyor line - conveyors, conveyor system, conveyor line

A system that transports parcels from the packing area to the sorting equipment consists of several components such as straight conveyors, straight ascending conveyors, bends, angular entries, among others:

The transport line consists of:

- Stacking conveyors for parcels
- Transport system
- A combination system for packet streams (merging)
- System for correcting the position of the package in front of the identification/ weighing-measuring unit.

• Control system

The control system consists of software:

- low-level, so-called PLC
- high level, so-called WCS

The low-level control system is an integral part of the sorting line.

Implementing this Industry 4.0 solution would enable faster and more efficient sort-

ing of packages into the correct sort code, which impacts the efficiency of all other processes within the company.

Another concept presented to Company A was an arm robot for moving parcels from point A to point B. Industrial robots are programmable machines that replace manual labor for complex, repetitive tasks. Such devices are equipped with sensors that measure data in real-time. In warehouses, robots of this type are represented by lifting mechanisms and automatic conveyors. More and more small and medium-sized companies are using automated warehouse management systems. The demand for these systems continues to grow, and it is suggested that a robot that can transport heavy objects is a good solution for oversized parcels.

The surveyed cosmetics company would like to purchase a robot for its factory, but the cost of purchasing a robot is very high, and the factory fears that it will not be able to finance such a project. Many industrial robot companies on the market lend or rent such equipment for the company's needs. Robots in the cosmetics industry increase the efficiency of production lines and reduce losses resulting from production errors and packaging damage during packaging and transport. They are also used at various stages of production to pack and palletize finished products and move pallets to shipping locations. Robots can be equipped with many grippers and tools, adapted to any shape packaging, and made of any material used in the cosmetics industry. As already mentioned, cobots work with people, handling materials, operating machines, assortment picking, packaging, and operating workstations. The robots can be programmed using a tablet or smartphone.

Robotisation of the warehouse has a number of significant advantages. These include a reduction in personnel expenses, an increase in the efficiency and speed of tasks performed by robots, and the possibility of optimizing warehouse space. Companies already using warehouse robotics can appreciate the benefits of automating warehouse processes during a coronavirus outbreak. At that time, the ability to solve multiple problems with minimal use of human resources can come to the fore.

An industrial robot is a technical system consisting of a universal machine and a programmable control system. It is most often in the form of a mechanical arm capable of precise and fast manipulating various objects - even those of very high weight. Thanks to the right arm design and the proper control, the robot can reach different points in the workspace. Moreover, an interface at the end of the arm makes it possible to connect different tools (grippers and other actuators). These can be used, for example, to paint, handle, cut or perform other tasks. This, in turn, gives a very wide range of possibilities for using such a device in warehouses and logistic processes. Thanks to modern technological solutions, it is possible to determine the directions of arm movement, the strength and precision of the manipulator, and even the number of operations performed by the robot. To make this possible, it is necessary to use the potential of kinematics for the proper functioning of devices automating production processes. Each industrial manipulator has its structure, thanks to which it is possible to achieve the appropriate mobility. Its most important part is the kinematic chain, i.e., the components connected in a coherent motion system. The movement is possible because there are moving, usually rotating, connections between the components.

The following describes the basic design of a standard industrial robot that can be

used in a company to handle bulky packages (Figure 5).

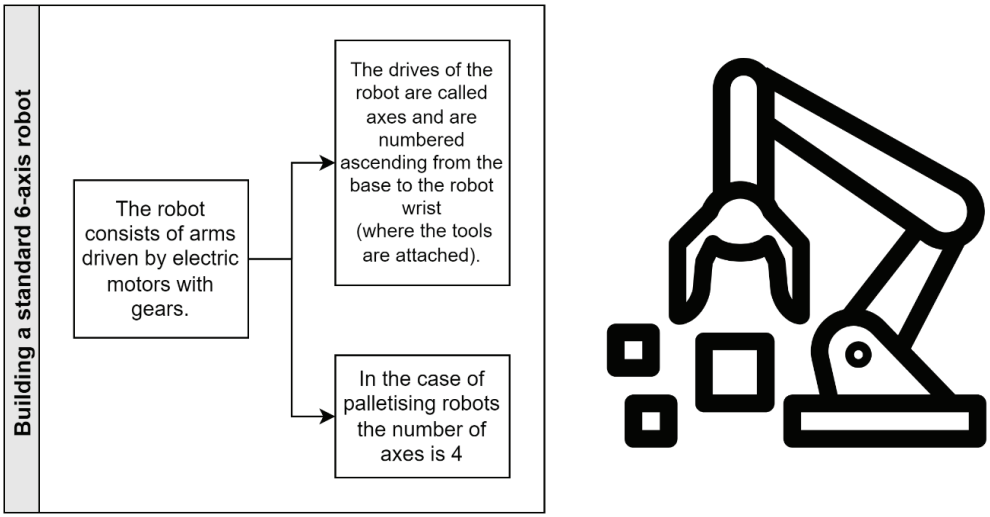

Fig. 5. Building a standard robot, Source: Training material

A technological solution for quality has also been presented from the broad spectrum of technological applications from Industry 4.0. The software used in vision systems will certainly facilitate and accelerate quality control in the company's production processes. In a few sentences, the cosmetics company manager described the functionality and usefulness of vision systems. A camera system registers images and analyzes them, thanks to appropriate algorithms, and controls the quality of a given assortment or already finished product with almost 100% efficiency. By comparison, the accuracy of human inspection is eighty percent. Therefore, the devices used for quality control can make it possible to avoid any errors related to subjective and unbiased assessments made by an employee. Another advantage is examining the most detailed shapes of any object (packaging) and focusing attention on each one, even if there are hundreds or thousands of them. Then, with vision systems, the overall production speed increases. Automating quality control processes means that many inspections are carried out on the production line at a very high speed. One more advantage is that automated quality control takes place within set tolerance ranges. Automatic documentation has also been discussed, which contains information from the entire production process, allowing data, e.g., photos, figures, to be linked to documentation, serial number, production batch with all important data subject to quality control. The presented quality tool positively surprised the surveyed companies, which would gladly introduce this solution into their quality processes.

One such solution is software that will show the correct article that a packstation employee has scanned on a monitor. Pack2Graph is a solution that provides a better graphical user interface for packing products directly before sorting and shipping. The project's premise is to present packers with images of the products used in the

process. This solution provides a correct preview that shows the production staff the product's image to be picked during order picking.

This solution can provide an improved, straightforward user interface integrated with the monitoring system at each packing station. The learning process for new employees will be shortened thanks to intuitive solutions. Thanks to product visualization, errors will be minimized, and packaging will be better adapted so that the shipment reaches the end customer safely.

The new system for the packing station is already being tested in other logistics and warehouse companies in a production environment. These companies have shown their approval of this quality solution.

You see the product scooter in the example below, and the monitor shows a preview of the same product. The employee can identify the product with the displayed information from the interface. This solution guarantees that the article can be checked on the current database of all articles and the individual number of the product, the name of the manufacturer, and the type of packaging that should be used to protect the product from damage.

Fig. 6. Graphic presentation of product visualizations (Source: Training material)

In Poland, the cosmetics industry is intensively developing and competing with Western neighbors, thanks to the quality of manufactured products and modern technologies in production processes. Additionally, the introduced automation of processes accelerates production, reduces costs, improves the quality and repeatability of products, and allows for faster response to changing market needs, thanks to greater production flexibility. Maintaining the competitiveness of cosmetic companies in the dynamically evolving market requires investments in modern technologies that will optimize production and be flexible and quickly respond to new trends and consumer

needs. Therefore, the presented Industry 4.0 solutions for the Lower Silesian company were aimed at introducing it to the above aspects and making it aware of potential profits in the future (Bieńkowski, M., 2018).

7. Future Research

Future research can be oriented on Industry 5.0 and Industry 6.0 to characterize them in terms of functionality and modern techniques to support business management. As a short introduction to the above subject, the most critical aspects of these two newest generations are presented and characterized. In the further development of enterprise automation and the technology used, a vision is already being generated to introduce Industry 5.0, which considers the use of artificial intelligence. The Industry 5.0 concept will focus on the return of humans to the production system. According to Industry 5.0, the autonomous workforce is to be perceptive and informed about people's intentions and needs (Nahavandi, S., 2019). In this revolution, man and machine will find ways to work together to improve the quality and efficiency of production. In industry 5.0, the focus is on the interaction of human and artificial intelligence, i.e., robots, which act together with people as cooperative devices for specific activities. In another context, probably a more accurate term instead of for Industry 5.0 is "Society 5.0" (SuperSmart Society), which was proposed in 2016 by Japan's most crucial business federation Keidanren and is strongly promoted by the Council for Science, Technology, and Innovation; Cabinet Office, Government of Japan (Nirmala, J., 2016).

According to research by Skobelev, P. O., & Borovik, S. Y. (2017), in contrast, to Industry 4.0 concept, Society 5.0 is not limited to the manufacturing sector but solves social problems by means of integration of physical and virtual space. In fact, Society 5.0 is a society in which advanced information technologies, IoT, robots, artificial intelligence, augmented reality (AR) are actively used in people's everyday lives, in industry, healthcare, and other spheres not for progress but the benefit and convenience of every human being. Industry 6.0 assumes that computer systems should manage productive resources and production should be with robotic sensors with AI. Artificial intelligence will manage the movement of resources, scientific activities, and living conditions for maximum efficiency. AI will not automate tasks, but it will automate certain professional skills. Most industrial tools or mechanical products will be operated without human intervention. Instead, it will use 3D printing, nanotechnology, and computer-aided manufacturing. Industry 6.0 is also defined as ubiquitous, customer-centric, virtualized, and characterized on the one hand by customer orientation, highly personalized thinking about production batch size; on the other hand, hyper-connected factories with dynamic supply chains where data flows between domains. While we already have strengths that prepare us to lead the next industrial revolution, we also have serious shortcomings. We need to raise ICT knowledge across the industry; we need multidisciplinary research, development and innovation, and a strategy for long-term public commitment and significant investments (Business Finland, 2021).

8. Conclusions

The concepts of assumptions of the Industry 4.0 will help cosmetics producers respond to individual customer requirements, as well as the related growing demands

for increased productivity and efficiency. The cosmetics industry focuses on smart factory solutions, emphasizing increasing production flexibility while reducing its costs. It is assumed that the new work organization will ensure the virtualization of economic processes will enable access and use of group intelligence by initiating, creating, and applying knowledge within informal knowledge networks and specialist knowledge without the need to hire external specialists. . In the future, cosmetics companies will have to establish global networks of machines, storage systems, and production equipment in cyber-physical systems. In a production environment, such systems will include intelligent machines, storage systems, and production devices capable of autonomously exchanging information, triggering actions, and controlling each other. This will facilitate fundamental improvements to industrial processes related to manufacturing, engineering, material applications, and the supply chain. The factories producing cosmetics in which innovations have been implemented and an effective supply chain are referred to as the modern factories of the future.

This research shows that managers of cosmetic companies are not negatively oriented toward new trends but are rather afraid of the financial costs and the fact that they do not have qualified managerial staff and engineering knowledge needed to implement the fourth revolution in their enterprises. This is confirmed by the Deloitte study (2018), which shows that nearly half - 43% of managers considered that human resources and talents are the main factors driving digital innovation in enterprises. In general, research has indicated two barriers related to the transformation of Industry 4.0; the first is the company's lack of proper organizational culture. The second is the lack of appropriate competencies by the employee team (BiznesRaport, 2021).

According to another study, it has been observed that only 15% of Polish factories are fully automated, 76% of the factories surveyed indicate partial automation, and only 6% indicated that they are only in the process of introducing the idea of Industry 4.0 (Astor, 2015). Moreover, only a small part of factories still use IT systems to manage and control production processes through MES (Manufacturing Execution System) systems.

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