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TITLE: REVIEW PAPER ON AUTOMATION INDUSTRY, INDUSTRY 4.0

Abheek Shah[1], Jahnvi Sheth[2]

[1] Student, Mechanical Department, Dwarkadas J. Sanghvi College of Engineering, Maharashtra, India
[2] Student, Mechanical Department, Dwarkadas J. Sanghvi College of Engineering, Maharashtra, India

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Abstract

This review study focuses on automated manufacturing in the automotive industry, with an emphasis on Industry 4.0 technologies. We go over particular Industry 4.0 technologies that are being implemented in manufacturing organizations, such as improved robotic devices, 3D printing, the Internet of Things, and automated production. Manufacturing enterprises in the automotive sector that operate in Slovakia and the Czech Republic made up our research sample. Both countries are major actors in the global automobile manufacturing industry. We created an electronic questionnaire and constructed questions based on a theoretical evaluation of prior studies and research to collect data. Two assumptions were made, and the average degree of technology use was used to verify them. We also looked at the level of automation and other Industry 4.0 technologies that have been implemented. Sensors, programmable devices such as PLCs and HMIs, and industrial robots were all used often, according to the findings. According to another examination of the data, large industrial organizations use automation aspects at a higher level than medium and small businesses.

Key Words: *Industry 4.0, Automation, Industrial Revolution, Levels of Automation*

1. Introduction

Automated features can be found in modern technology employed in modern automotive production. Automation has a number of advantages for manufacturing. It simplifies procedures and streamlines production, resulting in reduced time and personnel costs. On the market, we can find technologies that are both cheaper and more capable of accelerating the rise of completely automated production. Automation in the manufacturing industry can increase quality, reduce lead times, streamline production, and streamline workflow. In the automotive business, automation is crucial. Technology in the field of automotive automation is constantly improving. Sector 4.0 presents challenges and opportunities that have shifted the automotive industry dramatically since the first industrial revolution. We may distinguish four significant phases of the industrial revolution , each of which introduced new discoveries and technological advancements. The commencement of the industrial revolution can be traced back to the 18th century's 60s. The commencement of the first industrial revolution is symbolized by the use of a new source of energy, the steam engine. With the discovery of electricity and the adoption of assembly lines, the second industrial revolution improved output. Computer technologies, such as computers or PLC programmable devices, ushered in the third industrial revolution. Advanced robotic devices, 3D printing, the Internet of Things, and automated production are all introduced into manufacturing enterprises during the fourth industrial revolution. Since the start of the second industrial revolution, a good foundation has been established for the adoption of technologies in the automobile sector that are continually growing and progressing. The automobile business segment is quite appealing, and the market is essentially global. When adopting 4th industrial revolution technologies, automobile firms have a lot of options for using automation features, which can considerably simplify the manufacturing process. Artificial intelligence, automation, and sensors will almost certainly lead to a slew of new vehicle advances. "Industry 4.0" refers to the confluence of these new technologies. The automotive industry is seen as a forerunner of Industry 4.0, with an annual investment of roughly 65 billion dollars in innovative industrial technologies. In the perspective of industry 4.0, we define automation as a set of technologies that enable machines and systems to operate without requiring considerable human intervention. This is also the most significant distinction from manual labor. [10] HMI panels (Human Machine Interface), SCADA visualization (Supervisory Control and Data Acquisition), PLC programmable devices, industrial robots, autonomous logistics devices, and other systems are examples of such systems. Robots have the most important representation since they are self-contained, can be programmed, and have security mechanisms. In many European countries, as well as around the world, the automotive sector is currently dominant. The production sector accounts for the majority of state GDP, particularly in Slovakia and the Czech Republic. In our research, we decided to assess firms' level of adaption and development in implementing 4th Industrial Revolution technology and automation aspects. On the basis of theoretical knowledge, professional and current writings in the field, as well as personal experience and observation in the automobile sector, we developed two hypotheses. Automotive manufacturing companies and their Operations/Technical Managers received the questionnaire. We tested and compared the average level in different sorts of firms to confirm the assumptions (small, medium-sized and large). The following is a breakdown of the paper's structure. We cover developments related to Industry 4.0 after a brief introduction in the literature review. We give a brief overview and history of industrial revolutions, as well as the current direction and technologies of Industry 4.0 for the automotive manufacturing industry, in this section. The data and methodology of our study are described in the following section. The section Results presents and summarizes the study and analytical findings. Our significant findings are summarized and concluded in the final section.

2. Literature Review

2.1 Effect of industrial revolution on manufacturing

The characteristics of each epoch of the industrial revolution, the cross-section of technological developments, and individual milestones may all be found in the literature. The first industrial revolution began in the 18th century, when steam engines and factory production using new technologies were introduced to the textile sector. Machine production took the role of manual labor. Efficiency and productivity of work have been increased several times. The steamer was also a significant change in the transportation industry. Other characteristics include worker specialization and the use of new materials like steel. In the nineteenth and twentieth centuries, the second industrial revolution occurred. The invention of electricity and the concept of using an assembly line were the fundamental foundations of this period. In the automotive business, Henry Ford introduced belt production, which once again offered up the possibility of boosting production capacity while lowering prices. Computers were also invented at the same time as the first automated operations. In the middle of the twentieth century, the third industrial revolution began. Digital technologies, such as programmable logic controllers (PLCs) or robotics, are the most prominent features. As a result, automation, such as the peak of industrial production, became possible. Devices can connect with one another over a network and with the rest of the world via the Internet. The first computers and computer systems are also available; analogue connections have been converted to digital connections. [5] The human workforce is being replaced by automation. In the twenty-first century, technology experienced another "boom," resulting in the start of the fourth industrial revolution. IoT (Internet of Things), artificial intelligence features, enhanced robots, completely automated production, 3D printing, and high-speed network connections via optical fiber are all being included into the manufacturing process. Predictive maintenance, in which intelligent sensors detect issues ahead of time and hence dramatically reduce outages, is also gaining traction. The production process and expenses can be easily optimized with these technologies. It's important to remember that the 4th Industrial Revolution impacted manufacturing companies across the board, including logistics, management, and marketing. Man can be removed from the production process as a productive force, and intelligent machines can communicate with one another. [11] Automotive companies will almost certainly need to combine a number of innovative technology to succeed today. CASE (connectivity, autonomy, shared mobility, and electrification) technologies are those that are driving significant changes in the worldwide automotive industry.

2.2 Advantages of concept implementation of Industry 4.0 in manufacturing companies

- Agile supply chain - technologies can help with logistics concepts like JIT in a very effective way (just-in-time). It is possible to change orders fast and easily, reply swiftly, and tailor the process to your needs - whether you are the provider or the customer.

- Prediction and monitoring tools - production firms typically run 24 hours a day, seven days a week, therefore IT systems and production technologies must be able to prevent breakdowns or interruptions in output. Robust monitoring technologies, which aid in the early detection of problems or breakdowns on particular systems, are ideal in the context of the Industry 4.0 concept.

- System adaptability - previously, there was little room for change in the manufacturing process. Industry 4.0 technologies make it feasible to set up and program devices so that many models of a manufactured product (different colors, different components on the line, etc.) can be produced on the same line at the same time - in the expected sequence, of course.

- Network technology flexibility - this isn't just about configuring network elements in terms of communication speed, which is critical in the manufacturing process. However, it is also a means of connecting to and communicating with the outside world. As a result, the entire manufacturing process becomes more compatible and dynamic. Of course, while communicating outside the organization, the relevant security regulations must be followed.

- Document and process digitization - this can be viewed as a requirement for the adoption of automation procedures. The horizontal (supplier - company - customer) as well as the vertical (supplier - company - customer) chains should be digitized (across departments of the organization).

- Increased production capacity and efficiency - Industry 4.0 technologies may be used to optimize energy usage, the production process itself, better resource redistribution, create higher quantities on the production line, and find areas for future enhancements all at the same time.

Another benefit that we can always argue is cost savings. Regular maintenance and timely monitoring ensure the availability of technologies, preventing unexpected outages and the consequences of such outages, such as equipment damage and downtime, which results in a negative figure in the cumulative production plan. The frequency of errors and accidents at work is automatically reduced as a result of correctly working technologies. Automation, high-speed networking, machine learning, and low-cost computing are highlighted as current problems and relevant topics in Deloitte's current resources and insights in the automobile industry's Industry 4.0 concepts. One of the most important prerequisites for today's firms' success is to digitize all processes and invest in the most up-to-date technologies. New technologies offer new ways to gain a competitive edge. The firm also lists critical questions that a business should consider if it wants to succeed in Industry 4.0: What will customers demand in the future? Which benefits of innovation will have the greatest impact on the automobile industry? How will we fund necessary development and research investments? The automobile industry's present focus in terms of manufacturing will be mostly on electric cars and alternative forms of motor drives. Hybrid drives and electric motors are replaced by gasoline and diesel engines. Self-driving cars with their own control algorithms are a distinct phenomenon. A functioning infrastructure in the country, including as charging stations, is a key prerequisite for the sale and successful operation of such cars. The state, on the other hand, should provide substantial assistance. In this circumstance, there will be a natural demand for the appropriate vehicle. Countries including the United States, India, Germany, China, South Korea, and Japan are currently the market's biggest participants.

2.3 Automation in the context of Industry 4.0

The term "automation" in the context of Industry 4.0 refers to a set of technologies that allow machines and systems to operate without requiring considerable human intervention. This is the most significant distinction from manual labor. The following features should be present in such a system or device: sufficient information regarding the device's running / operating mode, warnings of dangerous dangers, and the potential of manual restriction or human intervention. HMI panels (Human Machine Interface), SCADA visuals (Supervisory Control and Data Acquisition), PLC programmable devices, industrial robots, autonomous logistics devices, and other systems are examples of such systems. There's also the possibility of automated processes convergent at the system level. These systems either perform, backup, or monitor (automatic) something. Individual production terminals have varied qualities that allow them to communicate with one another, as well as be optimized, programmed, and monitored. There are also devices that can control themselves or be controlled remotely. Because they are autonomous and can be programmed, robots have the most important representation. They also have security mechanisms. On assembly lines or, for example, during welding, such robots can take the position of humans. It's crucial to emphasize supporting technologies like IoT, cloud computing, big data analysis, 3D printing, artificial intelligence, process simulation, or monitoring when discussing automation within Industry 4.0. The Internet of Things (IoT) is a term that refers to various types of communication between terminal equipment (physical objects) and the Internet. The notion of IIoT (Industrial IoT) applies to industrial production and types of communication within manufacturing plants in manufacturing industries. It's also worth mentioning M2M (machine-to-machine) communication, which is a type of wireless or fixed network connection between two different devices. The term "smart factory" refers to a manufacturing company that uses Industry 4.0 concepts. All devices, services, network technologies, applications, sensors, software, and storage systems can be included in the IIoT. They may keep track of industrial processes and equipment, as well as their current status. They improve production efficiency and analyze real-time process operation. The Internet of Things (IoT) is a requirement for integrating automation in the manufacturing business. Specifically, we find a variety of technologies in the automobile industry, including industrial robots, programmable PLC devices, HMI stations, visualization technologies (SCADA), logistics solutions (logistics platform 4.0), and localization technologies such as RFID and RTLS. Such devices are capable of immediately exchanging data and receiving feedback, alarms, or other warnings. They are also linked to the command and control systems. Within logistics technology, the door is opening for cost reduction and optimization solutions through the improvement of existing routes. Devices can also save records, which are referred to as logs and can be reviewed by service management. However, one of the major downsides and concerns is the security risk and vulnerability associated with network connection within these Industry 4.0 devices.

3. Methodology

3.1 Research Goal

Many European countries, as well as the rest of the world, are today dominated by the automotive industry. The production sector accounts for the majority of state GDP, particularly in Slovakia and the Czech Republic. The technologies of the fourth industrial revolution are giving this segment a whole new dimension and propelling it forward by leaps and bounds. These two countries have consistently led the world in terms of automobile production per capita. In our research, we decided to assess firms' level of adaption and development in implementing 4th Industrial Revolution technology and automation aspects. We think this research to be valuable, especially for the automotive industry, because we do not yet have a similarly concentrated study at this level. The goal of our article is to determine the extent to which technology is being used in industry 4.0, with a focus on assisting automation, in a sample of Slovak and Czech automotive enterprises. We also included questions about automation deployment, IT service delivery, network outages, and Industry 4.0 supporting technologies in the survey. On the basis of theoretical knowledge, professional and current papers in the field, as well as personal experience and observation in the automobile market, we developed two hypotheses. We give the results, which demonstrate the average level of adoption of individual automation aspects across different size groups of firms, to aid verification. The sample was separated into three groups based on the size of the company (micro/small, medium-sized, and large). The elements in various questions were graded on a scale of 1 (not yet implemented), 2 (basic level of implementation), 3 (medium level of implementation), and 4 (highest/advanced level of implementation). Assumption 1: Across the whole automobile sector, robots and programmable devices are the most extensively employed parts in automated manufacturing. Assumption 2: Large manufacturing organizations employ more advanced automation techniques than medium and small businesses.

3.2 Research sample and data collection

To gather information, we created an anonymous questionnaire poll that allowed companies to freely express themselves. The questionnaire was created to provide a more thorough picture of the automotive manufacturing business in the Slovak Republic and Czech Republic while also protecting the companies' know-how. We decided to use an electronic questionnaire to obtain the data. We used a theoretical evaluation of prior studies and research to formulate queries. With an emphasis on production, we looked at firms in the automobile industry in Slovakia and the Czech Republic. We split them into three groups for research purposes: small, medium-sized, and large businesses. The questionnaire was issued to around 300 Slovakia and Czech Republic-based companies. FinStat.sk, ivéfirmy.cz, and azet.sk were used to choose companies from Slovak and Czech databases. The questionnaire was given to Operations and Technical Managers. We chose the following categories (SK NACE 29) for the specified automotive industry: manufacturing of motor vehicles, manufacturing of various parts and components for motor vehicles, manufacturing of modules (module supplier), and manufacturing of electronic components for motor vehicles. A total of 106 respondents correctly completed the questionnaire. Companies were classified into categories for research reasons based on their size, age, and fundamental business life cycle. Table 1 summarizes the results of the sample distribution. The majority of respondents (46) were from huge corporations, with only 18 from micro and small businesses. Companies that have been on the market for more than 15 years (79) and those that are now in the growth phase of their life cycle were the most common among those questioned. We believe that such organizations have a better chance of implementing Industry 4.0 concepts because they have a solid understanding of the market, external and internal conditions, suppliers' networks, competent personnel, and in-house research.

Table -1: Research Sample

Variable	Category	Number
Size	Small	18
	Medium	42
	Large	46
	Total:	106

Table -2: Research Sample

Variable	Category	Number
Age	<15 years	5
	5-15 years	22
	15+ years	79
	Total:	106

Table -3: Research Sample

Variable	Category	Number
Life	Establishment	2
	Growth	52
	Stabilization	46
	Critical Phase	6

4. Results and discussion

4.1 The level of automation implementation

We looked at the degree to which automation aspects were used in the manufacturing process in the first section. Industrial robots, programmable devices, autonomous devices, logistics technologies, localization technologies, SCADA systems, and automated monitoring are all included in this category. The following scale was used: 1 - we do not use automated manufacturing, 2 - we use it at a basic level, 3 - we use it at a medium level, and 4 - we use it at the highest / most advanced level. Only 8% of organizations reported a low level or no deployment of such automated aspects, as seen in Figure 1. Almost the same amount of businesses (37 percent and 39 percent, respectively) chose the basic or medium level of implementation, while 17% chose the advanced level. Large and medium-sized businesses with a history of more than 15 years on the market validated the sophisticated level of application. In terms of these companies' life cycles, the growth period was the most important. As expected, micro and small businesses in the stabilization phase (5-15 years on the market) responded by using automation technology sparingly or not at all. Motor vehicle manufacturers and enterprises that make additional parts and components for motor vehicles have the greatest / advanced level of automation deployment, according to the industry category.

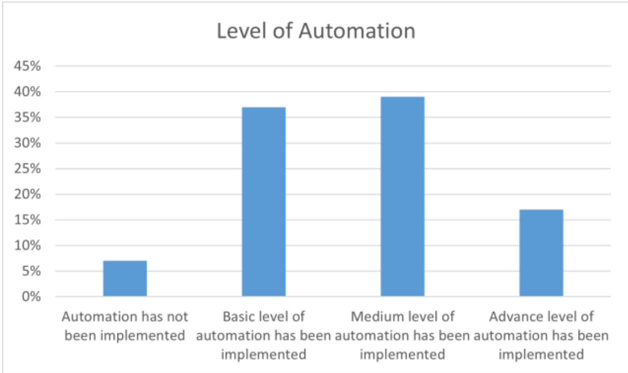

Chart -1: Level of automation elements implementation

4.2 Advantages of Industry 4.0

In the following section, we looked at the advantages that organizations obtain by implementing automated production. We observed the following advantages: improved production efficiency, cost savings, and digitization of paper documents. Errors and flaws are eliminated, product quality is improved, production procedures are simplified, monitoring tools are used to predict outages and provide an overview of the present status of production, and finally, workplace safety and protection are improved. The evaluation was given on a scale of 0 to 4, with 0 denoting no benefit and 4 denoting a significant/key benefit. The total results for all examined companies are shown in Figure 2. The following categories received the highest ratings (on a scale of 1 to 3): boosting production efficiency, cost savings, enhancing product quality, and simplifying production processes. The favorable effect was boosted by features such as the removal of errors, monitoring systems, and the digitization of paper documents (in the scale mostly 3 and 2 ranking). The features of greater safety and protection at work, as well as the reduction of errors, dominated the scale rated 1 and 2. The most essential factors for medium and big enterprises, according to the analysis by number of employees, are production efficiency, digitization of paper manufacturing, simplification of production processes, and monitoring systems. It's also worth emphasizing the cost-cutting criterion, which was imposed by the majority of small businesses. In the theoretical section, we discussed the individual benefits and causes. Each of these advantages, on the other hand, is an important aspect of any company's daily operation on the market. Cost savings and improving product quality were the most important considerations for enterprises with a life cycle of more than 15 years and operating on the market during the stabilization and growth period.

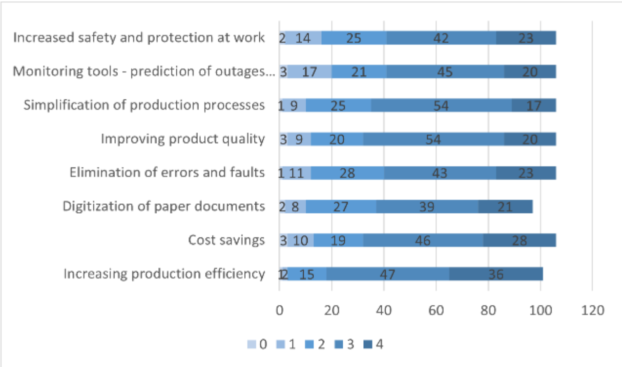

Chart -2: Advantages within the implementation of automated production

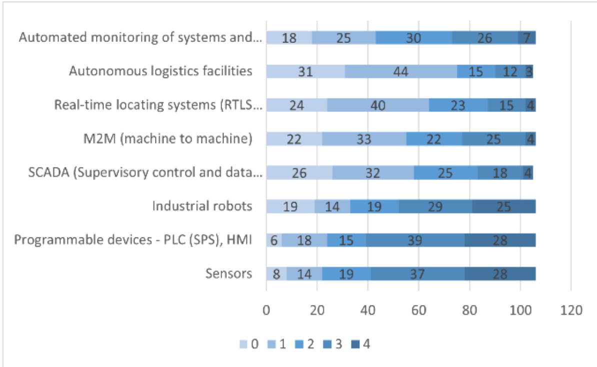

Chart -3: Level of use of Industry 4.0 components

4.3 Specific components of Industry 4.0 and the level of their implementation

Other technologies that complement automated manufacturing - IoT, cloud computing, big data, 3D printing, artificial intelligence, process simulation, energy monitoring, and others - were investigated at the application level. The evaluation was based on a Likert scale of 0 to 4, with 0 denoting little or limited use and 4 denoting advanced use. The results in Figure 3 demonstrated that sensors, programmable devices, and industrial robots were used at an advanced level. These technologies were generally employed in huge organizations with a 5-15 year history on the market that were still in the early stages of their operations. Medium-sized businesses affirmed the lower degree of use (on a scale of 0 to 1) of SCADA, M2M, and autonomous logistics facilities during the stabilization phase. SCADA is a system that aids firms in operational production but is not widely employed. It may monitor energy use and hence give input data for prospective system optimizations, in addition to reporting current status in manufacturing. Finally, the benefits of automated monitoring in manufacturing organizations can be summarized as follows: lower equipment maintenance costs, higher system availability, fewer outages, and early error identification. Energy consumption efficiency can also be monitored using monitoring tools. The absence of these systems in manufacturing organizations might result in a number of disadvantages when compared to competitors in the industry. As a result, organizations must adapt to these developments and prepare for the difficulties ahead.

4.4 Assumptions

Two assumptions were made. To help with verification, we've included Table 2, which displays the average level of utilization of individual automation aspects across different company sizes. We can view and compare the differences in size between three groups of companies based on the studied results.

Table -4: Average values of the implementation level of automation elements

	Companies size		
	Micro	Medium	Large
Sensors	1.61	2.40	3.15
Programmable devices	1.38	2.43	3.26
Industrial robots	1.17	2.05	2.87
SCADA	0.94	1.19	1.89
M2M	1.05	1.38	1.98
Real-time locating systems	1.22	1.16	1.65
Autonomous logistics facilities	1.00	0.83	1.52
Automated monitoring of systems	1.50	1.45	2.24
Number of companies	18	42	46
Level of automation implementation	2.27	2.38	3.04

Assumption 1: Across the whole automobile sector, robots and programmable devices are the most extensively employed element in automated manufacturing. We can observe from the data (Table 2) that large businesses use each technology at a higher level than medium and small businesses. It's also true that sensors and programmable devices in medium and

big businesses obtained the highest level in each category. On the third place, industrial robots were mostly deployed in large and mediumsized businesses. As a result, the supplied assertion in assumption 1 is incorrect. However, only part of the statement is true: programmable devices are the most widely utilized component in the automotive sector. Assumption 2: Large manufacturing organizations use more advanced automation techniques than medium and small businesses. We can see from the data (Table 2) that large organizations have a higher level of automation (3.04 on a scale of 1 to 4, with 4 being the highest and 3 being a medium level of implementation). In large firms, we can witness a better level of implementation in all components. It is also true that medium-sized businesses employ automation aspects at a higher rate than small businesses and micro-businesses. On average, none of the components are implemented at the highest / most sophisticated level. Result: Hypothesis no. 2 is correct, and major manufacturing organizations apply automation aspects at a higher level than medium and small businesses.

5. Conclusion

The importance of automated production was underlined in the article, which opens the door to manufacturing enterprises. Production procedures are vital for businesses, according to study, especially if they want to increase their efficiency and fluidity. Companies in the manufacturing business attempt to reduce excessive downtime and errors by preventing rather than solving accidents. As a result, investing in the proper, dependable, and supported technologies should be a given. The correct order in the operation of ITIL can be introduced in the processes themselves, in terms of IT and technology, by service management, which is regularly updated for the demands of services - presently the 4th generation of ideas. We discovered that sensors and programmable devices are the most commonly utilized elements in the automobile industry, and that major manufacturing organizations apply automation elements at a higher degree than small and medium-sized businesses, based on the verification of our hypotheses. Because smaller businesses have fewer resources, particularly in terms of capital, we may highlight the benefits of collaborating with external partners [21] such as research institutions, universities, or business incubators. These forms of collaboration can be less expensive than conventional market vendors; early costs were one of the most significant barriers to technology adoption. There's also room for wholly new technologies to be developed, existing systems to be improved, and industrial processes to be automated. Automation, high-speed networking, machine learning, and low-cost computing are contemporary technologies in Industry 4.0 in the automotive industry, according to current resources and insights from consulting firm Deloitte [12]. One of the most important prerequisites for today's firms' success is to digitize all processes and invest in the most up-to-date technologies. Not only to stay ahead of the curve, but also to invest in our own research, because new technologies are new competitive advantage carriers. Co-bots are currently referred to be a new generation of autonomous robots that are gradually replacing traditional industrial robots. In this segment, investments in new and accurate technology provide competitive advantages. Co-bots are far more adaptable, safe, and sophisticated than traditional robots. They are simple to use and integrate with existing systems. It's also possible to improve the quality or speed of the manufacturing process. On the global market, large firms like BMW and Nissan can already boast of this technology. We attempted to emphasize the utilization of technology and its positive impact on the company in this report. However, we must not overlook the drawbacks that this stage of the industrial revolution brought with it, such as security vulnerabilities, the cost of operational inquiries, the need to change business processes, and, most recently, the disruption and failure of wireless communication directly in production. These are also worthwhile areas to investigate further in terms of research questions.

REFERENCES

[1]. Tilley, J. (2017) "Automation, robotics, and the factory of the future." Retrieved from: https://www.mckinsey.com/businessfunctions/operations/our-insights/automation-robotics-andthe-factory-of-the-future

[2]. Patra, K.K., and Bhattacharjee, D. (2012) "Engineering, Economics and Costing." S Chand Publishing: New Delhi. Retrived from: https://books.google.sk/books?id=oXCa96h2KbQC&pg=PA256&lpg=PA256&dq=automation+simplified+production&source=bl&ots=Vq4_9coPlP&sig=ACfU3U1FhpRfGIzJkPn8bi6ESf1grRBMlA&hl=sk&sa=X&ved=2ahUKEwjAnLh6rxAhXH8bsIHTxvD8YQ6AEwB3oECAsQAw#v=onepage&q=automation%20simplified%20productio n&f=false

[3]. Salajová, N., and Kohnová, L. (2019) „Industrial Revolutions and their impact on managerial practice: Learning from the past." Problems and Perspectives in Management 17 (2): 462-478.

[4]. Cejnarová, A. (2015) "Od 1. průmyslové revoluce ke 4." Retrived from: https://www.technickytydenik.cz/rubriky/ekonomika-byznys/od-1- prumyslove-revoluce-ke4_31001.html

[5]. Kohnová, L., Papula, J., and Salajová, N. (2019) "Internal factors supporting business and technological transformation in the context of Industry 4.0." Business: Theory and Practice 20: 137- 145.

[6]. Helper, S., Martins, R. and Seamans, R. (2019) "Who Profits from Industry 4.0? Theory and Evidence from the Automotive Industry" NYU Stern School of Business. Retrieved from: https://ssrn.com/abstract=3377771

[7]. Agrawal, G., Goldfarb. (2018) "Prediction Machines: The Simple Economics of Artificial Intelligence." Harvard Business Review Press: Boston, MA.

[8]. Cassia, F. and Ferrazzi, M. (2018) "The Economics of Cars" Newcastle upon Tyne: Agenda Publishing.

[9]. Geissbauer, R., Vedsø, J. and Schrauf, S. (2016) "Industry 4.0: Building the digital enterprise" London: PricewaterhouseCoopers.

[10]. Akogbe, M. (2015) "Brief Overview of Automated Industrial Plant: A Review." Retrieved from: https://www.researchgate.net/publication/282199407

[11]. Popkova, E. and Ragulina, Y. and Bogoviz, A. (2019) "Industry 4.0: Industrial Revolution of the 21st Century"

[12]. Dut, D., Wilson, A., Natarajan, V. and Robinson, R. (2020) "Steering into Industry 4.0 in the automotive sector" Retrived from: https://www2.deloitte.com/us/en/insights/industry/automotive/industry-4-0-future-of-automotiveindustry.html

[13]. Geissbauer, R., Schrauf, S., Koch, V. and Kuge, S. (2014) "Industry 4.0 – Opportunities and Challenges of the Industrial Internet" Retrieved from: https://www.pwc.nl/en/assets/documents/pwc-industrie-4-0.pdf

[14]. Masters, K. (2017) "The Impact of Industry 4.0 on the Automotive Industry." Retrieved from: https://blog.flexis.com/the-impact-ofindustry-4.0-on-the-automotive-industry

[15]. Weg (2019) "How Companies Can Reduce Costs with Industry 4.0 Implementation" Retrieved from: https://www.weg.net/institutional/US/en/news/products-and-solutions/how-companies-canreduce-costs-with-industry-4-0-implementation

[16]. Vitale, J. and Giffi, C. (2020) "Industry 4.0 in automotive. Digitizing the end-to-end automotive value chain" https://www2.deloitte.com/content/dam/insights/us/articles/automotivenews_industry-4-0-in-automotive/DI_Automotive-NewsSupplement.pdf

[17]. Bahrin, M., Othman, M., Azli, N. and Talib, M. (2016) "Industry 4.0: Review on Industrial Automation and Robotic" Journal Teknologi 137-143.

[18]. Radziwon, A., Bilberg, A., Bogers, M. and Madsen, E.S. (2014) "The Smart Factory: Exploring Adaptive and Flexible Manufacturing Solutions", Procedia Engineering, 69: 1184-1190, ISSN 1877- 7058, https://doi.org/10.1016/j.proeng.2014.03.108.

[19]. Lampropoulos, G., Siakas, K. and Anastasiadis, T. (2019) "Internet of Things in the Context of Industry 4.0: An Overview." International Journal of Entrepreneurial Knowledge. (7): 4-19. doi:10.2478/ijek-2019-0001.

[20]. Tenghong, L., Rong, Y. and Huating, Ch. (2012) "Research on the Internet of Things in Automotive Industry." International Conference on Management of e-Commerce and eGovernement.

[21]. Volná, J. and Papula, J. (2013) "Analysis of the behavior of Slovak enterprises in the context of low innovation performance" Procedia - Social and Behavioral Sciences 99: 600-608

BIOGRAPHIES

Aspiring Industrial Engineer, currently pursuing B.Tech in Mechanical Engineering (4th year) from Dwarkadas J. Sanghvi College of Engineering, Vile Parle, Mumbai

Aspiring Data Science Engineer, currently pursuing B.Tech in Mechanical Engineering (4th year) from Dwarkadas J. Sanghvi College of Engineering, Vile Parle, Mumbai