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Innovative Automation of Production Processes in the Automotive Industry

Isak Karabegović[1], Edina Karabegović[2], Mehmed Mahmić[3], Ermin Husak[4]
[1,2,3,4]University of Bihać, Pape Ivana Pavla II 2, 77000 Bihać, Bosnia and Herzegovina,
[1]E-mail:isak1910@hotmail.com,[1]Tel:+38737226273[1]https://orcid.org/000-0001-9440-4441,
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***Abstract*—** The world is currently in the process of the fourth industrial revolution due to the development of digital technologies. Developed countries in the world, such as Germany, USA, Japan and those that want to reach developed countries like China, are rapidly developing and implementing innovative technologies with the goal of achieving "intelligent manufacturing processes" or "intelligent factories". Germany is developing and implementing digital technologies through strategy called "Industry 4.0". With their policy named ‘’Advanced Manufacturing Partnership 2.0’’, the United States want to create high-quality manufacturing jobs, initiate renaissance of the production processes and connect industry with the internet. In May 2015, the Government of China, inspired by the German "Industry 4.0", has announced a ten-year development strategy or a reform called "Made in China 2025", which aims to promote China into a leading technological force by 2025, improve global competitiveness through innovations, explore and apply new jobs through adapting production, or in other words to progressively restructure and innovate the production sector like other industrial countries in the world. The best example of innovation is the automotive industry, for two reasons. The paper presents the representation of industrial robots in production processes, with particular reference to the application of industrial robots in the automotive industry, as well as innovative solutions for the future in relation to industrial robots. The paper also provides a review of innovative solutions in regard to the automotive industry.

***Keywords*—** industrial robot, automotive industry, industry 4.0, automation, production process, vehicle production

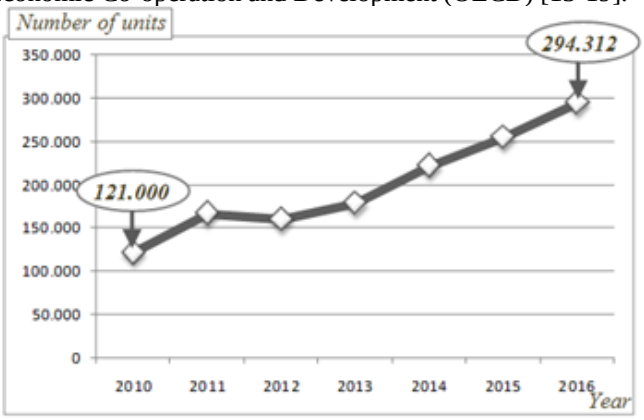
I. INTRODUCTION

Ever since the third industrial revolution in 1969, when automation in production processes started with the introduction of first industrial robots and computers, there has been a rapid development of digital technologies, as well as new methods and new technologies in the world. Companies worldwide that want to remain competitive in the market are forced to follow this development and implement its application with the purpose of modernization and automation of production processes. Digital technology brings fundamental changes, because the related industry becomes more flexible and more efficient. One of the reasons why these technologies are already available is due to the low price that is constantly decreasing and it is expected that in the near future they will be fully represented in production processes. Another reason why companies need to follow the development and implementation of these technologies is that customers are rapidly getting new information through ICT technology, thus expanding their requirements, which results in more complex products [1-7]. Companies around the world (including the governments) are working hard to implement adequate new technologies, primarily digital technologies, in the production processes of the industry, in order to use new information and communication technologies (ICT) to produce more efficiently, more productively and more effectively. German government has labeled its strategy of digitization of production processes as "Industry 4.0", and wants to maintain a leading position in the production and development of technology and standards, and export of solutions.Working Group on Industry 4.0 presented a set of Industry 4.0 recommendations for implementing the strategic initiative to the German federal government. At the Hannover Fair 2013, the final report of the Working Group Industry 4.0 was presented [8].The response to "Industry 4.0" in the United States is named "Advanced Manufacturing Partnership 2.0", which aims to create high-quality marketing jobs, initiate renaissance of the production processes and connect industry with the internet [9]. Japanese government initiated a strategy called "Revitalization and Robots Strategy", with the purpose of increasing productivity in the industry by promoting the development and implementation of the robotic industry, as well as the revitalization of the digital society and the industrial sector [10]. In May 2015 the government of China, inspired by the German "Industry 4.0", has announced a ten-year development strategy or a reform called "Made in China 2025", which aims to promote China into a leading technological force by 2025, improve global competitiveness through innovations, explore and apply new jobs through adapting production, or in other words to progressively restructure and innovate the production sector like other industrial countries in the world[11]. The above-mentioned reform in China will rely on institutions that will strengthen

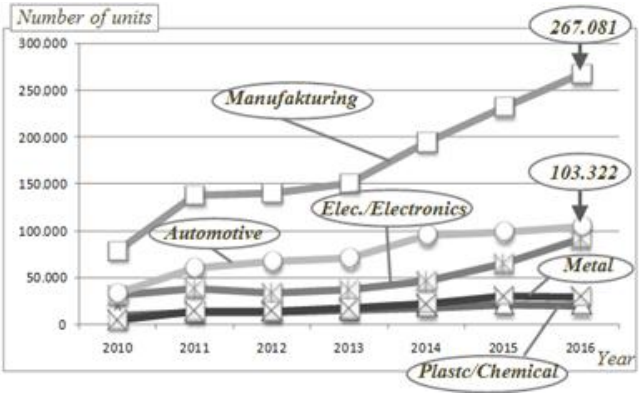
the protection of intellectual property rights for small and medium-sized companies, by enabling them to independently build the technology standards, develop digital technologies, ICT technology and sensor technology and their applications in all industries, especially in the automotive industry. Report Prepared on Behalf of the U.S.-China Economic and Security Review Commission in October 2016 say that in 2013, China surpassed Japan to become the world's largest market for industrial robots, and by 2018 will account for over a third of the industrial robots installed worldwide[12].Given that robotic technology is mostly used in the automotive industry, its development leads to the development of new generation industrial robots that can cooperate with workers. The companies are trying to introduce "intelligent automation" in production processes, using "intelligent machines" that will be the product of the fourth industrial revolution "Industry 4.0", which will eventually lead to "intelligent factories" in the future. In order to have a view of how this process is structured in the automotive industry, we need to make an analysis of the representation of robots in all industrial branches, with special emphasis on the automotive industry.

II. The Application of Industrial Robots in the Automation of Production Processes

Industrial robots are most important components in the process of automation and modernization of production processes. The actual state of automation in manufacturing processes in all industrial branches, especially in the automotive industry, will be shown in the analysis of the representation of industrial robots in production processes during automation and modernization of production processes. The analysis of the application of industrial robots in production processes worldwide was based on data from the International Federation of Robotics (IFR), the UN Economic Commission for Europe (UNECE) and the Organization for Economic Co-operation and Development (OECD) [13-19].



a –annual application of industrial robots

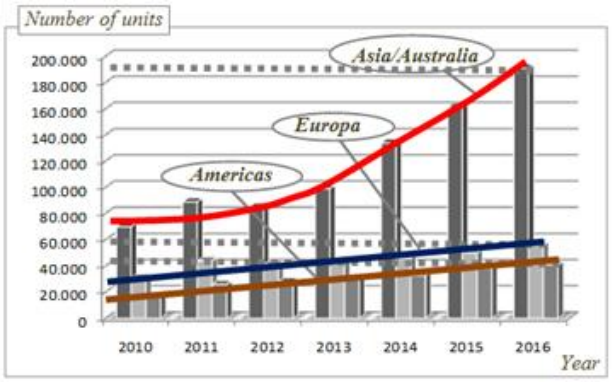


b – application per industrial branches

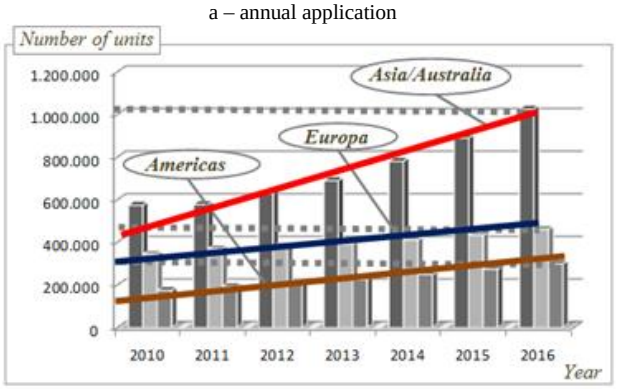
Figure 1. Annual application of industrial robots in the automation of production processes worldwide, as well as application in production: automotive, electric, metal and chemical (plastic) industry for the period 2010-2016

Based on Figure 1.a) we come to the conclusion that in the period 2010-2016 the annual tendencyof application of industrial robots in the world was constantly increasing, changing from about 121.000 units of industrial robots used in 2010 to doubled application in 2016, when approximately 294.000 industrial robot units were applied. Charts in Figure 1.b) provide an insight in the representation of industrial robots in the industry worldwide. The largest number of industrial robots, around 90%, is used in production processes in the industry. The first place in the automation of production processes is held by the automotive industry with the highest number of installed industrial robot units and a growing tendency of the application of robots in the automotive industry. The second place is held by electrics/electronic industry thatis experiencing a growing tendency, with an increase in the past three years compared to the previous four years. The third place in representation of industrial robots is occupied by metal industry with a slight increasing tendency on annual basis. There is somewhat lower representation of industrial robots in plastics and chemical industry than in metal industry. If we compare the representation of industrial robots in these two industries (metal, plastics/chemical) with automotive and electrical industry, we can see that they are far behind these two industries.It is evident that automotive and electrical industries are the leading industries in the application of industrial robots worldwide. In order to form a true image of the representation of industrial robots we need to conduct an analysis of the representation of industrial robots by continents (without Africa because their representation is very low and not worth the analysis), as shown in Figure 2.

The annual and total application of industrial robots on the continents of Asia/Australia, Europe and the Americas for the period 2010-2016 is shown in Figure 2. The annual industrial robot application on the above mentioned continents is shown in Figure 2.a), based on which we conclude that Asia/Australia is in the first place with increasing tendency that reached its highest value in 2016 with around 191.000 units of industrial robots.



a – annual application



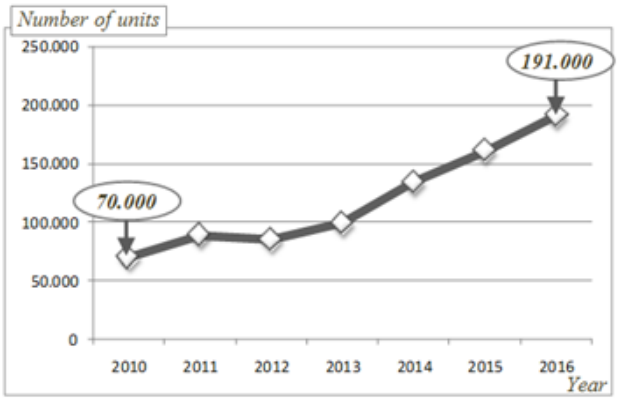
b – total application

Figure 2. Application of industrial robots in the automation of production processes by continents Asia/Australia, Europe and Americas) [13-19]

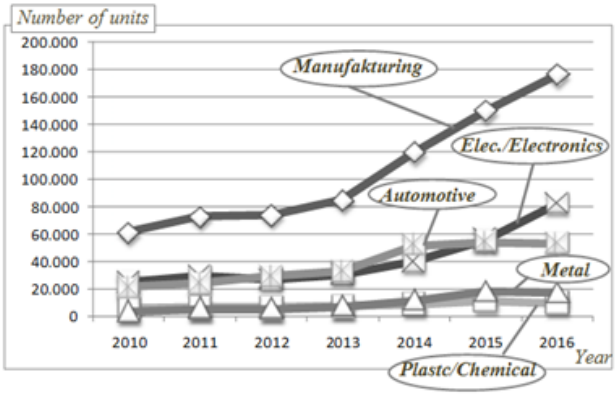
The second place, according to the industrial robots application, is held by Europe, whose increasing tendency is linear function that in 2016 reached 56.000 units, which is far less than the application in Asia. The third place is occupied by the Americas that has identical tendency as Europe, with lower annual application. The overview of the total representation of industrial robots on the continents is given in Figure 2.b), based on which we conclude that the first place is again held by Asia/Australia with linear growing tendency that in 2016 reached about one million industrial robot units. The second and third place is held by Europe and America whose linear growth of the total representation of industrial robots has a lower tendency than the representation of robots in Asia. The analysis of the application of industrial robots was conducted based on continents in different industrial branches, as shown in Figure 3.

The analysis of application of industrial robots in Asia/Australia for the period 2010-2016(Figure 3.I) indicates that the largest part of industrial robots is located in theproduction processes, so that the tendency of application in 2016 reached the highest value of around 180.000 robots, of total 191.000 robot units used. The representation of robot units is the largest in the electrical and automotive industries, which demonstrate growing tendency on annual basis, as shown in Figure 3.I-b). The implementation of robots in these two industries was almost identical until the end of 2015. However, situation changed in 2016 when greater representation of the industrial robots in the electrical industry compared to the automotive was recorded, indicating an increase of about 30.000 industrial robot units.

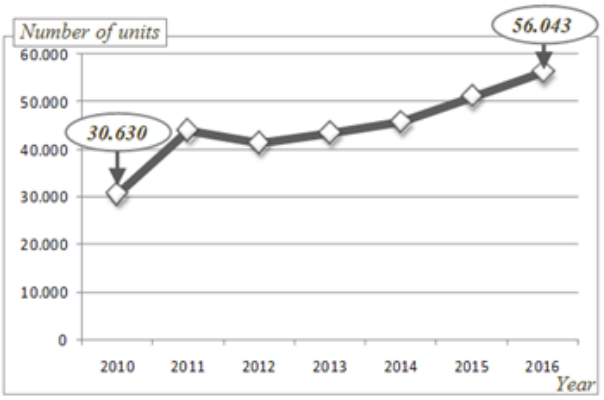
Following these two industries, the metal industry and the plastics/chemical industry are somewhat less represented, with a slight increase and almost identical application on the annual level, which in 2016 reached about 17.000 robot units in the metal industry and about 10.000 robot units robot in the plastics/chemical industry. It can be concluded that the continent of Asia/Australia implements the higher number of industrial robots in the automation of production processed in the electric/electronic industry. The application of industrial robots in the automation process in Europe is shown in Figure 3.I).



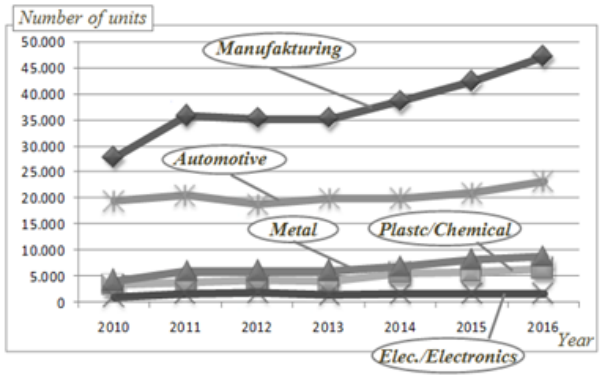
a – annual application



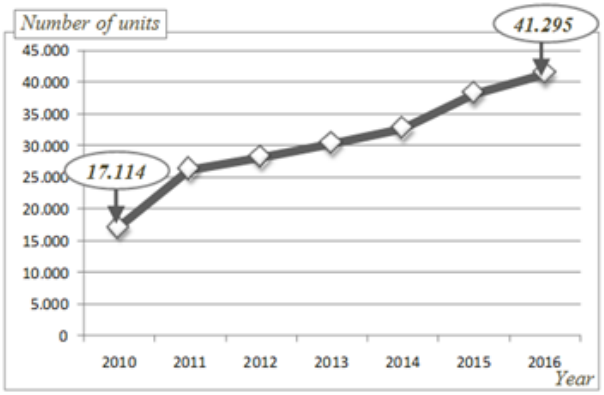
b – application per industrial branch
I- application of industrial robots in Asia/Australia



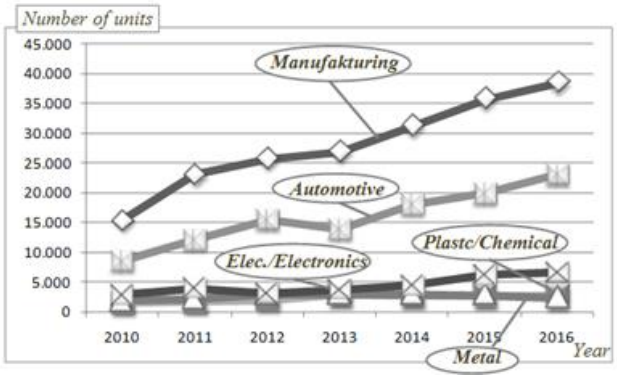
a – annual application



b – application per industrial branch
II - application of industrial robots in Europe



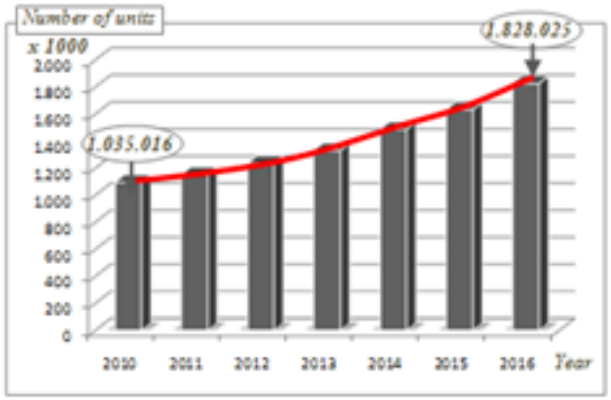
a – annual application



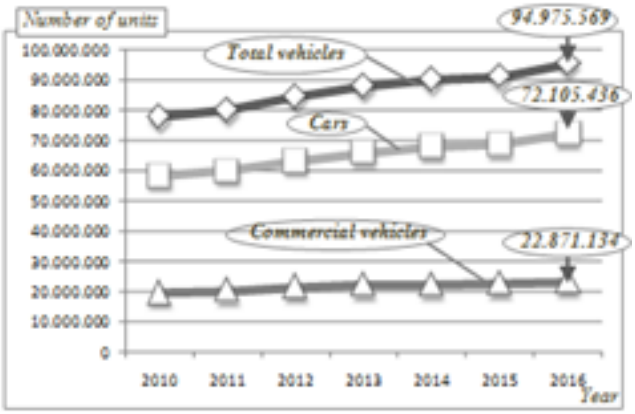
b – application per industrial branch

Figure 3. Application of industrial robots in the automation of production processes by continents, as well as application in production processes in automotive, electrical, metal and chemical (plastics) industry for the period 2010-2016 [13-19]

It proves that the industrial robot representation is lower than in Asia/Australiafor almost 60%. Trends in the representation of industrial robots by industry in Europe are different from the trends in Asia/Australia. According to the industrial robot application in the process of automation, the first place in Europe is held by the automotive industry, as indicated by Figure 3.I-b).We see that of total representation of industrial robots, automotive industry occupies almost 50% robotic units, with slightly increasing annual tendency for the period 2010-2016. The second place by the representation of industrial robots in Europe is held by metal industry, followed by plastics/chemical industry and lastly electric/electronics industry.By examining the industrial robots' application on these two continents, we come to the conclusion that Asia/Australia is focused on the automation of the electric/electronics industry, whereas Europe relies on the automation of the automotive and metal industry, which is mostly represented in Europe. The thirdcontinent by the industrial robot application in automation processes is America. If we compare the representation of industrial robots in America to Europe in 2016, we can see that America has applied 27% industrial robot units less than Europe. However, in relation to Asia, the representation of industrial robots in production processes is lower by 79% robot units.The tendency of representation of industrial robots is growing every year, as shown in Figure 3, III. The first place in automation of production process is held by automotive industry, as in Europe. The second place in application of industrial robots in America is held by metal industry, which is behind the automotive industry for about 90% of robot units. The third place, with slight increasing tendency, is held by plastics/chemical industry, followed by electric/electronics industry. The analysis of application of industrial robots in the automation of production processes in the world by continents (except Africa where representation is extremely low) provides the conclusion that the largest application of industrial robots is in Asia, followed by Europe and America. Similarly, automotive and metal industries occupy the first place in Europe and America, whereas electric/electronics industry and automotive industry have a leading position in Asia in the period 2010-2016. The answer to questions why application of industrial robots by industrial branches is growing and why the automotive industry holds the first place are provided in the comparative analysis of application of industrial robots and vehicle production in the automotive industry worldwide, as given in Figure 4. The total number of industrial robot units applied in the automation of production processes in industry in period 2010-2016 is given in Figure 4.a). As can be seen, it has an increasing tendency with slight exponential function and in six years it reached 1.8 million units.



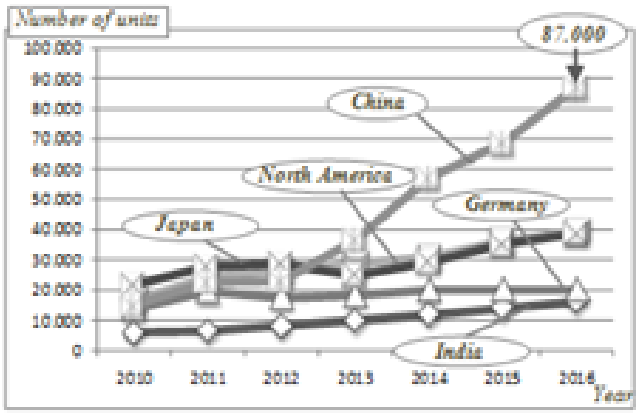
a – total application of robot units



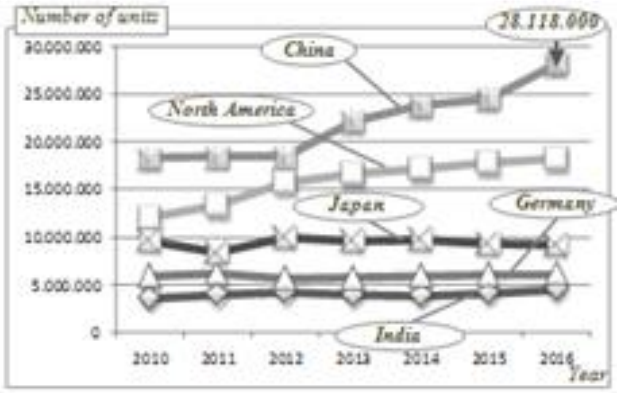
b – total production of vehicles

Figure 4. Total application of industrial robots in the automation of production processes, as well as total production of vehicles worldwide for the period 2010-2016 [20-22]

The tendency of application of industrial robots in production processes is the highest in automotive production processes, and it reflected the vehicle production worldwide, as indicated in Figure 4.b). The trend of vehicle production in the world for the same period is also growing, so that 78 million vehicles produced in 2010 increased to about 95 million in 2016. We see that far more cars are produced compared to commercial vehicles. In 2016 about 72 million car units were produced or about 76% of the total number of vehicles produced, whereas only 23 million units of commercial vehicleswere produced which takes only 24% of the total percentage of produced vehicles in the world in the same year. More detailed analysis of the dependence of vehicle production on the presence of industrial robots in automation of production processes can be provided if we analyze the representation of industrial robots and vehicle production in the countries with developed automotive industry, Figure 5. As shown in Figure 5, the following countries have been taken into account for the analysis: India, Germany, Japan, China and North America (USA, Canada, Mexico) for the period 2010-2016.



a –application of industrial robots

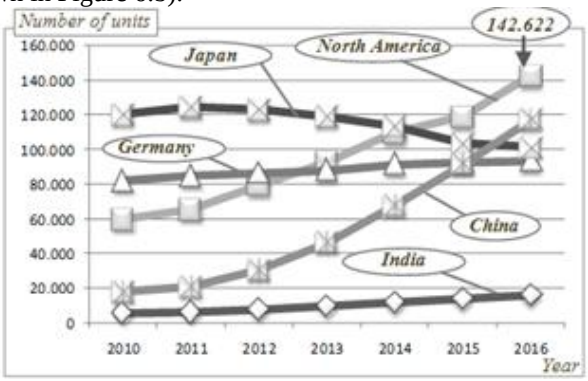


b – vehicle production

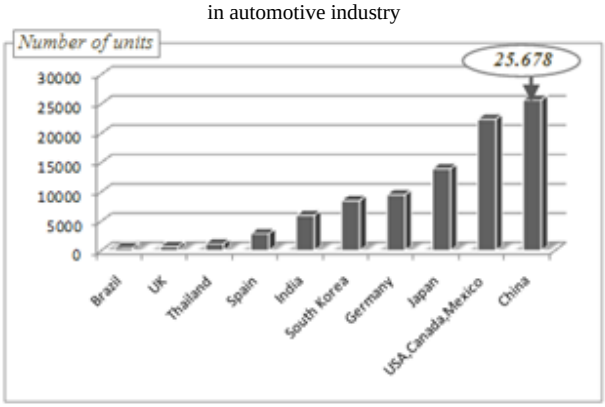
Figure 5. Application of industrial robots and vehicle production in India, North America (USA,Canada,Mexico),Germany,Japan and China[13-23]

Figure 5.a) shows the trend of application of industrial robots in production processes based on which we have concluded that China holds the first place in the past four years, and in 2016 it has reached its maximum in relation to all other countries. In addition, China is also the world's leader in vehicle production (Figure 5.b)) in the period 2010-2016. A sudden increase in robot application has led to rapid vehicle production in the last four years in this period. Japan and North America (USA, Canada, Mexico) are in the second and third place in the past couple of years with nearly identical application of industrial robots in production processes. In regard to vehicle production, North America (USA, Canada, Mexico) stands out compared to Japan, which is expected as there are three countries included. This was also confirmed by the fact that Japan dislocated the production of vehicles to other countries in the world, thus providing the difference in the tendency of vehicle production compared to North America (USA, Canada, Mexico). The world's fourth country in application of robots in production processes is Germany, which is also fourth in the vehicle production, Figure 5.b). India is ranked as the fifth in the application of industrial robots in production processes, and is also the fifth in vehicle production worldwide. In order to obtain clearer presentation, an analysis was conducted of application of industrial robots intoautomotive industry for the period 2010-2016, as well as application of industrial robots in the top ten countries in the automotive industry in 2016, as shown in Figure 6. The analysis of the trends of application of industrial robots in automotive industry for the period 2010-2016, (Figure 6.a), indicates that China and North America (USA, Canada, Mexico) mark a sudden growing tendency. For example, in 2010 Chinainstalledabout 18.000 industrial robot units in the automotive industry, and in only six years this number increased to about 118.000 units of industrial robots, which is six-fold increase. In 2016, China, (Figure 6.b) installed about 25.678 industrial robotunits in the automotive industry processes. Similarly, the total number of installed industrial robots in North America (USA, Canada, Mexico) in 2016 was 142.000 units, whereas it holds the second place in the annual

application of industrial robots in the automotive industry, as shown in Figure 6.b).



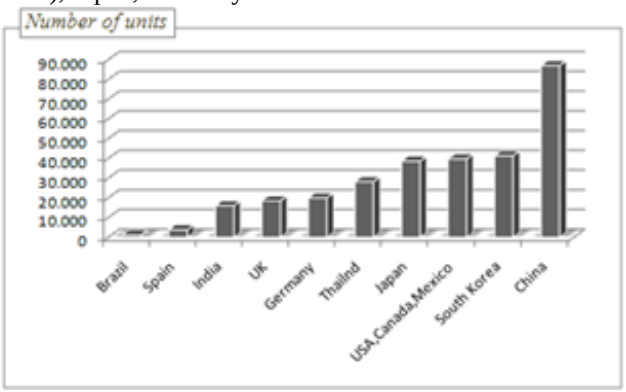
a – application of industrial robots in automotive industry



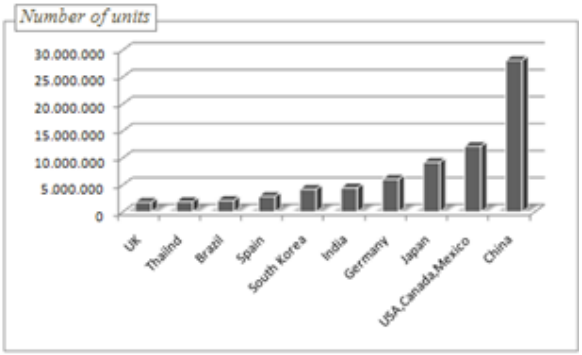
b – annual application of industrial robots in 2016

Figure 6. Application of industrial robots in automotive industry in India, North America (USA,Canada,Mexico), Germany, Japan and China in 2016 [13-23]

It is interesting to note that the tendency of totalnumber of installed industrial robots in the period 2010-2016 in Japan is decreasing (Figure 6.a), even though in 2016 Japan held the third place by installed robots in the automotive industry. On the other hand, there was a slight growing trend in the total number of industrial robots in the automotive industry in Germany and India. In regard to representation of industrial robots in automotive industry, the following five countries are leaders in the world: China, North America (USA, Canada, Mexico), Japan, Germany and South Korea.



a –application of industrial robots



b – vehicle production

Figure 7. Application of industrial robots and vehicle production in 2016 [13-22]

The analysis of chart given in Figure 7.a), which depicts the application of industrial robots in industrial productionprocesses in 2016 in ten top countries, reveals that China holds the first place. It is noted that China applies the largest number of installed robots in the automotive industry, as well as certain number of industrial robot units in the metal processing industry that produces different parts for the automotive industry. This is one of the important factors for vehicle production and it justifies the conclusion that China is the world's leader in vehicle production, as shown in Figure 7.b). The second place by application of industrial robots in 2016 is held by South Korea. However, in the same year South Koreawas positioned as sixth in vehicle production (Figure 7.b)), which indicates that the number of installed robots is not directed at the automotive industry. South Korea is applying the largest number of industrial robots in the electrics/electronics industry, which is confirmed by the fact that South Korea is not among five top countries in application of industrial robots in automotive industry, as shown in Figure 6.a. The third position byapplication of industrial robots in 2016 is held by North America (USA, Canada, Mexico), whereas it occupied the second place in vehicle production in the same year. The reason is that North America is the first in the world in total representation of industrial robots in automotive industry, as given in Figure 6.a). The fourth place in the application of industrial robots in industrial production process is held by Japan (Figure 7.a), while in the same year it occupied the third place in vehicle production, which can be justified by the fact that Japan was the first in the world until 2014. The application of industrial robots in 2016 was the highest in the following ten countries: China, South Korea, North America, Japan, Thailand, Germany, United Kingdom, India, Spain and Brazil, as given in Figure 7.a). Vehicle production in 2016 was the highest in the following ten countries in the world: China, North America, Japan, Germany, India, South Korea, Spain, Brazil, Thailand and United Kingdom. Based on the above analysis it can be concluded that this order is justified, and the predictions are that it will continue in the years to come [14-22].

The desire of the China to invest in technological development and the desire to implement the adopted technological reform

is shown in the Figure 8, which show the growth of innovations and patents in production processes for the period 2006-2015.

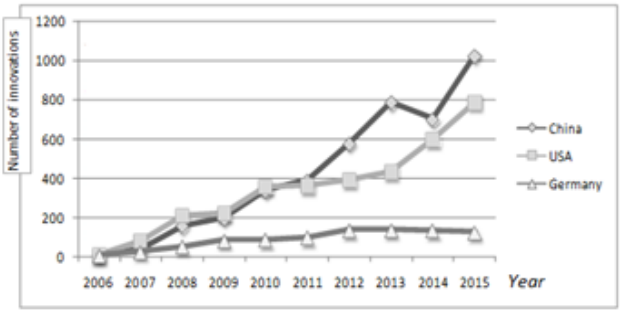


Figure 8.The tendency of innovation growth in the fourth industrial revolution [30]

Based on Figure 8, we can conclude that China, Germany and the USA had almost identical number of innovations and patents in regard to the fourth industrial revolution. However, these trends have changed in ten years and in 2015 China was the first in the world by number patents with about 1000 patents. The second place was held by USA with about 800 patents, whereas Germany was in the third place with about 180 patents. We can conclude that China has experienced the growth of its own patents for "Industry 4.0" each year, thus positioning itself ahead of the developed countries such as the USA and Germany since 2011.China is putting an emphasis on the innovation in advanced technologies. Chinese innovative activities are focused on industry robots, intelligent sensors and wireless sensor networks [23-31]. The predictions are that the fourth industrial revolution "Industry 4.0" will lead to "smart automation" or "smart factories" that could become reality in10 to 20 years. This process would not be possible unless new generation robots are placed in the center of automation of production processes in all industries.

III. CONCLUSION

The application of industrial robots is increasing on the annual basis. It is estimated that this tendency will continue in the future.The analysis of the application of industrial robots in countries with highly developed automotive industry has shown that China holds the first place (Figure 5a)) followed by North America, Japan, Germany and India. The identical order is evident in terms of vehicle production in aforementioned countries. This brings us to the conclusion that important aspect of vehicle production is the application of industrial robots in the production processes. The use of innovative technologies such as digital technology, IC technology, robotic technology enables the automation in the automotive industry to be more flexible and adaptable to any type of vehicle. Constant innovation, development of new methods and technologies enables the development of robotic technologyor robots of new generation that have much greater application possibilities compared to existing industrial robots, which will reflect and increase their use in the automotive industry

REFERENCES

[1] Kalpakjian S,; Schmid S.; 2007. Manufakturing Processes for Engineering Materials. Amazon ,(in USA)

[2] Sulavik C.; Portnoy M.;Waller T.; 2014. How a new generation of robots is transforming manufacturing. Manufacturing Institute USA, Gaithersburg, (in USA)

[3] Doleček V.; Karabegović I.**;** 2002. Robotika, Tehnički fakultet Bihać, Bihać,(in Bosnia)

[4] Karabegović I.; 2016. Role of Industrial Robots in the Development of Automotive Industry in China. International Journal of Engineering Works, Vol.3., Iss.12.,Kambohwell Publisher Enterprises, Multan, Pakistan, pp.92-97. https//www.kwpublisher.com/?paper=1-114-The-Role-of-Industrial-Robots-in-the-Development-of-Automotive-Industry-in-China#Author

[5] Karabegović I.; Karabegović E.; Mahmić M.; Husak E.; 2015. The application of service robots for logistics in manufacturing processes, Advances in Production Engineering & Management, Vol. 10. No. 4.Maribor, Slovenia, pp:185-194. http://dx.doi.org/10.14743/apem2015.4.201

[6] Karabegović I.; Husak E.; 2014. Significance of industrial robots in development of automobile industry in Europe and the World. Journal Mobility and Vehicle, Vol.40., No.1., 2014., University of Kragujevac, Faculty of Engineering, Kragujevac, Serbia, pp:7-16. http://www.mvm.fink.rs/Journal/Archive/2016/2016V42N3/volume_42_number_3_2016.pdf

[7] Mannan B.; Khurana S.; 2012. Enablers and Barriers for Introduction of Robotics as an AMT in the Indian Industrie. International Journal of Computer Applications, Januar 2012,New York, USA, pp:19-24.https://www.researchgate.net/publication/267450380; DOI:10.13140/2.1.2625.5368

[8] Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group, ACATECH-National Academy of Science and Engineering, April 2013.

[9] https://obamawhitehouse.archives.gov/the-press-office/2013/09/26/president-obama-launches-advanced-manufacturing-partnership-steering-com (15.09.2019)

[10] New Robot Strategy, Japan's Robot Strategy - Vision, Strategy, Action Plan, The Headquarters for Japan's Economic Revitalization, 2015, http://www.meti.go.jp/english/press/2015/pdf/0123_01b.pdf

[11] https://www.csis.org/analysis/made-china-2025 (10.08.2018)

[12] Ray J.; Atha K.; Francis E.; Dependahl C.; Mulvenon J.; Alderman D.; Ann Ragland-Luce L.; 2016. China's Industrial and Military Robotics Development. Research Report Prepared on Behalf of the U.S.-China Economic and Security Review Commission, Center for Intelligence Research and Analysis (CIRA), Vienna, (inAustria)

[13] World Robotics 2016, 2016. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[14] World Robotics 2015, 2015. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[15] World Robotics 2014, 2014. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[16] World Robotics 2013, 2013. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[17] World Robotics 2012, 2012. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[18] World Robotics 2011, 2011. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[19] World Robotics 2010, 2010. IFR Statistical Department, hosted by VDMA Robotics+ Automation, Germany.https://ifr.org/

[20] Jahresbericht 2010, 2010. Verband der Automobilindustrie e.v.(VDA), Berlin, Deutschland.
https://www.vda.de/de/services/Publikationen/jahresbericht-2010.html

[21] Jahresbericht 2014, 2014. Verband der Automobilindustrie e.v.(VDA), Berlin, Deutschland.
https://www.vda.de/de/services/Publikationen/jahresbericht-2014.html

[22] Jahresbericht 2016, 2016. Verband der Automobilindustrie e.v.(VDA), Berlin, Deutschland.
https://www.vda.de/de/services/Publikationen/jahresbericht-2016.html

[23] Makowieckaja O.; 2015. Industrial Robots on the Market of Means of Production Automation. Biuletyn Instytute Spawalnictwa,No.2. Gliwice, Czechoslovak, : pp:22-27. file:///C:/Users/isak/Downloads/03_makowieckaja_industrial_robots_on_the_market_of_means_of_production_automation.pdf

[24] Karabegović I (2017) The Role of Industrial and Service Robots in Fourth Industrial Revolution with Focus on China., Journal of Engineering and Architecture, 5(2), pp:110-117. DOI: 10.15640/jea.v5n2a9 URL: http://dx.doi.org/10.15640/jea.v5n2a9

[25] Robotics 2020 Strategic Research Agenda for Robotics in Europe (2013) Produced by euRobotics aisbl Robotics 2020, Draft 0v42 11/10/2013, euRobotics aisbl, pp:25-43.
https://ec.europa.eu/research/industrial_technologies/pdf/robotics-ppp-roadmap_en.pdf

[26] The UK Landscape for Robotics and Autonomous Systems (2015) Contact Info Robotics and Autonomous Systems Special Interest Group, Barttelot Road Horsham,UK. file:///C:/Users/isak/Downloads/PUB3InnovateUKRASreview2015.pdf

[27] Anderson J, Smith A (2014) AI, Robotics, and the Future of Jobshttp, Pew Research Center,Internet &Technology.//www.pewinternet.org/2014/08/06/future-of-jobs/

[28] Daniel F.; 2016. Cobots Expand Automation Opportunities, https://ifr.org/downloads/press/02_2016/Editorial_WR_Industrial_Robots_2016.pdf

[29] Annual Review 2015/2016, (2016) EDINBURGH CENTRE FOR ROBOTICS Innovation Ready,Edinburgh,Deutschland. https://www.edinburghrobotics.org/sites/default/files/Website%20version%20of%202015-16%20annual%20review_0.pdf

[30] Wübbeke J, Meissner M, Zenglein M, Ives J, Conrad B (2016) Made in China 2025.The Marking of a High-Tech Superpower and Consequences for Industrial Countries,Mercator Institute for China Studies,No.2. Decembar 2016:4-41.www.merics.org

[31] Presher A (2014) Automation & Motion Control, Automotive https://www.designnews.com/automation-motion-control/evolution-industrial-robots/139281170134199

Isak Karabegović
Qualification: Doctor of Technical Sciences
Professional and academic career: Full professor at University of Bihać
Competitive research or professional awards received: Author and coauthor of more the 26 books, 80 scientific papers published in international journals, 300 papers published proceedings in international conferences. Editor and coeditor of significant number of conference proceedings. Member in editorial board of 21 international journals. Sketch biography (200 words): Prof. Isak Karabegović is a Full professor at University of Bihać, Technical Faculty in Department of Mechanical engineering. He received doctoral degree from Faculty of Mechanical Engineering, University of Sarajevo in 1989, his Master of Science degree from Faculty of Mechanical engineering and naval architecture Zagreb, University of Zagreb in 1982, and bachelor degree of mechanical engineering from Faculty of Mechanical engineering Sarajevo, University of Sarajevo in 1978. His career as professor started on Technical College and later become Full professor at University of Bihać. In this period of time he was Dean of Technical faculty in several occasions and also rector of University of Bihać in several occasions. His research interest includes domains of Mechanics and Robotics. He also works as reviewer, editorial and technical board member in many reputed national, international journal and conferences. He publishes more then 400 papers of different type in international journals, conference proceedings and book chapters.

Full name : Isak Karabegović
Date of birth : 19.10.1955
Nationality : Bosnian
Department : University of Bihać, Technical facult

Area of teaching : Mechanics, Robotics
Email : isak1910@hotmail.com
Tel : ++38737226273
Bosnia and Herzegovina