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International Business – Central European Business Realities

Industry 4.0 and HR in Logistics

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Declaration

I hereby declare that I am the sole author of the thesis entitled “Industry 4.0 and HR in Logistics”. I duly marked out all quotations. The used literature and sources are stated in the attached list of reference.

In Prague on ..... Alexandra Ermolaeva

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Content:

List of figures:

List of abbreviations:

SCM – Supply chain management

IoT – Internet of things

IoS – Internet of service

IoD – Internet of Data

JIT – Just-in-time

CPS – Cyber physical system

RFID – Radio frequency identification

ICT – Information and communication technology

Introduction

Industry is an infallible part of any economy. Since the First Industrial Revolution that started the mechanization of industry, than the Second characterized by use of electrical energy and the Third that brought electronics and automation, production started its shifts due to the technological changes and innovations. Today's economy is facing the Fourth industrial revolution, impelled by social, economic, technological and political changes. The upcoming industrial revolution is also known as Industry 4.0, which will bring wave of digital transformation in existing business and current processes and will replace the manual business operations by digital computer structures.

Previous waves of technological transformation did not reduced overall employment although number of manufacturing jobs decreased, new jobs emerged and the demand for new skills grew. Smart manufacturing, implementation of Cyber Physical Systems (CPS) for production, augmented reality, embedded actuators and sensors, networks of microcomputers, and linking the machines to the value chain are technologies that Industry 4.0 aims to implement into business. The aim of this Diploma Master Thesis is to look into implementation of new technologies of Industry 4.0 and its influence on human recourses and labor market in the world.

To understand how the industrial workforce will evolve with Industry 4.0, deep analyses of current implementation of new technologies were made in production and logistic fields with focus on European and the US practices. With Industry 4.0 manufactories will be able to increase their productivity and competitiveness, which will enable them to expand their industrial workforce. As production becomes more capital intensive, the labor cost advantages of traditional low-cost locations will shrink, making it attractive for manufacturers to bring previously offshored jobs back home. The adoption of Industry 4.0 will also allow manufacturers to create new jobs although character of the job and required skills will change with manufacturing process and use of new technologies.

In the first chapter presents the concept of Industry 4.0 and describe its preconditions, industrial revolutions and their influence to industrial workforce. This part describes main

technologies of upcoming technological revolution and its current influence on main industries globally.

The second part focused on analyses of human recourses factor within changing environment, structural changes and companies' attitude. Based on this analyses and upcoming changes, appropriate management strategies proposals for the companies introduced. Finally, logistic sector has been chosen as an example of Industry 4.0 transformation of the industry and influence on workforce.

The third part illustrates examples of the technologically developed companies that already started implementation of Industry 4.0 technologies, their first success and difficulties regarding transition process.

1. Concept of Industry 4.0

Nowadays, all constituent elements of the future industry are rapidly developing with the main focus on the interaction of all parts in production and final products created as much automated as possible with current technological progress. New technologies are inalienable part of our daily life and its importance is expanding more with further development of Internet and technologies such as 3D printing, customized products, greater online sales services and etc.

Industry 4.0 known also as the Fourth Industrial Revolution are complex vision on future of industry that includes use of Big Data, inter connected machines, connected devices, cyber physical systems, cloud computing, software and Industrial Internet of Things.[1] Originally Industry 4.0 was a proposal for the development of a new concept of German economic policy based on high-tech manufacture strategies and firs mentioned in 2011 at Hannover Fair. However it is not only about manufacturing anymore and several parties, which were involved in Industry 4.0, move it to smart transportation and logistics, smart buildings, oil and gas, smart healthcare and even smart cities.

The main idea of Industry 4.0 is that in the future, industrial business will be build by global networks, which will connect their machinery, manufactures and warehousing facilities as cyber-physical systems and will control each other intelligently by sharing information and data processing that will head appropriate actions. These cyber-physical systems will take the shape of smart factories, smart machines, smart storage facilities, and smart supply chains. In manufacture process will be improved engineering, material usage, supply chains and product lifecycle management and centralized and offline systems that are not inter-connected.[2]

This global spread of the Industry 4.0 vision and technologies related with the universal challenges and possibilities across the globe and with the globalization and collaboration between EU, US and Japan and other countries industries. In this chapter aims clearly present the concept of Industry 4.0 and the fourth industrial revolution and analyze its preconditions, current situation and its influence on main industries globally.

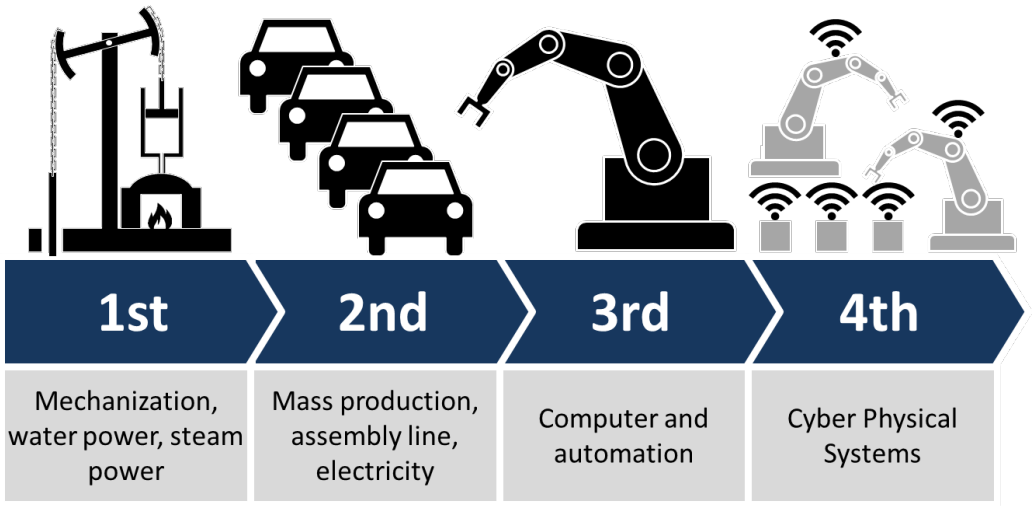
[1] Dhote, S. (2017). *What is Industry 4.0? Definition of Industry 4.0 and Its Revolution*. [online]

[2] i-SCOOP. (2017). *Industry 4.0: the fourth industrial revolution - guide to Industry 4.0*. [online] Available at: https://www.i-scoop.eu/industry-4-0/#The_origins_of_Industrie_40.

1.1 Premises to fourth industrial revolution

Industrial Revolution, in modern history is the process of change from an agrarian and handicraft economy to one dominated by industry and machine manufacturing. This process began in Britain in the 18th century and from there spread to other parts of the world. The main areas that were changed during the First Industrial Revolution were technological, socioeconomic and cultural. Main difference was a switch from hand production methods to machines with development of new chemical manufacturing and iron production processes. Improved waterpower and steam power efficiency, development of machine tools and the rise of the factory system leaded manufactures to higher performance level.

Figure №1 Technological revolutions



Source: Roser C. (2015) available at http://www.allaboutlean.com/industry-4-0/

Technological changes were incredibly progressive, changing the whole process to a new level. Most substantial changes were in ability to use new basic materials, mostly steel and iron. Similarly, energy sources used in production evolved from just human power to fuels, coal, steam engine, electricity, petroleum, and the internal-combustion engine. Important invention of new machines, such as the spinning jenny and the power loom allowed increasing production with a smaller expenditure of human energy. Developments in transportation and communication were the steam locomotive, steamship, automobile,

airplane, telegraph, and radio. These technological changes made possible a tremendously increased use of natural resources and the mass production of manufactured goods.[3]

Nonindustrial sphere was also changed and increased standards of living at that time. Substantially agricultural improvements that made possible the provision of food for a larger nonagricultural population and economic changes that resulted in a wider distribution of wealth, the decline of land as a source of wealth in the face of rising industrial production, and increased international trade. Changes in politics reflected the shift in economic power, as well as new state policies corresponding to the needs of an industrialized society. Growth of cities, the development of working-class movements, and the emergence of new patterns of authority are important changes in social patterns of society.[4]

The transportation industry also went trough significant transformation during the Industrial Revolution. Horse-drawn wagons and boats were the main distribution power for deliver of raw materials and finished goods. As it mentioned before, Industrial revolution changed energy sources and for transportation it was transfer from horses to steam-powered ships and locomotives. Development of railways had a major impact on farming, as perishable goods such as dairy products could now be moved long distances before they were inedible. New companies formed to both run railways and take advantage of the possibilities, and a major new employer was created. [5]

Industrial Revolution originally started in Great Britain but than quickly spread to the United States and Europe with a wave of inventions that were improving existing machines. Petroleum became an important source of energy, leading to a new class of mobile machines. Thus, Industrial revolution brought ability to combine several inventions to create complex systems for completely new process of manufacturing, transportation, and communications and significant change into workforce processes.

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[3] The Editors of Encyclopaedia Britannica (2017). *Industrial Revolution | Definition, Facts, & Summary*. [online] Encyclopaedia Britannica. Available at: https://www.britannica.com/event/Industrial-Revolution

[4] Mathias, P. (2013). *First Industrial Nation*. Florence: Taylor and Francis.

[5] History.com Staff (2009). *Industrial Revolution - Facts & Summary*. [online] History.com. Available at: http://www.history.com/topics/industrial-revolution

The Second Industrial Revolution was a phase of rapid industrialization came in the early 20th century, when Henry Ford mastered the moving assembly line and ushered in the age of mass production.[6] Process of the Second Industrial Revolution or Technological Revolution is generally dated between 1870 and 1914 up to the start of World War I. Progress of the Second Industrial Revolution was similar with The First, because the main changes were also in terms of basic materials. Industry started to develop many natural and synthetic resources such as lighter metals, new alloys, and plastics as well as use of new energy sources, leaded by electricity.

Production of steel was one the main improved industry during the Technological Revolution. An example of this is Bessemer process, which allowed the mass production of steel. Open-hearth production process with use of internal combustion engine, which is early prototype of modern engines, made possible invention of the first airplane by Wright brothers in 1903. During the construction of railroad in the United States was developed first long distance communication method known as telegraph that were faster than physical transportation of the message. Later on invention of the telephone in 1876 by Graham Bell made real time communication possible and readily available. The invention of electricity and petroleum is considered to be a milestone in revolutionizing industries. The new industrial processes were a base for mass production, distribution and shipment, and boosted the growth of international trade. [7]

Important aspect of the Second Industrial Revolution is various socioeconomic problems. Already in that times machines started to replaced people and unemployment rates rose. As a result two depressions rocked the world's economy during the industrial revolution, in 1873 and 1897 and cause movement of the laborers. Many factors influenced rose of unemployment and one of them can be fact that the expanding size of factories made relations between labor and management increasingly impersonal. Mechanization allowed many industries to substitute semi-skilled and unskilled laborers for skilled craft workers. A massive influx of immigrants from southern and eastern Europe saturated labor markets, slowing the growth of working-class incomes.

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[6] The Economist. (2012). *The third industrial revolution*. [online] Available at: http://www.economist.com/node/21553017

[7] Sawe, B. (2016). *What Was The Second Industrial Revolution?*. [online] WorldAtlas. Available at: http://www.worldatlas.com/articles/what-was-the-second-industrial-revolution.html.

In the United States during the late 19th century, a radical transformation took place in the way in which American business was structured and operated. Rapid growth of factory value leaded to the growth of corporation's size and capitalization. The typical business establishment before the 1870s was financed by a single person or by several people bound together in a partnership because the average factory investment was less than $1,800.[8] Even the largest textile factories represented less than a million dollars in investment. But steel and oil industry value grew rapidly and for example, John D. Rockefeller's Standard Oil Company was worth $600 million and U.S. Steel was valued at $1 billion. Additionally ownership of production also underwent changes. The oligarchical ownership that characterized the Industrial Revolution in the beginning of 19th century transformed into a wider form of ownership through purchase of common stocks by individuals and by institutions such as insurance companies and governments. These changes influenced politics as well and instead of the laissez-faire theory, which means natural self-regulation of economy, governments generally moved into the social and economic realism to meet the needs of more complex industrial societies.[9]

The Second Industrial Revolution continued development of the processes, which began during the First Revolution. Main difference is greater impact on society and wealth. First aspect was direct influence on real wages and standards of living that significantly changed from 1870 to 1914. Secondly, it changed the geographical focus of technological leadership from Britain to the west Europe and America with leadership of industrial monopolies. Finally, it change the way of new technology adaptation and changed the relations between nature and technological practices, made people more open minded to new things and significantly moved the world to the beginning of technological era.[10]

The Third Industrial Revolution in difference with the First and Second is not a historical terminology, but dates to 1970s when computers started to be used in business and till present time. This latest existing revolution began with creation of computer and still last till now. In the figure 1 all mentioned revolutions are presented in info graphics.

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[8] Mintz, S., & McNeil, S. (2016). The Second Industrial Revolution and Its Consequences. [online] *Digital History*. Available at: http://www.digitalhistory.uh.edu

[9] Hackett, L. (1992). *Industrialization: The First Phase*. [online] History-world.org. Available at: http://history-world.org/Industrial%20Intro.htm.

[10] Mokyr, J. (1990). *The Lever of Riches*. New York: Oxford University Press, pp.151-152.

The great economic transformation is a race for the near zero marginal cost phenomenon, brought digitization of everything. Private enterprises are continuously hunting for new technologies to increase productivity and reduce the marginal cost of production and distributing goods and services so they can lower prices, win over competitors and keep the sufficient profit for their investors. The ideal situation that economists predict that modern economy will have a concept of 'extreme productivity' with bringing marginal costs toward zero, making communication, energy and transportation, as well as many other physical goods and services, potentially very cheap in the common market.

The greatest impact that near zero marginal cost phenomenon brought was to informational industry and media goods such as recording, publishing, filming and etc. Consumers started to use Internet to produce and share their own music via file sharing services, their own videos on YouTube, their own knowledge on Wikipedia, their own news on social media, and even their own e-books, all for nearly free. At the same time the online education becoming more massive and available with again close to zero marginal costs and with teaching by professors from all over the world. This phenomenon has changed music, television, newspaper and magazines and companies that survived well are only ones who adopted their business to the Internet.[11]

While powerful effect of near zero marginal cost on informational goods was admitted by society and economist, it was argued if digital advances will change economy of energy, transportation, and physical goods and services. Here is a new term appears - Internet of Things (IoT), it is a network of internet-connected objects that able to collect and exchange data using embedded sensors.[12] It is developing concept of conventional business enterprises that can make, store and distribute their own renewable energy, manufacture an increasing quantity of 3D-printed physical products and other goods and services and than use shared vehicles on an automated, GPS-guided and soon driverless Transportation and Logistics Internet. Most importantly able to operate on a very low marginal cost or even near to zero cost depending on market situation. Internet of Things will connect everything and everyone, which brings significant economic benefits but also security risks arise.

[11] Rifkin, J. (2017). *Welcome to the Third Industrial Revolution*. [online] Wharton Magazine. Available at: http://whartonmagazine.com/issues/summer-2015/welcome-to-the-third-industrial-revolution/#sthash.4NozqAyf.dpbs

[12] Meola, A. (2016). *What is the Internet of Things (IoT)?*. [online] Business Insider. Available at: http://www.businessinsider.com/what-is-the-internet-of-things-definition-2016-8

Protection of company assets, know-how and personal date will be very important aspect while implementing new technologies.[13]

Nowadays a lot of IT leading companies are transferring their business in accordance to IoT future era. In the future every industry will be transformed virtually to common connected to each other platforms. For instance, there is new wave of micro manufacturers open which are ready to decrease their productivity while reducing marginal costs to near zero. New technology, which enables small factories or even individuals to do it, is called additive manufacturing.

Nowadays 3D printers are already producing products from jewelry and airplane parts to human prostheses. The difference between new technologies of three dimensional printing from traditional centralized manufacture are approachability for everyone. Software and design concepts are shared in open networks between of the users. More flexible intellectual property protection, reduction of time for prototyping and transportation of slow turn over items make 3D printing business attractive.[14]

The establishment of the Third Industrial Revolution infrastructure is the step to progressive society and advanced technologies. The line between Third and Forth Industrial Revolution and is that it was a start of progress and development of new technologies and now is massive application into business will start. These activities are changing our reality right now and will continue to do it intensively in nearest future.

1.2 Main characteristics of Industry 4.0

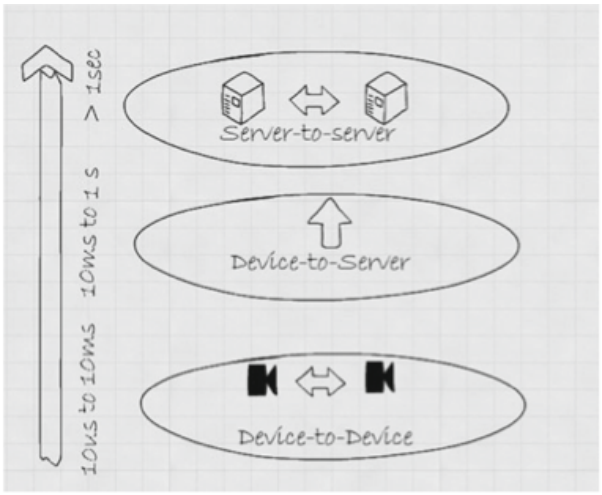
The phenomenon of Industry 4.0 was first mentioned in 2011 in Germany as a proposal for the development of a new concept of German economic policy based on high-tech strategies. The concept is launching The Forth Industrial Revolution and developing technologies that include cyber-physical systems, the Internet of things (IoT), and the Internet of services. That concept includes communication via Internet that allows a

[13] Markillie, P. (2012). [online] A third industrial revolution: manufacturing and innovation. Available at: http://web.mit.edu/pie/news/Economist.pdf

[14] Rifkin, J. (2014). *The zero marginal cost society*. Palgrave Macmillan, pp. 89-91.

continuous interaction and exchange of information not only between humans and human and machine but also between the machines themselves with incredibly high speed.[15]

Figure №2: Interaction between services and gadgets within Industry 4.0 concept



Source: Gilchrist, A. (2015). Industry 4.0. Apress, p135

The main point of Industry 4.0 is establishment of a communication channel for the continuous exchange of information about needs and individual situations in real time to e-retailers, health care workers, manufacturers, coworkers, customers themselves, energy suppliers, and etc. Mechanism will be that machines are streaming data via wireless sensors and sending these data to the smart service or product providers' decentralized multiple small centers, where large amounts of data will be analyzed. The main advantage of such automation is the individual customer-oriented adaptation of products and services that will increase value added for organizations and customers.[16]

During the Fourth Industrial revolution all processes become fully atomized and digitalized with the use of electronics and information technologies in manufacturing and services in a private environment. Small and medium enterprises will be significantly changed by new technologies such as 3D printing and new sales online services. From customer point of view the advantage is personalized service or product in real time, which leads to

[15] Heiner L., Fettke P., Feld T. and Hoffmann M. (2014) "Industry 4.0," *Business & Information Systems Engineering* Available at: http://aisel.aisnet.org/bise/vol6/iss4/5

[16] Roblek, V., Meško, M. and Krapež, A. (2016). A Complex View of Industry 4.0. *SAGE Open*, 6(2).

satisfaction and loyalty benefit in case of provider companies. Companies have to understand how connected consumer products and services can serve as a critical basement in their decision making process.[17]

Industry 4.0 will bring changes to society and politics but the most influential changes will be in economic sector. Looking to upcoming changes deeper from economic point of view, the theory that every great economic consists of three elements that interacts with each other for the system to operate as a whole. These elements are a communication intermediate, a power source and a transportation mechanism. Communication is for managing activities, energy to power it and logistics to transport it through the value chain. Together, these three operating systems form what economists call a general-purpose technology platform.[18]

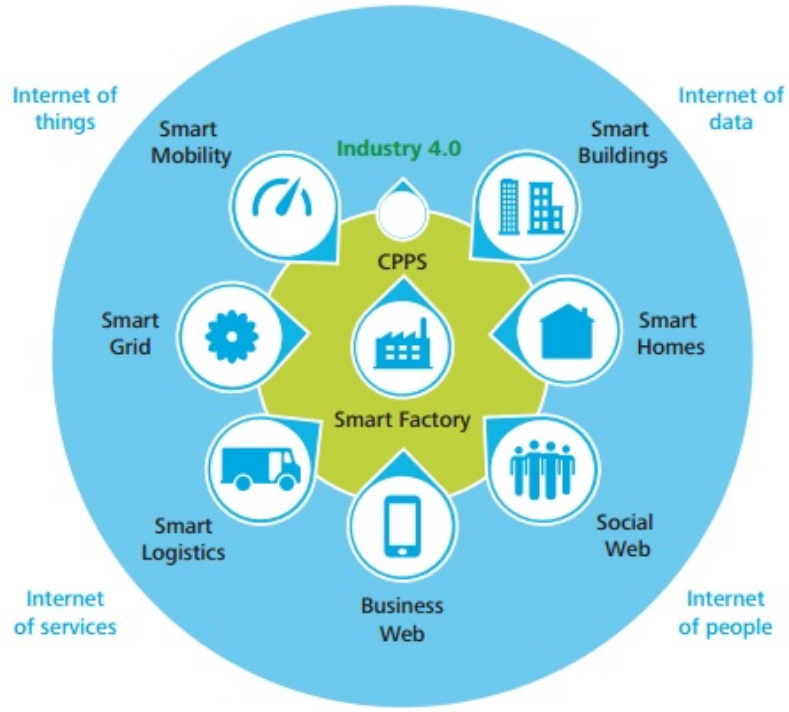
Power source or energy is what created the core of the world. It influence organization, commerce, trade and distribution, thus, political power is substantial factor for forming social relations. Fossil fuels, which are coal, oil, and natural gas represents natural sourced energies that can be found only in some regions and countries. It requires huge investments to secure and manage these resources as well as control systems and massive concentrations of capital to move them from underground to the end users. The ability to centralize production and distribution is the most essential factors for modern business. It is crucial to show the effective performance of the system as a whole. Centralization of energy infrastructure establishes the conditions for the rest of the economy and directs similar business models throughout every sector.

There is a common misconception that Industry 4.0 will benefit only the manufacturing industries but it is not the only field that will be improved. Manufactures are the main focus of Industry 4.0's but changes will impact on all contiguous areas. It will affect not only the local cyber-physical systems and local industrial processes but also the entire

[17] Andersson, P. and Mattsson, L. (2015). Service innovations enabled by the "internet of things". *IMP Journal*, 9(1), pp.85-88.
[18] Aghion, P. and Durlauf, S. (2005). *Handbook of economic growth*. Amsterdam: Elsevier, p.186.

value chain, including the producers and manufacturers, suppliers, and workers. In the figure 3 shows main components of Industry 4.0. [19]

Figure №3. Components of Industry 4.0



Source: Das, R. (2015) available at: https://www.linkedin.com/pulse/industrie-40-fourth-industrial-revolution-facts-challenges-ranen-das

Although the transformation of the digital industry is still in progress, there are already some indicators such as artificial intelligence, big data, and connectivity that show main focus of the Forth Industrial revolution. Industry 4.0 is on the way and will have an important influence on the complete transformation of industry because it represents progress on three points.

- Digitization of production, which means new information systems for management and production planning;

- Automation on a new level with systems for data acquisition from the production lines and using machines;

- Automatic Data Interchange for linking manufacturing sites in a comprehensive supply chain.[20]

[19] Rifkin, J. (2015). *The Third Industrial Revolution* [online] The World Financial Review. Available at: https://www.fona.de/mediathek/gek/vortraege/eroeffnung_rifkin_jeremy_01_presentation_ge2012.pdf

The rapid increase over the last decade in digital technologies and especially data volumes, cloud storage and computing power allowed analysis of operational data. Implementation of this technology especially seen in new wide-area networks with low power utilization and perspectives to use new data in their manufacturing operations. New technologies also will help with product development process, which requires significant analytic capabilities and than better that process will be done than higher quality will have end use product.

Industry 4.0 will bring new form of human and machine interactions. These include the development of augmented-reality, virtual reality systems, robot collaboration, and systems that make full use of touch interfaces and other hands-free operating systems. For industrial companies the first who will start to use all these new technical tools will become more competitive against the ones who will keep processes old way.[21]

Main characteristics of Industry 4.0 are vertical integration of smart production systems, horizontal through global value chain networks integration, acceleration of manufacturing and through engineering across the entire value chain.[22]

Vertical integration means that vertical networking through cyber-physical production systems will enable plants to react rapidly to changes in demand or stock levels. Smart factories will be able to organize themselves and enable production that is customer-specific and personalized. Horizontal integration via a new generation of global value chain networks is a new value-creation networks that in real-time optimize networks and increase integrated transparency with a higher level of flexibility to respond more rapidly to problems and solve them. Similar to networked production systems, these local and global networks provide networking via CPPSs, from inbound logistics through warehousing, production, marketing and sales to outbound logistics and downstream services.

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[20] Schlechtendahl, J., Keinert, M., Kretschmer, F., Lechler, A. and Verl, A. (2014). Making existing production systems Industry 4.0-ready. *Production Engineering*, 9(1), pp.143-145.

[21] Gilchrist, A. (2015). *Industry 4.0. The industrial internet of things* Apress, pp.195-201.

[22] Bernard, M. (2016). What Everyone Must Know About Industry 4.0. [online] *Forbes,* Available at: http://www.forbes.com/sites/bernardmarr/2016/06/20/what-everyone-must-know-about-industry-4-0/#6bab00f44e3

Through-engineering across the entire value chain is the process of development and manufacturing of new products and production systems as one and synchronized product life cycles, enabling new synergies to be created between product development and production systems. Acceleration through exponential technologies is that most of business operations, particularly those that involved in manufacturing and require use of many technologies, but most are not innovative or expensive, and most of them already exist, which makes Industry 4.0 very likely to become reality soon. [23]

Concept of Industry 4.0 based on the assumption of continuity of current globalization and urbanization trend. The rise and expansion of Industry 4.0 with its current fundamental concepts are based on the assumption of increasing global urbanization. Demographic structural changes in the last decades start to become a challenge for urban extension and development that requires changes in the infrastructure of existing residents for keeping quality of life stable.[24]

Smart technology is current trend that suppose to support further urbanization and social development. New technologies will be used to develop efficient business with increased revenues, lower capital spending, and improved services and mobility. Industry 4.0 will be a tool to achieve these economic aims.

One of the main point which Industry 4.0 will provide is the smart factory and smart manufacturing, it is also known as intelligent factory or factory of the future. All these terms stands for more intelligent, flexible, and dynamic manufacturing process. Manufactures will be equipped with sensors, actors, and autonomous systems. New technologies enable machines and equipment to be able to improve processes autonomously through own decision making and self-optimization. This will lead to self-organization of manufacturing process, it will change logistic and production chains. All these changes in manufacturing processes will be also closely connected across corporate

[23] Lee, J., Bagheri, B., & Kao, H. A. (2015). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. *Manufacturing Letters*, *3*, 18-23.

[24] Maskey, V., Collins, A. and Brown, C. (2013). Three Ownership Scenario Analyses of a Historic Site Management: Lessons Learned from a Historic Mill. *Journal of Management and Sustainability*, 3(2).

boundaries.[25]

Recently it is easy to mention personalized trend in product and services. People want to have some product, which will have functions and appearance that satisfy their needs the most. Industry 4.0 will level up this process and personalized products and services will not mean higher price and will be approachable for mass. Next generation of the products will be also smart. It will have sensors and microchips that allow communication via the IoT with each other and with people. It is already starting to be implemented with cars, watches and other electronics. To become smart product has to be attached with sensor to the package that can detect when the product is being used and can communicate with smartphones when scanned. It will definitely bring a lot of benefits to people but questions of invasion of privacy and personal safety can be arising.

As well as new manufacturing will be created the retailer's systems will be also changed to follow human needs and new standards. The prediction of such new systems can be seen from prototypes that companies launching already now. It is robotic-like tools such as personal intelligent agents, with examples such as Siri, Viv and Google Now, and others. IoT will change traditional face-to-face model of the interaction between buyers and sellers.[26]

Systems will integrate computation, networking, and physical processes. Embedded computers and networks will monitor and control the physical processes, with feedback loops where physical processes affect computations and vice versa. An example is control of vital human functions that allow urgent health care through mobile applications, sensors in clothing, and sensors and surveillance cameras in flats.

Smart city is another important concept of Industry 4.0. It is a city of the future that consist of six components such as smart economy, smart mobility, smart environment, smart people, smart living, and smart governance. It should be a result of fast development of the new generation IT and traditional economy. It will be based on the network combination of the Internet, telecommunications network, broadcast network, wireless broadband network,

[25] Hessman, T. (2013). The dawn of the smart factory. 262. 14-19.

[26] Whitmore, A., Agarwal, A. and Da Xu, L. (2014). The Internet of Things—A survey of topics and trends. *Information Systems Frontiers*, 17(2), pp.261-269.

and other sensor networks with the IoT as its core.[27]

In regard to Industry 4.0, there is no place for limited thinking about robotics and the automation of production because it is a digitization of business processes as a whole. It will involve procurement process of materials and how the product moves through the production and delivery process to the customer. Added value will be found in new products and new solutions and handling figures is not productive work. Each object can potentially be connected and networked. Different business models will be designed involving the Internet and connectivity. [28]

1.3 Impact on main industries

Industry 4.0 concept was created firstly for smart manufacturing and across industries but how it was already mentioned in above all of the industries, society and politics will be influenced by the Forth Industrial revolution. Important factor for every industry is energy sources. Energy infrastructure sets the conditions for the economy and encourages similar business models across every sector. Most of all of the other critical industries were emerged from the oil culture such as modern finance, telecommunications, automotive, power and utilities, and commercial construction. As well as the oil industry these industries are similarly to aim from economy of scale and centralized structure and require significant investments operate.

Half of the TOP 10 companies in the world today are oil companies such as Sinopec Group, China National Petroleum, Royal Dutch Shell, Exxon Mobil and State Grid (energy). Underneath these five giant energy companies are five hundred global companies representing every sector and industry—with a combined revenue of $27.7 trillion in 2016, which is the equivalent of 37,5% of total world GDP, which are inseparably connected to and dependent on fossil fuels for doing their business.[29]

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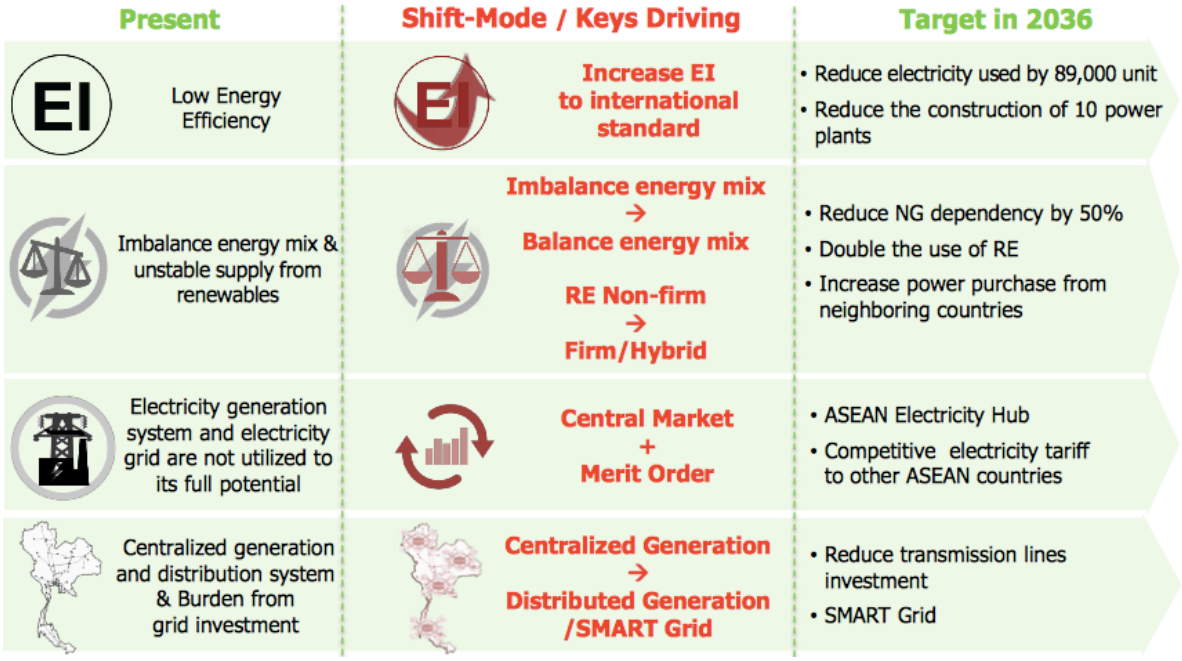
[27] Kane, G. C., Palmer, D., Phillips, A. N., & Kiron, D. (2015). Is your business ready for a digital future? *MIT Sloan Management Review*, *56*, 37.

[28] Pejic Bach, Mirjana. (2014). Exploring Information and Communications Technology Adoption in Enterprises and its Impact on Innovation Performance of European Countries. Ekonomicky casopis. 62. 335-346.

[29] Fortune. (2017). *Fortune Global 500 List 2016*. [online] Available at: http://fortune.com/global500

Recently it is possible to find one more term related to Industry 4.0 and it is Energy 4.0, which is not an official buzzword of German politics but already a developing concept of future of the industry. Main concept is the digitization of the energy in partially electricity sector and new processes of generation of energy. Main factors will be intermittent renewable energy, ways to put nuclear phase out and safe storage of energy.[30]

Figure №4. Development of electricity in Thailand within Energy 4.0 concept.



Source: Chantanakome, W. (2017). Thailand's Energy 4.0. available at: http://www.asew-expo.com

Key elements of Energy 4.0 are also cyber-physical systems that composed of physical entities, controlled and monitored by computer-based algorithms. Clearly development of Industry 4.0 and Energy 4.0 will be mutually dependent on each other processes. On the 6th International Energy Forum, which took place in Thailand in June 2017, Energy 4.0 was the main topic to discuss. Figure 4 represents plans for energy development in Thailand and perspectives for other countries.

[30] Lang, M. (2016). *From Industry 4.0 to Energy 4.0: Future Business Models and Legal Relations*. [online] Available at: http://www.germanenergyblog.de/wp-content/uploads/2016/04/160317_Lang_IBE_Bochum_From_Industry_4_0_to_Energy_4_0_fin.pdf

All companies looking for the ways to optimize their value chain, regardless their size, because all need partners in activities such as design and development, marketing, supply chain and etc. Usually for the manufactures the main aim is to focus on production and outsource supply, logistics, marketing, and sales. In this way it is more likely to reduce expenses while maximizing profits. Thus, a value chain, by best manufacturing and industrial practice, is mandatory for any producer of goods or services.

According to Porter's value chain there are two components: primary activities and support activities. Primary activities related directly to the physical creation, sale, maintenance and support of a product or service. The support activities, assist with procurement, human recourses, infrastructure, IT and etc.[31]

Primary activities add value to the product, and they include functions such as inbound and outbound logistics and operations. Inbound logistics represents delivery of the raw materials into the company. It is the costs that caused by raw material costs, landing costs, taxes, and the cost of storage and distribution. Outbound logistics are the costs associated with shipping products to customers with storing, distributing, and maintaining stock. Operations are basically manufacturing from the raw material to a saleable product and this is where profit is determined. [32]

The other two primary activities are marketing with sales and service. Value is also added at the marketing and sales stage because it is the process of convincing the customer to buy concrete product from the company and eliminate the competitors. After-sales the service function considers the value of maintaining a product through its lifecycle.

The other value chain component that must not be overlooked is the support function. It represents company infrastructure, stability of the company and its reputation. Qualities of goods and after purchase services are the main measurements for reputation of the company. Another important factor is human recourses and how company manages and treats their workforce. And last one but not least in case of Industry 4.0 is technology

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[31] Mindtools.com. (2014). *Porter's Value Chain: Understanding How Value is Created Within Organizations*. [online] Available at: https://www.mindtools.com/pages/article/newSTR_66.htm

[32] Ashe-Edmunds, S. (2015). *Primary Classifications of Business Activities*. [online] Smallbusiness.chron.com. Available at: http://smallbusiness.chron.com/primary-classifications-business-activities-60083.html

development that relates to the innovation and quality of the technology and engineering teams.[33]

In 2016 The Boston Consulting Group studied the status of adoption of the new digital industrial technologies that are known as Industry 4.0 in Germany and the US. In survey were more than 600 participants were equally divided for companies from Germany and the US. The study shows that both nations have set high ambitions for Industry 4.0 but will need to accelerate their efforts to implement these technological advances and achieve their goals.

The results of the survey shows that German companies are better prepared to adopt Industry 4.0 because 47% of the German companies have developed their first full Industry 4.0 concepts. In contrast, only 29% of US companies have developed their first concepts, and 41% say that their company is not yet prepared. In terms of manufacturers, German respondents have higher ambitions than their US competitors with respect to applying, or planning to apply, advanced technologies. For example, approximately 60% of German manufacturers have applied, or plan to apply (within the next one or two years), digital factory logistics or predictive maintenance, compared with approximately 40% of US manufacturers.[34]

Figure 5 represents which fields and new technologies already applied n German and the US companies and the ones that are in nearest plan. This date shows that there is still a lot of space for improvement and currently industry is on the first stage of adaptation of new technologies because with potential future benefits there also big challenges that Industry 4.0 brings right now.

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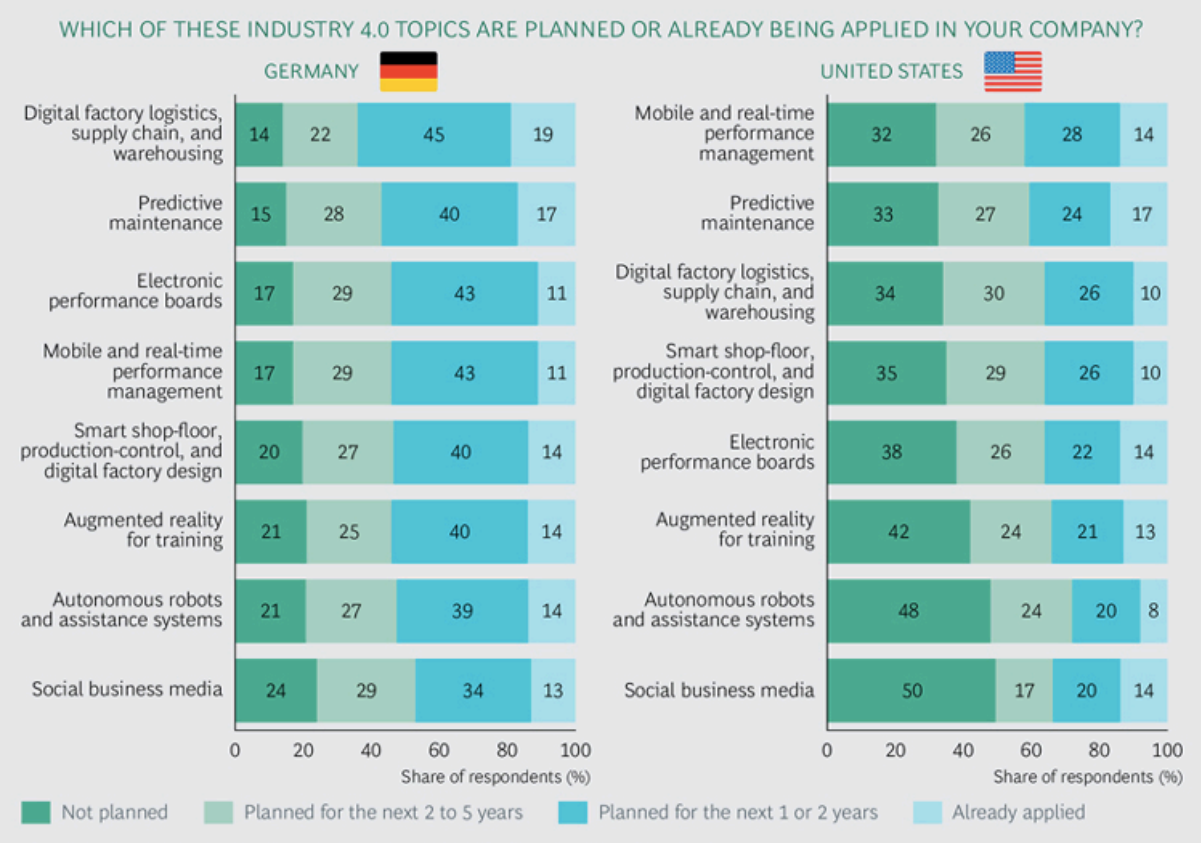
[33] Saha, A. (2011). *Mapping of Porter's value chain activities into business functional units*. [online] Managementexchange.com. Available at: http://www.managementexchange.com/hack/mapping-porter's-value-chain-activities-business-functional-units

[34] Lorenz, M., Küpper, D., Rüßmann, M., Heidemann, A. and Bause, A. (2016). *Time to Accelerate in the Race Toward Industry 4.0*. [online] www.bcgperspectives.com. Available at: https://www.bcgperspectives.com/content/articles/lean-manufacturing-operations-time-accelerate-race-toward-industry-4/#chapter1

Figure №5 Status of implementation of Industry 4.0 in Germany and the US



Source: BCG online survey (2016) of 312 German companies and 315 US companies

The most obvious challenge of Industry 4.0 is investments and change because building a complex value network that produce and distribute products requires change with of partners of the company. Change or implementation of new technologies has to be done for suppliers and distributors but also for technology companies and infrastructure suppliers such as telecoms and Internet service providers.

Large investments are needed if enterprises decided to make transition to Industry 4.0 and that is why Germany launched a project with €40 billions annually until 2020 for donations to small and medium-sized enterprises that are afraid to go digital. Even with this amount of investment only one fifth of the companies in Germany use interconnected IT systems to control its production process and only half are planning to implement in the future. There are also criticism of the Industry 4.0 that claims that systems are too expensive, too

unreliable and oversized and benefits mostly to producers of the equipment rather than customer demand.[35]

Another concern regarding Industry 4.0 is security because large quantities of data will be collected and shared with partners in the value network and business needs to be clear about who owns what industrial data and to be confident that competitors will not use their data. Thus legal issues can appear in the side of employees who for example use augmented reality glasses and can be used to monitor and evaluate workers or if an autonomous manufacturing system that links different value networks produces a defective or dangerous product. For the court it will be hard to determine responsible side in this process.[36]

Last but not least challenge is employment and skills development that will show significant shift from manual labor to programming and control of high performance machine. Employees with low skill level will be replaced unless they are retrained. Labor challenge will be determine in next chapter of the thesis.

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35 Digital Europe (2015). *Digital transformation of European industry and enterprise*. [online] Available at: http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=967&language=en-US&PortalId=0&TabId=353

36 Westkämper, E. (2014). *Towards the Re-Industrialization of Europe: a concept of manufacturing for 2030*. Springer.

2. Human resources factor in the concept of Industry 4.0

As it was analyzed in the first part of this thesis, industrial production significantly changed during industrial revolutions. Firstly, by steam power in XIX century, than, by another new source of energy – electricity in the early XX century and as latest, by development of automatization in second half of past century. However these waves of technological advancement did not reduce overall employment rate but it grew proportionally to population during all this time. Demand for manufacturing jobs decreased but new job positions with another skills were formed. Nowadays, another workforce transformation in industrial area is coming. Manufactures and all across supported business will be transformed with new digital industrial technologies by the Forth Industrial revolution.

In this chapter the effects of the new technologies on labor market will be analyzed. Main data was taken from Germany as most advanced industrial country and first adopter of Industry 4.0. With implementation of Industry 4.0 manufacture productivity will be increased and it can allow company to expand their industrial workforce. As production becomes more capital intensive, the labor cost advantages of traditional low-cost locations will be reduced. It becomes attractive for manufacturers to bring previously offshored jobs back into company.

Based on analyses made by the Boston Consulting Group it is most likely that Industry 4.0 will not decrease unemployment rate but increase it in future perspective. Higher productivity will expand existing market and create new jobs to introduce new products and services. This favorable scenario contrasts with previous eras of technological advancement, during which the number of manufacturing jobs declined despite an increase in overall production volume. For instance, automation and offshoring caused an 18 percent decrease in Germany's manufacturing workforce from 1997 through 2013, at the same time that production volume increased.[37]

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[37] Lorenz, M., Rüßmann, M., Strack, R., Lueth, K. and Bolle, M. (2015). *Man and Machine in Industry 4.0*. [online] www.bcgperspectives.com. Available at: https://www.bcgperspectives.com/content/articles/technology-business-transformation-engineered-products-infrastructure-man-machine-industry-4/#chapter1

2.1 Structural changes on labor market

Industry 4.0 will stimulate significant changes in how industrial workers execute their jobs and completely new scope of jobs will be created while others totally disappear. One of the main topic discussed among experts is to which extend robots will replace humans at manufactures. Main researches and surveys show that companies plans to use robots to assist workers but not to replace people totally. General trend that will appear by increased use of assistance systems is that the number of physically demanding or routine jobs will be decreased, while the number of jobs requiring flexible responses, problem-solving, and customization will increase.[38]

Main changes for workers will be in transition from only hard skills to its combination with know-how related to a specific job or process. Examples of such work can be a use of techniques for working with robots and changing tools on machines, with IT competencies. IT knowledge is definitely has a range from basic, that can be a use of spreadsheets and access to programs, to advanced such as advanced programming for the machines and creation of cyber-physical systems.

From the other hand, the importance of soft skills will increase significantly. Workers have to be open to changes, demonstrate great flexibility to adapt to new roles and work environment and get conventional to continual interdisciplinary learning. Industry 4.0 will reconstruct demand on the labor market and everyday routine working process because an ability to adapt and learn fast will be even more important and required skills for the workers. [39]

Switch to Industry 4.0 digital technologies definitely will not influence all industries to the same extend. As it was mention in the previous part, change in energy supplies and technologies will have the impact on the energy, industrial manufacturing, logistics and mobility industries. Processing of big data and cloud technology will have strong effect on

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[38] Jepsen, M. and Drahokoupil, J. (2017). The digital economy and its implications for labor. The consequences of digitalization for the labor market. *Transfer: European Review of Labor and Research*, 23(3), pp.249-252.

[39] WEF. *The Future of Jobs. Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*; World Economic Forum: Davos, Switzerland, 2016; Available online: http://www3.weforum.org/docs/ WEF_Future_of_Jobs.pdf

structure of information and communication technologies, financial services, and professional services. For understanding to which extend Industry 4.0 will influence on different field and workers there, the Boston Consulting Group interviewed 20 industry experts in 2015 and determined which specific job families would be impacted most and how. This survey content ten existing job examples on which it will be determined the impact of new digital technologies and level of worker's adaptation to it.

The first example is an automotive assembly-line worker, for assistance to workers with manual tasks such as heavy lifting that can require dangerous physical positions and health damage for the workers. A robotic device could be used to relieve a line worker from physically demanding tasks as well as to improve ergonomics. For instance, a robot can lift a car's interior-finishing elements, such as a roof lining, inside of the car than with manual cooperation with a worker, fix the part to the chassis.

Another example is mobile service technician that nowadays spent significant time traveling to the site and discussing the service problem and a solution with other experts or second-level support colleagues. New digital technologies will dramatically improve the productivity of service technicians in the field with the decrease of manual operations. With constant access to a stream of real-time data on machine performance, the technician will be able to proactively identify defects and order spare parts before arriving at a site. Than prepared technician with guidelines from experts if necessary will be able to repair any machine with help of augmented-reality technology as well. All work will also be automatically documented. These productivity improvements will reduce total machine downtime from approximately one day to two hours, giving significant benefits to the customer and allowing the technician to work at multiple sites each day.[40]

An example of how manufactures will increase productivity with lower number of people is machine operator job. Responsibilities of machine operator are handling work-in-progress and monitoring performance and product quality at a single machine. With new

[40] Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P. and Harnisch, M. (2017). *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries*. [online] www.bcgperspectives.com. Available at: https://www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries

technologies one operator will be able to handle and monitor work of several machines. Automated system will help to monitor machine performance and single worker will be controlling its work on screens or even with just special glasses. The operator will need less machine- and product-specific knowledge but will have to be able to use digital devices and software and accessing a digital knowledge repository.[41]

In the same with evolving of currently existing jobs, totally new ones will appear. According to the BSC survey one of this new profession will be industrial data scientist. After implementation of Industry 4.0 technologies manufacturers will need to create a new role for industrial data scientists. These specialists will interact with machines and extract and analyze data and apply their findings to improve products or production process. This job will require understanding of manufacturing processes and IT systems and ability for strong analytic skills to identify correlations and draw conclusions.

Another new job that will appear after the Forth Industrial Revolution is robot coordinator that sounds fantastic now but will be ordinary job n the future. Main function will be overseeing robots on the shop floor and respond to malfunctions or error signals. The coordinator will carry out both routine and emergency maintenance tasks and involve other experts if needed. In many cases, manufacturers will be able to retrain machine operators to take on this role, reducing the need for new hires.

Structural changes on labor market will have significant impact on industrial companies, education systems, and governments. Companies which decide to make transition of their systems to technologies of Industry 4.0 will have to retrain their employees, adopt new way of work and organization models, recruit for Industry 4.0, and draw strategic workforce planning.[42]

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41 Bonekamp, L. and Sure, M. (2016). *Consequences of Industry 4.0 on Human Labour and Work Organisation | Journal of business and media psychology*. [online] Journal-bmp.de. Available at: http://journal-bmp.de/2015/12/auswirkungen-von-industrie-4-0-auf-menschliche-arbeit-und-arbeitsorganisation/?lang=en

42 Walsh, B. and Volini, E. (2017). *Rewriting the rules for the digital age 2017 Deloitte Global Human Capital Trends*. [online] Deloitte University Press. Available at: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/central-europe/ce-global-human-capital-trends.pdf

In technologically developed and industrially strong countries such as Germany, companies should be ready constantly to retrain their employees to stay competitive on a current market. Many companies already started their campaign to requalify their workforce but these efforts will need to be expanded and developed. Effective training programs for specific job-related skills should be combination of job instruction and classroom instruction. Online courses will become even more popular and will be developed in the way to provide the scope and scale of the necessary retraining with flexible scheduling. Training in a broader set of skills will often be required, because many employees will be working on a greater variety of tasks. Promotion of a positive forecast and changes among employees will be essential to help them to adapt to new processes and challenges.[43]

Industry 4.0 creates new types of interactions between people and machines that will have great importance for the nature of work and organization structures. With increased variability in production schedules companies will have to take into consideration new work models that include flexible schedules similar to those, which already applied in office settings. Decision making authority will also have to be reorganized in the way that people will not slowing down work of robots. For instance, emergency repair should be done immediately without authority employee aloud robot to do it. [44]

In many cases, companies will benefit from implementing flatter organization structures in order to manage the more dispersed use and control of data. With transition to digital technologies, IT department and the operational departments will be cooperating more inside of the companies. It will allow software developers fully understand how their solutions are being used in production and operators and effect on other solutions. Interactions between developers and operators must be created in a way that ensures unified handling of complex IT tasks. Companies must also be aware that people remain responsible for innovation and coordinate overall processes, rather than trying to automate these critical capabilities.

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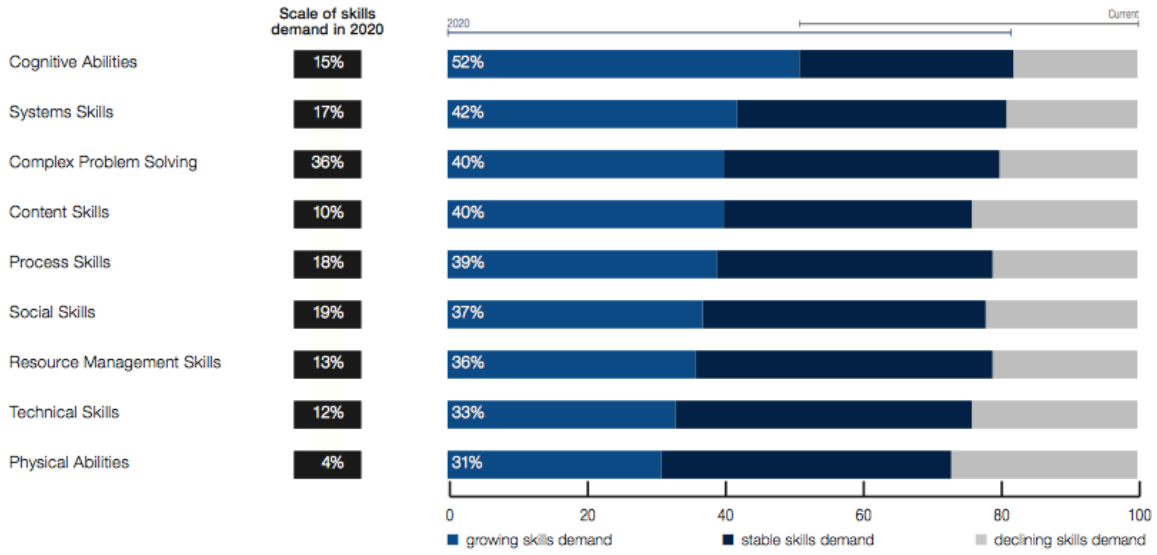
[43] Bowles, J. (2014). *The Computerisation of European Jobs. Who Will Win and Who Will Lose from the Impact of New Technology onto Old Areas of Employment?* Available at: http://www.bruegel.org/nc/blog/detail/article/1394-the-computerisation-of-european-jobs/

[44] Ingo Wolter, M., Mönnig, A., Hummel, M. and Schneemann, C. (2015). *Industry 4.0 and the consequences for labour market and economy*. [online] IAB Forschungsbericht. Available at: http://doku.iab.de/forschungsbericht/2015/fb0815_en.pdf

Recruitment process will also be changed with Industry 4.0, companies will have to be focused on capabilities and not just qualifications determined by degrees and roles. Employees will be working on a greater variety of tasks unrelated to their core education, recruiters will often have to look beyond formal degrees to identify workers with the relevant skills for specific roles. Companies should underline the relevant characteristics and capabilities in their job specifications, because formal degrees and training matter less.

Survey made by the World Economic Forum about employment and workforce shows in the figure 6 that the respondents forecasted that a wide range of occupations would require a higher degree of cognitive abilities, which are creativity, logical reasoning and problem sensitivity. More than half of all jobs expected to require these cognitive abilities as part of their core skill set in 2020. In another 30% of jobs demand for these skills is currently already high and will remain so over the 2015– 2020 period.[45]

Figure №6. Change in demand for core work-related skills, 2015-2020, all industries



Source: Future of Jobs Survey (2015) World Economic Forum

[45] Schwab, K. and Samans, R. (2016). *The Future of Jobs. Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution*. [online] World Economic Forum. Available at: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

Additionally except the transformation of the frontline industrial workforce, Industry 4.0 influence on demand of leadership skills and make the competition for talent in many countries more intense. To be competitive in this talent racing, companies need to focus their significant attention to strategic workforce planning. This planning is starting with systematical collection of baseline information related to all employees and categorizing the various types of employees into job families according to it. Analyze of quitted and retired employee for predicting staff requirements and to create company's forecast rates of Industry 4.0 transition, productivity improvement, and revenue growth and than use in analyses such as people development, transfers, insourcing or outsourcing, and adoption of new recruiting goals, that companies should undertake.[46]

In the Accenture Consulting survey, which was hold in 2017, manufacturers shared that a typical digital Industry 4.0 team will contain individuals who have domain-specific industry expertise, data analytics capabilities, and some understanding of the business. Except data analytics professionals, industrial sector will needs cross- trained digital talent. This means variety of engineering workforce from undergraduates to mid-career professionals with a variety of broad digital skills and knowledge.

As it was mentioned before technical knowledge is not everything and soft skills will be also demanded by companies and except the ability to apply technology to their jobs, employees will need the acquisition of skills and capabilities such as creative to problem solving during the work. As machines begin assuming routine tasks, the workforce will evolve from performing just knowledge work to real judgments at work. In the Industry 4.0 workplace, knowledge is readily available and provided by machines, while people focus their efforts on judgments and actions after that. An Accenture study estimates that this deep analytical work will contain about 75 percent of an employee's job. Analytical job will not only mean having access to the scope of information at the right time and place, but more importantly taking the most optimal action given with information available.[47]

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[46] Colotla, I., Faeste, A., Heidemann, A. and Winter, A. (2016). *Winning Industry 4.0 race*. [online] The BCG. Available at: https://innovationsfonden.dk/sites/default/files/bcg-winning-the-industry-40-race-dec-2016.pdf

[47] Lay Lim, T. (2017). *Manning the mission for advanced manufacturing*. [online] Accenture Consulting. Available at: https://www.accenture.com/se-en/_acnmedia/PDF-50/Accenture-Manning-Mission-Advanced-Manfacturing.pdf

From another side, labor market is very worried about unemployment. One of the main worker's concerns is affordability of trainings needed to get a job in rapidly changing technology era. Many workers will need to be reskilled with long-term course of trainings before they will be properly educated with technologies of Industry 4.0. Another fear that people in developed countries are faced is continuously growing trend of outsourcing jobs in less cost labor countries and the question is if Industry 4.0 will reverse or continue this trend. For example, in the United States, workers remain concerned that jobs could shift to other countries, as they have over the last few decades especially in manufacturing sector, which is leading in terms of outsourcing jobs; more than 50 percent of manufacturing companies outsourced jobs in 2016.[48]

Another trend on a labor market is that the workforce profile is changing rapidly and looks different than a few generations ago. Time when people were staying in the same job for the span of your career is gone and today's millennials are used to work on the multiple jobs. The world is constantly changing and young generations are coming to the workforce with very different expectations than previous generations. According to MIT research, for employees across age groups from 22 to 60, the vast majority wants to work for digitally progressed organizations.[49]

Currently employees have the opportunity to focus their learning process more on digital, intelligence and technology-focused knowledge and skills. Certainly those who master these new skills will be guaranteed employed. Large enterprises are also changing and evolving toward recognizing and respecting the young employees preference for work-life balance. Working conditions are transforming to more flexible work arrangements, such as job-sharing programs and work from home opportunities.[50]

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[48] Statistic Brain. (2017). *Job Overseas Outsourcing Statistics*. [online] Available at: http://www.statisticbrain.com/outsourcing-statistics-by-country/

[49] Kane, G., Palmer, D., Phillips, A., Kiron, D. and Buckley, N. (2015). *Strategy, not Technology, Drives Digital Transformation*. [online] MIT Sloan Management Review. Available at: http://sloanreview.mit.edu/projects/strategy-drives-digital-transformation

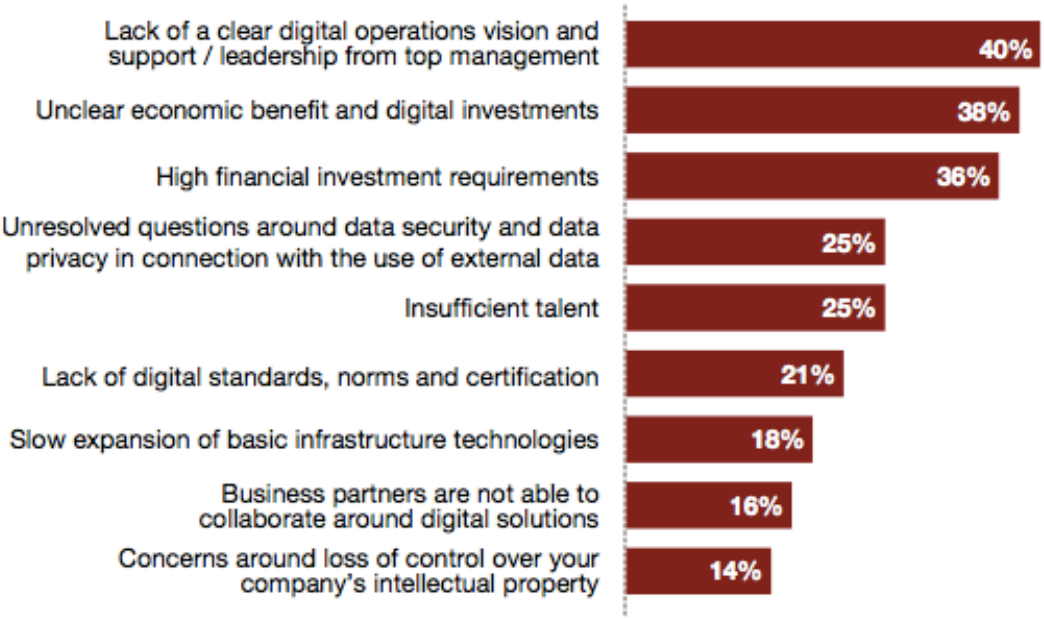
[50] Brown, D. and Buntz, B. (2017). *How Industry 4.0 Will Change Your Job*. [online] IoT Institute. Available at: http://www.ioti.com/industrial-iot-iiot/how-industry-40-will-change-your-job

2.2 Management approaches for Industry 4.0

In the research made by the PwC in 2015 about Industry 4.0 was reviewed that companies will need to make sure that their employees clearly understand how the company is changing and how they can be a part of it. Internal issues such as culture, organization, leadership and skills are in greater concern of companies. External issues such as the right standards, infrastructure and intellectual property protection were also named during survey by participant companies but to less extend.

More companies than any other identified the absence of a digital culture and the right training as a top challenge. That was equally true for companies rating themselves as technically advanced and others within all regions and countries. The PwC survey also proved that lack of skills or competencies in the company's workforce is the biggest challenge that companies see in a future with Industry 4.0. Figure 7 illustrates the biggest challenges that respondents named their companies will face with implementation of digital technologies of Industry 4.0.

Figure №7. Biggest challenges for building digital operations capabilities



Source: 2016 Global Industry 4.0 Survey, PwC

Industry 4.0 from management point requires practices that provide a climate of learning and innovation to the employees. Appropriate changes in management practices will be important in transition period to digital technologies and increase productivity of the company. In this part preferred management approaches for Industry 4.0 will be described and analyzed in order to match with the technological progress with raising climate of learning and innovation. If company decides to change their processes with technologies as CPS, they need intelligent employees, and climate for learning and innovation, which requires suitable management practices. With Industry 4.0 companies need to develop capabilities across different dimensions such as business models, possible changes in products and service portfolio, market and customer access, internal value chain, legal risks and security, and organizational culture.[51]

When environment is changing fast and rapidly, organizational structures can play a significant role in the development of a climate suitable for learning and innovation. There is a range between mechanistic design and organic design in which companies can find right approach depends on the size, industry and culture. Mechanistic design is characterized by a centralized structure, specialized tasks, many rules and formalities, vertical communications, and strict hierarchy of authority and it is suitable in a stable environment, which is not couple with changing reality Industry 4.0.

Unstable changing environment, and is matching with the organic design of organization, which is can be described as decentralized, empowerment, with few rules and formalities, horizontal communication, and collaborative team work. This approach is more suitable for innovation strategy and changing environment. With Industry 4.0 companies need management approach with the flexible structures according to their needs and situations, there is no unified treatment that can be suitable for every organization.[52]

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[51] Schrauf, S. and Berttram, P. (2016). *Industry 4.0: How digitization makes the supply chain more efficient, agile, and customer-focused*. [online] Strategyand.pwc.com. Available at: https://www.strategyand.pwc.com/reports/industry4.0

[52] Van der Sluis, L.E. (2004). Designing the workplace for learning and innovation: Organizational factors affecting learning and innovation. *Development and Learning in Organizations: An International Journal, 18(5)*

One of the suitable options for organization within Industry 4.0 can be matrix structure. It refers to a structural form in the organization, where activities are aligned among more than one authority line. In the matrix structure groups of people and resources divided by function and product at the same time with a use of a dual reporting system. This structure it is very flexible and can quickly respond to the upcoming changes. In the matrix structure each employee has to work with two head of different departments, one product manager, and other functional manager. Matrix structures can also support the formal linking mechanisms by connected problem solving from the product and functional managers.

A team-based structure makes different processes and functions in single group to be considered a common objective. It breaks the borders built by the functional and departmental barriers and accelerates the decision making process, strengthening generalist skills, and supports the learning in the organization. In a new ambiguous environment of Industry 4.0, where changes are expected very frequently and innovation is a key to success, project based teams is a good option to support learning and innovations. Technological development requires new technical solutions and reconsideration of existing structures and project teams can contribute knowledge and new approaches. However it should be considered that for project teams is curtail to have a strong manager, which will motivate the group members for learning and will lead by own example and supervision.[53]

In terms of organizational hierarchy, the most suitable option for Industry 4.0 is flat hierarchy. Hierarchy specifies the authority of managers at different levels in the company. The specific of the flat structures is fewer level of hierarchy, and wide range of control. In a flat structure there are less managerial levels in hierarchy but number of employees reporting to one manager is usually higher than in a tall structure, where number of levels are high. Flat structure characterized by quicker communication, and lower power distance between employees and the top management. This type of structure gives chances to stimulate employees to participate in discussions and decision-making processes. It can

[53] Khedhaouria, A., & Jamal, A. (2015). Sourcing knowledge for innovation: knowledge for innovation: knowledge reuse and creation in project teams. Journal of Knowledge Management, 19(5)

increase the chances of employees to learn faster with direct feedback from top managers.[54]

Overall decentralization can be good practice for Industry 4.0 because it allows making decision on the lower levels of organizations, which is important for prompt changing environment. In the decentralized system lower managers and even non-managerial employees have the authority to take their decisions to some extend and have certain level of independency with no approval from managers. In uncertain environment where situation changes very frequently, decentralization is preferable for many companies. It provides the employee the chance to make fast decision, to change the direction, with the change in the business environment.[55]

Regarding management approaches in Industry 4.0 it is also worth to mention human recourses management and its possible transformation within companies moving to digital technologies. Human recourse management is one of the primary sources by which companies can shape the skills, capabilities, behaviors, and attitude of its employees to achieve organization goals. Managers can enhance the innovativeness, knowledge management capacity, and learning among employees by designing the HR practices accordingly. The main instruments, useful for Industry 4.0, are training, staffing, performance appraisal, compensation and job design. Companies need to design these HR practices with the intention to promote innovativeness and learning in the organization.[56]

As one of the main point is to train soft skills that are same important as technical hard skills for employees in Industry 4.0 companies need to develop their training programs to boost the innovative capability and learning. Organizations should offer different type of training to the employees to enable them for multitasking. These trainings are not necessarily should be relevant for daily employee job but needed to increase the variety of employee's skills. Trainings have to be focused on team building and teamwork skills, and mentoring system should be well established, especially for the new comers. Thus, training

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54 Chan, H. (2015). Internet of Things Business Models. *Journal of Service Science and Management*, 08(04), pp.552-568

55 Hindle, T. (2008). Guide to management ideas and gurus. London: Profile, pp.57-62

56 Donate, M. and Sánchez de Pablo, J. (2015). The role of knowledge-oriented leadership in knowledge management practices and innovation. *Journal of Business Research*, 68(2), pp.360-370

sessions for developing problem solving skills are also highly important for the employees of the future.

Recruitment process within Industry 4.0 should be based on testing of variety of skills, and heterogeneous knowledge. Companies have to improve their recruitment to multistage process because cost of mistake of not right candidate will be much higher. It should be focused on identifying the features necessary for innovative behavior and openness to experience, which can be evaluated through psychometric testing in the selection process. Another attributes that companies should test on interviews are openness to new experience that characterized by active imagination, inner feeling attentiveness, variety preferences, intellectual curiosity, creativity, and flexible thinking. In the process of recruitment and selection, organizations should also evaluate the goal orientation of the candidate, which can be learning orientation and performance orientation. To promote innovation and learning in the organization, recruiters should prefer candidates with high learning orientation. Learning goal orientation engage people in challenging tasks and motivate to improve themselves, to develop a new set of skills, and tend to achieve mastery.[57]

Industry 4.0 will require different performance assessment system to be established by the companies. Changes should be focused on employee developments, result based approach, and behavior based approach, as these approaches can facilitate learning and innovation. Important factor will be feedback that employees should receive on their performance on regular basis. Thus, all process shod be more objective with clear goals and matrixes to evaluate the performance quantitatively. Assessment process should include performance standards, communicated expectations, measured actual performance, and than discussion on the appraisal with the employee, and suggestion on corrective action where necessary.[58]

The compensation system in Industry 4.0 should reflect the contribution of employees to the company. Employees should receive the compensation based on individual, group, and organizational performance measured by assessment performance. Link between performance and the reward such as profit sharing or additional incentive pay boost

[57] Ma Prieto, I. and Pilar Pérez-Santana, M. (2014). Managing innovative work behavior: the role of human resource practices. *Personnel Review*, 43(2), pp.184-208

[58] Odoardi, C. (2015). The relationship between proactive goal generation and innovative behavior at work. *Journal of Management Development*, 34(5), pp.553-565

employees motivation and productivity. This kind of compensation system potentially facilitates the climate of innovation and learning in the organizations.

Overall developing key for workforce is to meet present and future market needs is to determine the identification of required competencies. Competencies are a set of skills, abilities, knowledge, attitudes and motivations an individual needs to use with job-related tasks and challenges effectively. There are four main classification categories of competencies: technical, social, personal and methodological competencies that include all skills and abilities for general problem solving and decision-making. Competence development has to be a continuous improvement cycle and companies learning process is a core instrument for that.

In case of Industry 4.0 technical competences will be playing one of the key roles and can be indicated as comprehensive technical skills that needed to switch from operational to more strategic tasks, process understanding for higher process complexity, media skills for virtual work, coding skills for digital processes and awareness in cyber security. In terms of social skills the most important for the companies will be intercultural skills, multilingualism, networking skills, ability to compromise and cooperate in teamwork and leadership skills. Personal competences that should be identified in Industry 4.0 employee are flexibility, ambiguity tolerance, learning motivation, ability to work under pressure and sustainable mindset. Methodological competences are one of the most essential for effective work and include creativity, entrepreneurial thinking, problem solving, analytical and research skills.[59]

The main difficulties that companies can face while managing Industry 4.0 workforce is that reskilling and retraining efforts may not give the desired return if employers are not aware of forthcoming disruptive change and instead keep their content primarily on today's requirements or past successes. According to the World Economic Forum survey only 53% of respondents are confident regarding the sufficiency of their organization to prepare for the shifts in future workforce strategy.

The main barriers to a more active approach were named a lack of understanding of the disruptive changes ahead, resource constraints and short-term profitability pressures and

[59] Hecklau, F., Galeitzke, M., Flachs, S. and Kohl, H. (2016). Holistic Approach for Human Resource Management in Industry 4.0. *Procedia CIRP*, 54, pp.1-6

lack of adjustment between workforce strategies and firms' innovation strategies. In order to meet the talent and skills challenges hold by expected business model changes, companies provide consistent innovative workforce strategies; supplying employees with wider exposure to roles across the firm, stepping up efforts to target the female talent pool and collaborating with the education sector more closely than in the past are some of the more popular measures. Across all industries, plans to invest for reskilling of current employees feature evidently among all reported future workforce strategies.

2.3 Logistics and Supply chain management within Industry 4.0

Industry 4.0 will influence all industries and how it was mentioned before, the strongest influence will be on manufacturing but the industry, which is closely connected to it, is logistics. It will be also significantly impacted by new technologies. Reliable and fast transportation and efficiency of logistics services became more important in the activities of many companies. However companies that are totally focused on their core business or do not have sufficient resources are outsourcing logistic services.

Logistics service providers embrace sector for the activities of different companies within their size and needs. Logistic companies vary from very large to small that are offering different range of services such as warehousing, palletizing, packing, to full service of supply chains. Logistic companies can cover some region, country or the whole world and be focused on transport management, warehouse management or other transport services Logistic companies usually centered across well-developed operating system, which consists of workforce and infrastructure. In this system parcels, documents and heavy freight are sent, but also information about them.[60]

To guarantee a fast and correct flow of information between individual objects of the operating system, logistics companies have to use appropriate information technologies. Information and telecommunication technologies are now so closely connected with the operating system that one cannot exist without the other. Companies that are not aware of the essence of modern technology have no opportunities for further development and are not competitive without modern IT system.

[60] Hae Lee, Y. (2016). Smart logistics and global supply chain management. *Maritime Economics & Logistics*, 18(1), pp.1-2

Logistics companies apply information technology mainly in order to increase efficiency and automate workflow. Informational technologies provide access to numeric data, verification and control of costs, revenues, sales and other data. Certain level of information technology such as online tracker of the delivery is an expected feature by potential and existing customers. These are the customers for whom time and safety of delivery and full information about the logistics process is more important than the price of the services.

Industry 4.0 features that can be applied in logistics are interoperability, when CPS allow humans and smart factories to connect and communicate with each other through Internet of Things and Internet of Services, virtualization to connect physical systems with virtual models and simulations, decentralization and independency of decision making and management processes and real time capability and modularity to quick changes of the situation. The main conditions required for the successful implementation of Industry 4.0 are standardization of systems, platforms, protocols, connections, work organization, availability of products, new business models, intellectual property protections, trained skilled workers, professional development, legal framework.[61]

In logistics sector, digital IT applications enable to improve analysis, communication, design and optimization of the processes. Industry 4.0 in logistics will bring transformation and creation of "smart logistics" solutions. Generally, main parameters according to which customers select logistics service are time and price. Nowadays due to globalization, increased competition and environmental protection policies and energy efficiency customers pay more attention to sustainability of a logistics services.[62]

Supply chain integration is one of the factors that boost implementation of new technologies in logistic industry. Reducing of the cost, improve of responsiveness, increase in service level are examples of implementation of Industry 4.0 into the industry. Firstly, information sharing and collaboration are instruments to enable the supply chain visibility and avoid the information delay and misrepresentation, which can result in vast variations and inefficiencies. Secondly, digitalization will provide the ability for the logistic

[61] Maslarić, M., Nikoličić, S. and Mirčetić, D. (2016). Logistics Response to the Industry 4.0: the Physical Internet. *Open Engineering*, 6(1)

[62] J. C. P. Cheng, K. H. Law, H. Bjornsson, A. Jones, and R. Sriram, (2010) A service oriented framework for construction supply chain integration. *Automation in Construction*, vol. 19, no. 2, pp. 245– 260

companies to respond promptly and accordingly and be ready to rapid and unexpected changes in global market. When the highly distributed and heterogeneous resources located in different warehouses, it became more challenging to manage them within supply chain management. In this context, supply chain integration has higher requirements for real-time information sharing, response speed, and flexibility in prompt management and new technologies are able to meet all these requirements.

One of the recent modifications that started to be implemented by logistic providers is a part of intelligent process perception. For collection of various condition information required by supply chain integration and management, different intelligent condition perception technologies were developed, such as RFID, embedded technology, barcode, and other sensor technologies. RFID is an automatic identification technology, which depends on a distance storing and retrieving data using RFID tags. Combined with the traditional tracking manual system, the RFID started to be widely used in the supply chain management with the characteristics of automatic identification, retrieving, tracking, and storing.[63]

RFID system consists of two components: readers connected to one or more antennas and RFID tags, which store generated information in the form of electronic product code. Nowadays the barcode system is the most popular management approach that has obtained much attention in the field of logistics and RFID technology has great unique advantages with wireless operations, it still cannot completely replace barcodes due to the cost and work environmental constraints.[64]

Another trend that appeared in logistics is heterogeneous network access convergence, which means the resource access adaptation and its data transmission is beginning of information analysis in the supply chain management. It aims to collect information during the logistic processes such as cargo condition information, vehicle position information, and warehouse basic information and communicates in real-time. During the supply chain process, collected information is multi-source, massive, and heterogeneous and traditional single transmission mode is not satisfying the diverse needs in distributed information in

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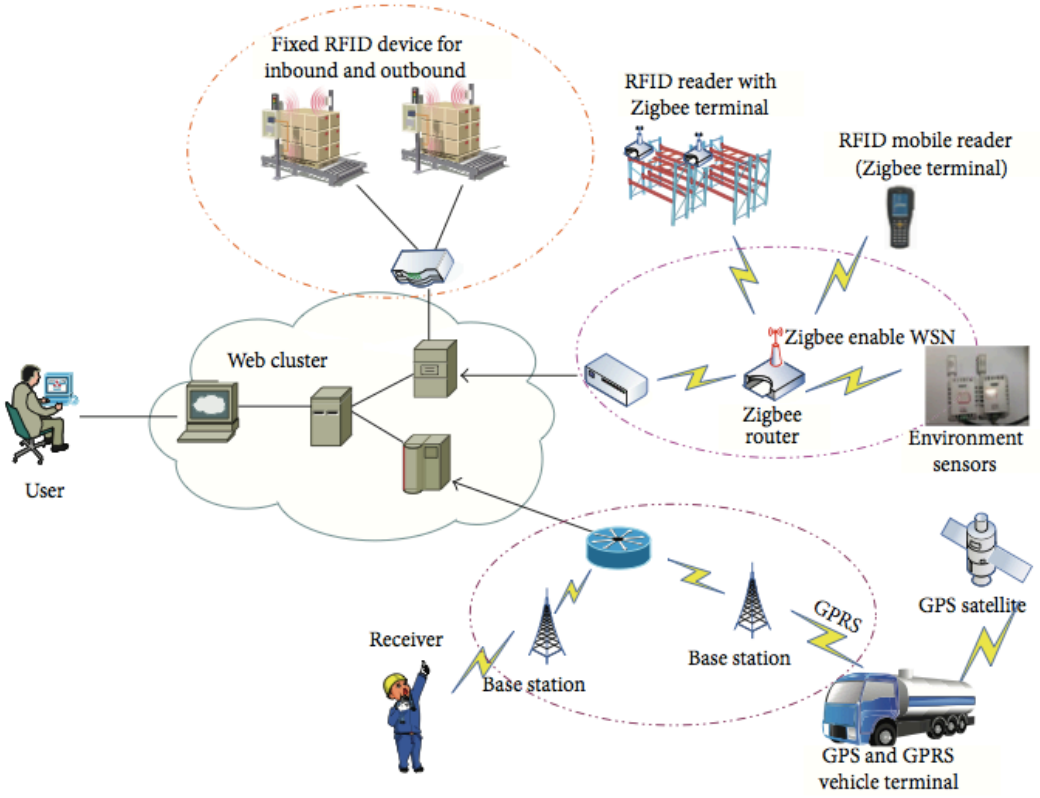
[63] Lim M. K., Bahr W., and Leung S., (2013) RFID in the warehouse: a literature analysis of its applications, benefits, challenges and future trends, *International Journal of Production Economics*, vol. 145, no. 1, pp. 409–430

[64] Rho, S. (2014). Analysis of RFID Standard Patent Data for RFID Technology Trends. *The Journal of Korea Navigation Institute*, 18(2), pp.185-190

such complex working environment. The heterogeneous network allows having access on reliable and real-time transmission of the dynamic condition of the information. Main examples of these technologies can be Internet, WiFi, Zigbee, and GPRS that are used in special devices according to the types of information perception and the application scenarios. Figure 8 demonstrates the example of the network accessing and convergence for connecting the resources in the supply chain process. For example, the goods information, acquired by the RFID readers, which are located in the door, is transmitted using the WiFi, the distributed sensors collect the warehouse environment information and the Zigbee networks will send the shelves information at the same time. In the process of transportation, the information from GPRS will be automatically collected such as location, name, and count. After arriving at the destination, the goods will be checked by customers, with scanning the RFID tags by his phone and send the checked information with GPRS to the server.[65]

Figure №8. Example of heterogeneous networking solution in logistics



Source: Research Article: Intelligent Supply Chain Integration based on CoT (2014)

[65] Yan, J., Xin, S., Liu, Q., Xu, W., Yang, L., Fan, L., Chen, B. and Wang, Q. (2014). Intelligent Supply Chain Integration and Management Based on Cloud of Things. *International Journal of Distributed Sensor Networks*, 10(3)

Cloud of Things is an IoT connected products management solution that enables its customers to connect any device to any cloud. The CoT guides the development of the whole supply chain integration and management, in particular for the service management platform. The platform is developed to manage the whole supply chain using the supply chain information collected by the process condition perception modules. Table 1 describes supply chain processes and time that each step takes. For example, the warehouse management module is designed with the services provided by the distributed warehouse management system. Meanwhile, the supply chain management platform also can provide cloud service for other users by gathering the distributed resource services.[66]

Table 1. Comparison of Cloud of Things and original system

Stage	CoT-based system operations	Original system operations	CoT-based system operation time (s)	Original system operation time (s)
Inbound	Scanning RFID tags	Scanning barcodes	2.47	15
	Record automatically and show on the platform	Record data in platform manually	5.18	10
Shelves management	Scanning RFID tags on shelves	Manual count	2.72	60
	Record automatically and show on the platform	Record data in platform manually	4.16	10
	Send environment information by ZigBee (temperature, humidity)	None	16.96	None
Outbound	Scanning RFID tags	Scanning barcodes	3.51	15
	Record automatically and show on the platform	Record data in platform manually	5.23	10
Logistics	Fix position by smartphone	None	2.5	None
	Record and show the position on the platform		5	
	Accept goods by smartphone		1.5	

Source: Research Article: Intelligent Supply Chain Integration based on CoT (2014)

Another feature of implementing Industry 4.0 is need in processing of big amount of data and cloud service management. When the massive and heterogeneous data will be collected during industrial processes, the traditional data analysis tools cannot satisfy the

66 Ceniga, P. and Sukalova, V. (2015). Future of Logistics Management in the Process of Globalization. *Procedia Economics and Finance*, 26, pp.160-166

requirements of such data processing. Therefore, a new data processing technology will playing an increasingly important role in data storage, exchange, and processing. The goal of big data technology is to improve data processing capability and improve the data value. The conception of CoT guides the development of the whole supply chain integration and management, in particular for the service management platform. The platform is developed to manage the whole supply chain using the supply chain information collected by the process modules. The supply chain management platform also can provide cloud service for other users by gathering the distributed resource services.[67]

Big data is core idea of the fourth industrial revolution, but the massively growing information flow will be useless without the right analytics techniques. The rapidly growing number of sensors, embedded systems and connected devices as well as the increasing horizontal and vertical networking of value chains result in a huge continuous data flow. Data is coming from multiple sources, in different formats, and there is a need to combine internal data with data from outside sources.

As a continue of Industry 4.0 concept, which will be developing during next years in different industries, as part of IoT idea of new type of city was born - smart cities. With collaboration of government, private companies and implementation of information and communication technologies can make smart cities reality of our near future. Increase of IoT and constant growth number of devices like smartphones, tablets, laptops and they are accompanied with sensors, which are able to join the Internet. In the context of smart cities, it makes sense to consider the scenario of the various different and heterogeneous devices, the wireless sensor networks interconnected to each other, and development of these connections to activate new type of services.[68]

Smart cities will have many facilities that must be integrated as part of daily smart city processes. The most important elements of relevant producers of data are transportation that can analyze dynamic route calculation on information of accidents and traffic, energy for reporting of faults, emergency services to detect of accident and crimes, waste management to discover full bins and etc.

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[67] Hofmann, E. and Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, 89, pp.23-34

[68] Petrolo, R., Loscrì, V. and Mitton, N. (2015). Towards a smart city based on cloud of things, a survey on the smart city vision and paradigms. *Transactions on Emerging Telecommunications Technologies*, 28(1)

There are different challenges related to the IoT in smart cities, from technical and privacy points of view. First, is at was described before is big amount of data to store and properly analyze and secondly, privacy and security issues exist for a long time in the computing literature, and many law acts have been published to protect users.[69]

Lack of digital skills and transformation culture are most common issues companies in any industry facing willing to transit to Industry 4.0 technologies. Many industrial companies will need to develop digital skill sets around creative digital strategy design, technology architecture and design, user experience design, or rapid prototyping capabilities. Digital culture will be important trigger to keep talents in the company. Company's culture has to be collaborative, crossing organization boundaries and include partners and customers. Companies that say constrained by functional boundaries are unlikely to achieve the integration that is so important to Industry 4.0. In the third part of the thesis some of pioneer companies that started implementation of Industry 4.0 will be described and analyzed.

[69] Lewis, D. (2017). *Will the internet of things sacrifice or save the environment?*. [online] the Guardian. Available at: https://www.theguardian.com/sustainable-business/2016/dec/12/will-the-internet-of-things-sacrifice-or-save-the-environment

3 Current implementation stage of Industry 4.0

Whole industrial world aware of next coming the Forth Industrial Revolution and understand that the adoption of Industry 4.0 will brings important benefits. According to the BCG 1/4 of German respondents and 2/3 of US respondents connect Industry 4.0 with cost reduction and increased productivity. Thus, many respondents, 48% in Germany and 43% in the US, associate it with revenue growth. That means most of the companies understand and accept concept of Industry 4.0 and digital technologies.

Looking into adoption stage it is clear that there is still long way to go and there are not many companies that completely transit their business to Industry 4.0 conception. As it was already mentioned before transition to new technological level is very challenging in terms of investments, security and skill development. Despite all these factors there are companies that started their industrial revolution and changing their processes according to new technologies in order to get competitive advantage in nearest future.

Nowadays ICT vendors and traditional manufacturing enterprises in core industries are joining forces to demonstrate new business models. Governments and international organizations are taking part and promoting standardization and collaboration across countries and industries and by global connectivity, IP-based equipment, mobility, data sharing, and security schemes. Generally speaking implementation of Industry 4.0 and its technologies are going on around the globe are changing the way we live and see the world.

In this final chapter, examples of three pioneer technology developed companies demonstrate current stage of Industry 4.0 implementation, its advantages and disadvantages and first results for the industries.

3.1 Case study: Huawei

Huawei was founded in 1987 and firstly was focused on manufacturing phone switches, but than expanded business to telecommunications networks, providing operational and consulting services and equipment to enterprises inside and outside of China, and manufacturing communications devices for the consumer market. The company has around 140,000 employees working and almost half o them are involved in research and development departments. Huawei is well-known and speeded globally information and communications technology solutions provider and seeking for innovations company.

Current status and focus of the company across Industry 4.0 is taken from the interview with Tian Qiming, Huawei Senior Solution Architect and published in official webpage of the company. With high competitiveness of the business, companies are not sharing their latest developments and production developments in open sources according to that base of this research was found from most sharing information with community companies. First statement on Industry 4.0 within the company is that digital technologies are enchasing efficiency and competiveness. Key role is on vendors that provides right equipment to each industry players and have to understand requirements and develop the most appropriate technologies and products.

Industry 4.0 has to keep elasticity and flexibility of the systems, which means support applications in enterprises of all sizes and be able respond quickly and dynamically to upcoming changes. Solutions have to be built on standards-compliant, open architectures in which components can be easily added or removed to meet the exact demands in the production process. [70]

Industry 4.0 details future, inter-connected factories to collaborate by employment of embedded systems, networks, cloud data, and secure exchange technologies. Huawei's industry-specific solutions, including Smart City, Smart Transportation, Smart Energy, Smart Grid, and Smart Manufacturing, have established solid track records in global markets.

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[70] Qiming, T. (2015). *4 Characteristics You Need to Know About Industry 4.0*. [online] Huawei Enterprise Blog. Available at: http://hweblog.com/4-characteristics-you-need-to-know-about-industry-4-0

As a manufacturer Huawei is interested in Smart Factories solutions that are a key feature of Industry 4.0. With networked, distributed production facilities, Smart Factories are built to leverage Smart Production systems to manufacture goods more efficiently. For instance, it includes the incorporation of advanced logistics management, man-machine interaction, and three-dimensional, augmented reality, visualization technologies into production processes.

Some of the new technologies that Huawei is already trying on their manufactures are upgrades to existing machinery with networked sensors, optimum use of the large volumes of data generated by machines and production processes and deployment of Big Data cloud platforms that offer factory automation and analytics. It will bring optimized production processes with improved product quality, increasing production efficiency, and ensuring production safety.

According to Tian Qiming "Huawei's Smart Factory solutions enable efficient wireless communication at both short and long distances, while providing a hybrid, unified wired and wireless foundation. The hybrid network facilitates efficient data exchange between machines, and between machines and cloud data centers. Huawei provides service-centric, scalable, and integrated manufacturing cloud solutions that help manufacturers to exploit the computing, storage, and Big Data analytics capabilities within the ICT infrastructure."

Another strategically important component is mechanical engineering hat is the process of shifting to a service model by providing engineering design and assistance as a professional service to customers. Predictive maintenance is also playing a great role in shifting industry to manufacturing services. The efficiency of outsourcing predictive service is gained by reporting real-time engineering information, including location, running data, and status, to recording centers against baseline data sets for fault modeling and failure analysis.

For the next year on the main focus of Huawei is developing of innovative application platforms for mechanical engineering enterprises with their partners in accordance to help with acceleration of the shift from production centric to service centric manufacturing.

Even in our modern world there are a lot of cases as production accidents and hazardous material that can cause worker injury, property losses, and long-term environmental damage. The best-practices solution to lower and prevent such accidents is implementation of strict rules and managing system to control them. With development of IoT technologies, data collection costs for sensors and communications will decline and it can be much easier to implement and control rules on preventing accidents.

One of Huawei's Smart Factory solutions suggests IoT and 4G mobile communication technologies for clear monitor of petroleum production and storage facilities. By enhancing the collaboration between operation and production teams, the Huawei solutions deliver a wide range of benefits that include reduced costs, increased efficiency, mobile operations and management, and coordinated responses to dangerous circumstances. Huawei brings the expertise to interconnect all relevant networks related to predictive maintenance, including sensors for machinery, telematics for engineering vehicles, wireless carriers, and local area networks for mechanical engineering sites. In addition, Huawei offers a unified IoT management platform that ensures reliable data connections between equipment, sensors, and servers.

Another specialty of Huawei is intelligence solutions for logistics and proof of that is contract with DHL sighed earlier this year. Customer Solutions & Innovation organization at DHL is where Huawei provides main point of contact for DHL's customers at a global and regional level and driving innovation and sector leadership on behalf of the group. Developments of innovative industry-tailored solutions are the main point in this collaboration.

As well as great presence in Asia, Huawei is expanding its boundaries on the west and great example of it is Innovation Center established near global headquarters in Bonn, Germany. Second new Innovation Center in Singapore to better accommodate for Asia-Pacific-based customers that was opened in the end of 2015 and preparation to open Americas Innovation Center close to Chicago, Illinois, in the USA in 2018.[71]

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71 Heutger, M. (2017). *Leading New ICT, The Road To Digital Transformation*. [online] E.huawei.com. Available at: http://e.huawei.com/topic/leading-new-ict-en/dhl-logistics-case.html?utm_campaign=lni17_minisiteen&utm_medium=sm&utm_source=facebook&source=eebghq175142o

3.2 Case study: Tesla

Tesla Company was founded in 2003 by a group of engineers inspired by improving electric vehicles to be better, quicker and more fun to drive than gasoline cars. Tesla designed and launched the world's first premium all-electric sedan - Model S, which has become the best car in its class in every category. With combination of safety, performance, and efficiency, Model S has reset the world's expectations for the car of the 21st century with the longest range of any electric vehicle, over-the-air software updates and a record acceleration time of 2.28 seconds as measured by Motor Trend.

Tesla's vehicles are produced at its Fremont factory in California, where the vast majority of the vehicle's components are also made. As Tesla continues to expand its product line, Tesla's production plan is also set to increase to a rate of 500,000 vehicles a year by 2018.[72]

Tesla was ranked with second place in the World's most Innovative Companies list made by Forbes in 2017. Company is implementing new technologies not only in their electro cars but also to their manufactories. Tesla has installed 160 special robots at its assembly line with performing 4 tasks while typical robots in automotive industry perform just a single function. For instance, a robot at the Tesla factory can be involved in welding, riveting, bonding and installing a component, while other robots typically do only one job. The use of robotic systems also expands to recharging the car's battery at Tesla's Supercharging stations. The company's latest system removes the old battery and replaces it with a new one in 90 seconds, before it was taken time of one hour.[73]

Nowadays auto production process efficiencies and cost management continue to be based around principles of lean manufacturing with their origins in the "continuous flow" assembly lines of Henry Ford with its concentration on reducing and avoiding inefficiencies and minimizing waste. Issues of mass customization are different than those of mass production's assembly line speed. Industrial robots are also becoming an

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[72] Tesla.com. (2017). *About Tesla | Tesla*. [online] Available at: https://www.tesla.com/about

[73] Sisson, P. (2017). *Elon Musk's Gigafactory and the rise of the high-tech, robot-run smart factory*. [online] Curbed. Available at: https://www.curbed.com/2016/7/29/12326402/gigafactory-manufacturing-robotics-technology

integrated part of the evolving lean process. Their value is increasing as they become more intelligent, collaborative and autonomous as a result of the Industrial Internet of Things with technologies of embedded sensors, big data, real time analytics, and machine learning.

For Tesla it became essential to have its own IT solutions to drive production volumes and build its online model. Tesla therefore built its own internal ERP system and e-commerce platform. Tesla's chief information officer and his team created hole the system in 4 months. Important character of Tesla is that they want to change the automotive industry and keep patents related to electric vehicles in open sourced. The idea is that other auto companies will share theirs as well and, collectively; the industry can progress more rapidly towards the development of electric vehicles, which is distinctive feature of truly Industry 4.0 company.[74]

Partnerships play a key role in Tesla's plan, and originally focused on serving the needs of the connected car. With the company's announcement to open up its patents, the opportunity to create an even more robust set of business partnerships, markets, and co-created products is now on the table. While this may be new in the auto industry, this kind of co-innovation model already exists in other industries. Tesla also gains a new revenue source to sell batteries, super charging stations, and other services not only in the auto industry but also to homeowners, businesses, and utility companies.[75]

Obviously that Tesla is a manufacturing company as of now but its service content is growing fast. The company uses its own distribution unlike other automakers to control the sales and contact with the customers. Also their wide customer service at every touch point, and makes the vehicle better over time via such remote upgrades. First, the in-car touch point with the consumer is a huge dashboard in the car, synched with the customer's mobile phone. Local sensing of every aspect of the asset operations in the field gives significant visibility to Tesla. For example, the management of the cells in the battery pack

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[74] Capgemini Consulting, (2014). *Tesla Motors: A Silicon Valley Version of the Automotive Business Model*. [online] Available at: https://www.capgemini-consulting.com/resource-file-access/resource/pdf/tesla_motors.pdf

[75] Koushik, S. and Mehl, R. (2017). *The automative industry as a digital business*. [online] Available at: https://emea.nttdata.com/uploads/tx_datamintsnodes/1508_EN_Whitepaper_Automotive_as_a_Digital_Business_V1.02.pdf

helps maximize its lifetime and utility. Locally on-board computers can reconfigure innumerable aspects of the car, via remote upgrades similar to a mobile phone.

Wide plants and warehouses are now being covered in green roofs and solar panels and Tesla is into building one this sustainable plants. Construction started in June 2014 outside Sparks, Nevada with the name Gigafactory, which comes from the word "Giga," the unit of measurement representing "billions." The factory's planned for production batteries for electro with capacity of 35 gigawatt-hours (GWh), with one GWh being the equivalent of generating 1 billion watts for one hour. This is nearly as much as the entire world's current battery production combined.

The Gigafactory is being built in phases and current structure has a footprint of more than 1.9 million square feet, which houses more than 4.9 million square feet of operational space across several floors. Currently factory is about 30% ready and already runs battery production on low volumes, once completed, Tesla expects the Gigafactory to be the biggest building in the world – and entirely powered by renewable energy sources, with the goal of achieving net zero energy.[76]

With the Gigafactory gain its production plan, Tesla's cost of battery cells will significantly decries through economies of scale, innovative manufacturing, reduction of waste, and the simple optimization of locating most manufacturing processes under one roof. With reduced cost of batteries, Tesla can provide it products to more people and make possible transition to the world of sustainable energy.

The $5 billion plant supplies the batteries for the vehicles and growing Tesla's energy division, which develops the company's at-home battery, and commercial battery. Tesla aims to grow commercial battery with support of the solar business and launching of its solar roof product. Another advanced project by Tesla is building of the world's largest

[76] Lambert, F. (2017). *Tesla gigafactory | Electrek*. [online] Electrek.co. Available at: https://electrek.co/guides/tesla-gigafactory/

battery in Australia. The Tesla's Powerpack system will store energy from a wind farm in South Australia to power up to 50,000 homes.[77]

On the main factory of Tesla in California, company reconstructed manufacturing process with new equipment and already implemented robots to work with collaboration with humans. Although society was concerned that Tesla factory workers were injured at a rate 31% higher than industry average – and seriously injured at a rate more than double the industry average.

Tesla's manufacturing practices appear to have been most dangerous in its earliest years of operations. The company does not dispute that its recordable incident rate (TRIR), an official measure of injuries and illnesses that is reported to workplace safety regulators, was above the industry average between 2013 and 2016. The reason of injured workers mostly in overworking hours and high production plans from top management of the company. It also proves that robots are still not on the level to substitute all hard manual work even on such modern factories as Tesla's and we sill have long way to go.[78]

3.3 Case study: DHL

DHL was found in 1969 and formed its name from the last names of the three company founders, Adrian Dalsey, Larry Hillblom and Robert Lynn. The founders began with shipping papers by themselves by airplane from San Francisco to Honolulu with starting customs clearance of the ship's cargo before the actual arrival of the ship and dramatically reducing waiting time in the harbour. With this concept, a new industry was born: international air express, the rapid delivery of documents and shipments by airplane.

DHL rapidly developed into an express delivery service between California and Hawaii, then quickly expanded to the east. The company's main customer was the Bank of America, which needed a single company to carry its letters of credit and other documents.

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[77] Muoio, D. (2017). *New aerial photos appear to show just how massive Tesla's Gigafactory is*. [online] Business Insider. Available at: http://www.businessinsider.com/tesla-gigafactory-massive-photos-2017-7

[78] Wong, J. (2017). *Tesla factory workers reveal pain, injury and stress: 'Everything feels like the future but us'*. [online] the Guardian. Available at: https://www.theguardian.com/technology/2017/may/18/tesla-workers-factory-conditions-elon-musk

DHL branched into the international market in the early 1970s when it began flying routes to the Far East. In addition, while competitor Federal Express was developing its domestic overnight delivery network, DHL focused on further developing its international service.[79]

Nowadays DHL is world logistics service provider leader with around 325 000 employees all over the world and steadily growing revenue of €14 billion in 2016. Company invests into research and development and implementing new technologies in transportation and warehousing processes.

Currently DHL invests into augmented reality technologies such as Vision Picking Program that is in trial in the Netherlands. Since the beginning of testing period, DHL and partners Google, Vuzix and Ubimax have refined the vision picking solution and DHL is now expanding the program across different industry sectors on a global scale, forging another step forward for augmented reality solutions in logistics.[80]

Technology works with advanced smart glasses that visually display where each picked item needs to be placed on the trolley. Vision Picking enables hands free order picking at a faster pace, along with reduced error rates. The data available from these trials will further define the technology's potential for broader implementation. The pilot sites are spread across the United States, Mainland Europe and the United Kingdom.

"The Vision Picking Program is DHL Supply Chain's first translation of what augmented reality solutions can look like for supply chains. The broad spectrum in which the technology can be applied across various sectors is exciting to us, and the potential of this technology for business is still largely untapped. We believe this program is a game changer in how we run our supply chain operations and deliver added value to our customers," states Markus Voss, CIO Supply Chain. DHL Supply Chain will be one of the first logistic companies to widely implement the technology into their operations.

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79 Referenceforbusiness.com. (2016). *DHL Worldwide Express - Company Profile, Information, Business Description, History, Background Information on DHL Worldwide Express*. [online] Available at: http://www.referenceforbusiness.com/history2/17/DHL-Worldwide-Express.html

80 Dhl.com. (2016). *DHL | Press Release | DHL rolls out global augmented reality program*. [online] Available at: http://www.dhl.com/en/press/releases/releases_2016/all/logistics/dhl_rolls_out_global_augmented_reality_program.html

Just like ecommerce is still evolving, the logistics industry will look entirely different in the next 5 to 15 years. Markus Kückelhaus from DHL is looking at innovations and trends every day and has great expectations of six different technologies that he thinks will change the logistics industry by 2030.

In Nordic Delivery Conference that was held in 2016 Markus Kückehlaus, Vice President Innovationics in DHL shared his vision of the logistics industry during Nordic Delivery Conference 2016. He pointed that many start-up technology companies are interested in developing their solutions for logistics and it makes industry more interesting than in the past. DHL is continuously investigating trends that they think will affect the future of the logistics industry. They develop and test these trends at the company's innovation centers in Bonn and Singapore.

As it was mentioned in the second chapter Big Data is inalienable part of future progress and Industry 4.0. DHL has already some done tests with big data in risk management, so they could advise their customers and suppliers proactively on potentially failed shipments, that is showing customer orientation focus of the industry. Also another technology that DHL wants to implement in their business more is the use of motion and depth sensors, to identify free space on a pallet, truck or at a warehouse.

Another new technologies that DHL is planning to implement in nearest few years is robots that will be implemented in picking, packing, and moving goods in the logistics environment. The speed of technological progress is increasing rapidly with new advancements and breakthroughs occurring almost daily. The outlook for robotics is very exciting and the world of logistics will benefit from the coming developments in robotic technology.[81]

Nowadays about 80 percent of warehouses around the world are manually managed. DHL is testing robots that integrate with the warehouse operators. The self-driving picking trolley called EffiBot is one of these examples. It follows the operator and once it reaches

[81] Dhl-graduates.com. (2017). *New Technology in DHL – DHL Graduates*. [online] Available at: http://www.dhl-graduates.com/new-technology-in-dhl/

full capacity, the picker simply sends it to the designated drop-off location, while another picking cart joins. This solution makes moving from single to multi-order picking a more efficient and ergonomic process.

Drones are very perspective technology for transportation and logistic companies have certain expectation to it. DHL already successfully tested its own drone, the Parcelcopter, in Germany in May 2017. It is intended primarily for situations that mesh poorly with established infrastructures or where standard delivery methods are overly lengthy or blocked with natural barriers such as water or mountains. The DHL Parcelcopter is thus seen as a tool for improving infrastructure in hard-to-reach areas, improving the lives of the inhabitants there. It gives a lot of perspective and drones nowadays can do a lot but there is also legal regulatory aspect especially in European countries that was also mentioned in previous chapters. So there are still a lot of challenges that implementation of Industry 4.0 has to overcome before this level of technologies became our daily reality.

Conclusion

After analyses based on surveys conducted by trustful consulting group as the Boston Consulting Group, the PricewaterhouseCoopers, the Accenture Consulting, the World Economy Forum data following conclusions regarding Industry 4.0 and its influence on labor market and specifically industrial workforce. The significant changes are coming in how industrial workers execute their jobs and completely new scope of jobs will be created while others totally disappear. Current researches and surveys show that companies plans to use robots to assist workers but not to replace people totally. General trend that will appear by increased use of assistance systems is that the number of physically demanding or routine jobs will be decreased, while the number of jobs requiring flexible responses, problem-solving, and customization will increase.

Main challenges of Industry 4.0 is investments and change because building a complex value network that produce and distribute products requires change with of partners of the company. Another concern regarding Industry 4.0 is security because large quantities of data will be collected and shared with partners in the value network and business needs to be clear about who owns what industrial data and to be confident that competitors will not use their data.

Last but not least challenge is employment and skills development that will show significant shift from manual labor to programming and control of high performance machine. The importance of soft skills will increase significantly. Workers have to be open to changes, demonstrate great flexibility to adapt to new roles and work environment and get conventional to continual interdisciplinary learning. Industry 4.0 will reconstruct demand on the labor market and everyday routine working process because an ability to adapt and learn fast will be even more important and required skills for the workers.

Additionally except the transformation of the frontline industrial workforce, Industry 4.0 influence on demand of leadership skills and make the competition for talent in many countries more intense. To be competitive in this talent racing, companies will need to focus their significant attention to strategic workforce planning. Industry 4.0 from

management point requires practices that provide a climate of learning and innovation to the employees.

Appropriate changes in management practices will be important in transition period to digital technologies and increase productivity of the company. As one of the main point is to train soft skills that are same important as technical hard skills for employees in Industry 4.0 companies need to develop their training programs to boost the innovative capability and learning.

After analyses of implementation of Industry 4.0 on technologically developed companies: Huawei, Tesla and DHL, it demonstrates that digital technologies and industry transformation is our reality but not without challenges. Practical examples show that companies' pioneers in Industry 4.0 are facing challenges determined by various surveys. Legal aspects, security of information, Big Data storage, advanced analyses and luck of qualified labor are main challenges but governments, companies and society are working together on bringing new technologies and standards into our reality.

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