Rise Of Industry 4.0 and Coping Mechanisms in The Global Business Era.

Mast. Afrin Sultana, Green University of Bangladesh.

E-mail: Chinu_afrin@yahoo.com

Abstract

Industry 4.0 has both expanded the possibilities of digital transformation and increased its importance to manufacturing with an emphasis on globalization, international trade and foreign direct investments. Industry 4.0 combines and connects digital and physical technologies including artificial intelligence, the Internet of Things, additive manufacturing, robotics, cloud computing, and others to drive more flexible, responsive, and interconnected enterprises capable of making more informed decisions (Tim, Andy, Matt, & Brenna, 2018). This Fourth Industrial Revolution carries with it seemingly limitless opportunity and seemingly limitless options for technology investments. As organizations seek digital transformation, they should consider multiple questions to help narrow their choices: what, precisely they hope to transform; where to invest their resources; and which advanced technologies can best serve their strategic needs. Further, digital transformation cannot happen in a vacuum; it does not end simply with implementing new technologies and letting them run. Rather, true digital transformation typically has profound implications for an organization affecting strategy, talent, business models, and even the way the company is organized (Tim, Andy, Matt, & Brenna, 2018).The infusion of digital technologies in the value chain processes of Research and Development, Design, Production, Marketing, Distribution and Customer Services will drive efficiency in production, thereby increasing the ambits of international trade. The increase in the pace of international trade will further shrink the interconnectedness of the world i.e. globalization. Shrewd businesspeople are already taking positions in moving capital abroad in form of foreign direct investments (FDI) to countries that embraced the digital transformation. The adoption of industry 4.0 has challenges including political, environmental, legal, technological and socio-economic impacts. These can be surmounted if the benefits of the fourth industrial revolution are well-harnessed by all the relevant stakeholders.

1. Introduction

The term "Industry 4.0" was created in 2011 at the Hannover Fair. In October 2012 the Working Group on Industry 4.0 presented a set of Industry 4.0 implementation recommendations to the German federal government. The Industry 4.0 workgroup members are recognized as the founding father and driving force behind Industry 4.0 (Mario, Tobias, & Borris, 2016). On 8 April 2013 at the Hannover Fair, the final report of the Working Group Industry 4.0 was presented. This working group was headed by Siegfried Dais (Robert Bosch GmbH) and Henning Kagermann. As Industry 4.0 principles have been applied by companies, they have sometimes been re-branded, for example the aerospace parts manufacturer Meggitt PLC has branded its own Industry 4.0 research project as M4 (Stock & Seliger, 2016). This displays the legitimacy and acceptance of industry 4.0 within industries. The first profound shift in our way of living, the transition from foraging to farming happened around 10,000 years ago and was made possible by domestication of animals. The agrarian revolution combined the efforts of animals with those of humans for the purpose of production, transportation and communication (Klaus, 2016). The agrarian revolution was followed by a series of industrial revolutions that began in the second half of the 18^{th} century. These marked the transition from muscle power to mechanical power, evolving to where we are today, the fourth industrial revolution, which simply means enhanced cognitive power is augmenting human production (Klaus, 2016).

The first industrial revolution spanned from about 1760 to around 1840. Triggered by the construction of railroads and the invention of the steam engine. It ushered in mechanical production. The second industrial revolution, which started in the late 19^{th} century and into the early 20^{th} century, made mass production possible, fostered by the advent of electricity and assembly line. The third industrial revolution began in the 1960s. It is usually called the computer or digital revolution because it was catalyzed by the development of semi-conductors, mainframe computing (1960s), personal computing (1970s and 1980s) and the internet (1990s) (Klaus, 2016). The fourth revolution began at the turn of this century and builds on the digital revolution. It is characterized by a much more ubiquitous and mobile internet, smaller and more powerful sensors that have become increasingly more affordable, and artificial intelligence and machine learning. The fourth revolution, however, is not only about smart and connected machine systems. Its scope is much wider. Occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing. It is the fusion of these technologies and their interaction across the physical, digital and biological domains that make the fourth industrial revolution fundamentally different from previous revolutions (Klaus, 2016). International business rides on globalization. To understand the implications of Industry 4.0 on International Business, we shall briefly discuss the trends in globalization, and how it is being driven by Industry 4.0.

2. Characteristics That Define Industry 4.0

Robots play an important role in modern manufacturing industry. The number of multipurpose industrial robots developed by players in the Industry 4.0 in Europe alone has almost doubled since 2004 (Mohd Aiman Kamarul, Mohd Fauzi, Nor, Nor, & Muhamad, 2016). An essential face of Industry 4.0 is autonomous production methods powered by robots that can complete tasks intelligently, with the focus on safety, flexibility, versatility, and collaborative. Without the need to isolate its working area, its integration into human workspaces becomes more economical and productive and opens up many possible applications in industries (Mohd Aiman Kamarul, Mohd Fauzi, Nor, Nor, & Muhamad, 2016).

Manufacturers in many industries have long used robots to tackle complex assignments, but robots are evolving for even greater utility. They are becoming more autonomous, flexible, and cooperative. Eventually, they will interact with one another and work safely side by side with humans and learn from them. These robots will cost less and have a greater range of capabilities than those used in manufacturing today (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

Artificial Intelligence (AI) printed circuit board designs and engineering processes bring further flexibility and create a new generation of products, such as connected objects, smart home devices, smart building, IoT devices. Printed Circuit Boards (PCB) for connected devices have been reinvented in order to add the artificial intelligence aspects. Furthermore, EMS companies and smart factories that have their own AI system for supply chain, combining machine learning and big data, are innovating for smart devices.

Cloud computing allows you to store all retrieved data, and to transmit specific instructions, and standardize electronics manufacturing processes and smart supply chain management. Having a cloud strategy in line with your product lifecycle management is a critical aspect of the relationship with an Electronic Manufacturing Services (EMS) company. The relevant tools would help to store the right documentation, allowing production and engineering to make sure the latest revision levels are being used and therefore ensuring that the manufacturing process is robust.

Companies are already using cloud-based software for some enterprise and analytics applications, but with Industry 4.0, more production-related undertakings will require increased data sharing across sites and company boundaries. At the same time, the performance of cloud technologies will improve, achieving reaction times of just several milliseconds. As a result, machine data and functionality will increasingly be deployed to the cloud, enabling more data-driven services for production systems. Even systems that monitor and control processes may become cloud based. Vendors of manufacturing-execution systems are among the companies that have started to offer cloud-based solutions (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

3D-Printing significantly reduces the manufacturing time for printed circuit board prototypes, 3D-Printing is one of the key aspects of Industry 4.0. This opens more doors for customizing ultra-products: connected devices, Internet-of-Things products, smart home products, etc. PCB Prototyping is now easy to produce.

Internet of Things Platforms refers to a manufacturer's sensors and machines that are networked and make use of embedded computing. They are typically organized in a vertical automation pyramid in which sensors and field devices with limited intelligence and automation controllers feed into an overarching manufacturing-process control system. But with the Industrial Internet of Things, more devices—sometimes including even unfinished products—will be enriched with embedded computing and connected using standard technologies. This allows field devices to communicate and interact both with one another and with more centralized controllers, as necessary. It also decentralizes analytics and decision making, enabling real-time responses. Bosch Rexroth, a drive-and-control-system vendor, outfitted a production facility for valves with a semiautomated, decentralized production process. Products are identified by radio frequency identification codes, and workstations "know" which manufacturing steps must be performed for each product and can adapt to perform the specific operation (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

Big Data Analysis & Algorithms is another important area of the Industry 4.0. By precisely analyzing users' behaviors, both consciously and subconsciously, systems are able to rapidly create precise diagrams to answer and anticipate the needs of each individual with increasing accuracy, as the data continuously compiles. Thus, PCB boards for smart devices are produced with high-end engineering and manufacturing solutions, using big data.

Analytics based on large data sets has emerged only recently in the manufacturing world, where it optimizes production quality, saves energy, improves equipment service, and more. In an Industry 4.0 context, the collection and comprehensive evaluation of data from many different sources, production equipment and systems as well as enterprise, and customer-management systems will become standard to support real-time decision making, for instance, semiconductor manufacturer Infineon Technologies has decreased product failures by correlating single-chip data captured in the testing phase at the end of the production process with process data collected in the wafer status phase earlier in the process. In this way, Infineon can identify patterns that help discharge faulty chips early in the production process and improve production quality (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015). This Data also allows for firms to look into potential overseas opportunities with a less substantial amount of resources. Furthermore, it will shorten the distance between reality and the firm's expectations in a foreign country. Ultimately, this assists companies wanting to pursuit international business opportunities more frequently. Thanks in part to this emerging technology big data is more valuable than ever and mining it has become a focus among large global firms. As advanced as the technology is, this is just the beginning as big data is pushing technology to be more sophisticated daily.

With cyber security becoming essential for all smart supply chain companies, data protection is becoming an integral part of this new industrial revolution. On the other hand, protecting data and product is an essential value for the client's success. Thus, an intellectual property protection strategy must be part of the electronics manufacturing process.

3. Industry 4.0 and Globalization

Globalization and technology are intimately intertwined. The movement of people, goods, and ideas is accelerated and broadened by new forms of transport and communication. Technological development is, in turn, enhanced by the diversity of ideas and the increased scale that comes from global reach (Nicholas & Derek, The Fourth Industrial Revolution is driving Globalization 4.0, 2018). During each phase of globalization, technology has played a defining role in shaping both opportunities and risks. As the Fourth Industrial Revolution drives a new phase of globalization – "Globalization 4.0", here are four things we can learn from looking backwards, and forwards, at the impact of technology (Nicholas & Derek, 2018).

Firstly, as technology improves, globalization cannot be avoided. While it may be tempting to think of globalization as a core characteristic of modernity that has steadily progressed since the First Industrial Revolution, this is not the case. The last major reversal occurred thanks to the First World War and the subsequent period of economic turmoil. Indeed, levels of global economic integration reached a peak in 1914 and it took until the second half of the 20th Century for these levels to be achieved again. Secondly, global systems and standards matter more than individual technologies. The falling cost of transport and communications makes it viable to exchange more goods, services and intellectual property just as the steamship reduced the time and cost to cross the Atlantic on a reliable schedule during the 19th Century. But it's important to note that it's only when technology becomes infused in a global system that the world changes. The spread of global standards that were formed in the mid-1960s, made it possible for increase in productivity to spread around the world. This directly affected employment in the shipping sectors, as manual jobs were automated by the arrival of cranes and containers. Global trade and global wealth not only jumped but moved to a new rate of growth which persisted over decades as entrepreneurs and whole new economies found it viable to supply to markets around the world (Nicholas & Derek, 2018).

Thirdly, the global village is built on digital foundations. The spread of the internet and the relatively low cost of digital technology mean that people lucky enough to have access to digital networks are becoming more global and more local at the same time. Small traders in shanties on the outskirts of Nairobi export across east Africa. In China, 'Taobao villages' allow previously cut-off rural populations to sell goods on Alibaba's trading platform. New industrial technologies – including 3D printing, new forms of factory automation and machine learning – are rapidly enabling the mass customization of products and local optimization of supply and demand. As a result, the trade and the sharing economy are both expanding rapidly (Nicholas & Derek, 2018).

Finally, Positive, shared values should be driving Globalization 4.0. Global rules and institutions – just like technologies – are far from neutral. They embed our values, assumptions about the world, and desires for what we think the future should look like. Past periods of globalization have been justly criticized for leaving people behind while also being celebrated for generating wealth, spreading technologies and raising living standards around the world. But we can, and should, do better in Globalization 4.0. The printing press is often cited as an historical precedent for our tech-driven revolution in society (Nicholas & Derek, 2018).

4. Industry 4.0 and its Impact on International Trade

Central to the fourth industrial revolution is interconnected network (internet). The internet enables many small firms to participate in global trade, thus leading to more inclusion; it makes it possible for more products to be exported to more markets, often by newer and younger firms. A 10-percent increase in internet use in the exporting country is found to increase the number of products traded between two countries by 0.4 percent. A similar increase in internet use of a country pair increases the average bilateral trade value per product by 0.6 percent (Nino, 2018).

Online platforms overcome trust and information problems through feedback and rating systems and by offering escrow and dispute resolution mechanisms. Easier trade of intermediate products encourages further "unbundling" of production processes, not just in the markets for goods but also for services (Nino, 2018). The role of the internet is highlighted in the most works examining impact of digitalization on the trade: The Internet greatly increases firms' potential to produce new goods and service and serve new markets. The Internet reduces transaction costs – communication, information, and coordination – using emails, websites, and dedicated platforms and online marketplaces, making it easier for firms to participate in international trade.

There are delicate and complex relationship between international trade and the Internet: Recent preferential trade agreements (PTAs) such as the Trans-Pacific Partnership Agreement (TPP) and the Japan – Mongolia Economic Partnership Agreement (Japan – Mongolia FTA) contain legal provisions on cybersecurity, data protection, data localization, consumer protection, net neutrality, spam control, and protection of online intellectual property, intended to facilitate electronic commerce and enable cross-border data flows. Many issues related to Internet policy are also central to trade in digital economy. Issues of cybersecurity, privacy and data protection can not only act as barriers to electronic commerce, but also facilitate electronic commerce – this perspective necessitates a reorientation of legal provisions in trade agreements (Nino, 2018).

New methods of trading, such as e-commerce, create both new opportunities and new challenges for traders and policymakers. E-commerce promotes the ability of small and medium-sized enterprises (SMEs) to go from being small players in the domestic market to be-coming global exporters. But a variety of impediments in policies, and in the business environment, can prevent e-commerce from reaching its full potential (Nino, 2018). Towards a stronger and resilient digital economy, the discussions in the preceding sections indicate that international trade agreements are important tools in shaping the future of the digital economy.

5. How Industry 4.0 will change Foreign Direct Investments (FDI)

In addition to revolutionizing business processes, the unprecedented velocity and scope of industry 4.0 will change the way that foreign investors select locations and methods of business expansion. The due diligence process comprises consideration of how 4.0 will affect project profile factors and how much project-specific characteristics will determine the extent to which external factors and technological innovation affect the decision model. In some cases, aspects of 4.0 will change the way in which country indicators are explored. In others, innovations will overhaul the due diligence process by changing which indicators are used to make short- and medium-term decisions (Robert, 2018).

Company A's analysis about the impact of 4.0 will focus on the direct and indirect effects of automation. Direct effects analysis will ask one primary question: will manufacturing jobs for widgets be replaced by machines that produce them more efficiently than human beings? If widgets can be made using automation, then Company A's primary motivation for focusing on production in less developed countries will vanish. If machines can replace these jobs, Company A will strongly consider production in the US. If the widget manufacturing process cannot be automated, Company A's analysts will focus on the indirect effects of artificial intelligence (AI). The indirect analysis requires consideration of how AI will affect wages, labor relations and education statistics in developing countries where they might set up. For example, AI's replacement of employees in a given industry will produce excess supply of labor, and consequently minimize the leverage and negotiating power of labor. As a result, many experts argue that the changes of 4.0 will favor providers of capital over labor (Robert, 2018).

Because the competitive advantage of doing business in Country B will diminish as 4.0 flourishes, government officials must find another way to attract inbound FDI. In the 4.0 investment environment, the key to attracting inbound projects is to develop agile economies that embrace innovation. Foreign investors who are creating new technologies require investor-friendly regulations that foster rather than stifle innovation. Developing economies can adapt to the digital economy under 4.0 by providing investors with tax credits and other incentives that help technology start-ups. While it will be difficult to convince elected officials to focus on medium- to long-term goals, host countries that develop a regulatory framework which encourages innovation will be the most coveted host countries for FDI in 4.0 (Robert, 2018).

6. What are the untapped opportunities of Industry 4.0?

6.1 Triumph of the open model

Standardization is pivotal to the ability of German and European manufacturing to compete in the future. They do not need to go as far back as the pitched battle over video recorder systems in the late 1970s: Recent developments in information and communications technology (ICT) are enough to underscore the tremendous importance of standards. While Cisco built absolutely everything around the Internet Protocol in the 1990s, European equipment manufacturers stood by their proprietary – read: closed – network technology standards for corporate customers and telecom firms for the longest time. Although it was less flexible, the open model ultimately won the day, as standardization quite simply offered too many benefits. As a result, European ICT providers – companies posting revenues in the tens of billions – gradually saw their competitiveness erode, dissolved completely or were swallowed up by global rivals (Torsten & Gerrit, 2015).

6.2 A world apart

Flexible and connected production requires business ICT and factory equipment to be deeply integrated. Driven as a standard by US corporations, the Industrial Ethernet has already penetrated factories in the form of a wired network infrastructure. Yet even so, proprietary solutions – isolated silos and barely compatible architectures – can still be found in many industrial ICT installations. In such cases, business ICT systems (such as ERP software and CRM systems) are often linked to production ICT only via customized, vendor-specific interfaces. In most cases today, this block of production ICT systems, ranging from industrial control systems (such as ICS and SCADA) to sensors, actuators and production robots, constitutes a self-contained and often production-segment and provider-specific environment. Responsibility for these areas is typically split between the CIO and the CTO/COO, which does not exactly make it easy to integrate the various levels along the lines of Industry 4.0 (Torsten & Gerrit, 2015).

7. Challenges in the implementation of Industry 4.0

It is not an easy thing to achieve Industry 4.0, and it is likely to take ten or more years to realize. Currently, Industry 4.0 is a vision for the future, because it involves many aspects, and faces many types of difficulties and challenges, including scientific challenges, technological challenges, economic challenges, social problems and political issues (Keliang, Taigang, & Lifeng, 2015).

7.1 Social Challenges

Need for enhanced skills. The use of new technologies requires a certain level of knowledge. Due to the low technical competency, there will be an increasing need for staff training and development as well as the increasing need for integration skills. Hence, the big challenge is to create and develop new competencies, to optimize the project organization and to attract new talents to the workforce, like staff with shared technical knowledge and integration experience as key selection criteria. Additionally, companies should encourage employees to collaborate and engage idea sharing for creating innovation and therefore create opportunities for interdisciplinary groups to collaborate and elevate performance (Thuy Duong & Teuteberg, 2016).

Acceptance. The manufacturing industry is known for its strong resistance to changes and new technologies as well as the conservatism and inability to adapt by workers. Furthermore, one of the major concerns of employees about the adoption of new technologies is the job-loss, as they might be replaced by machines, computers or robotics. In any case, communication and change management for helping employees to adapt is required, since acceptance is a critical success factor for the adoption of new technologies. Thus, companies can involve change agents as “opinion leaders” during the implementation process and implement leading ideas of employees to help them feel ownership over performance improvement (Thuy Duong & Teuteberg, 2016).

7.2 Technological Challenges

Data security and data protection. The growing data volumes, the increasing demand for mobility, collaboration and sharing information with external partners, e.g. by applying the BYOD-approach (bring your own device) results in an increasing need for data security and data protection. Companies should protect their data against unauthorized access and any kind of misuse through centralized cloud-based user-identity, access management, device management and data protection tools (Thuy Duong & Teuteberg, 2016).

Enhancement of existing communication networks. The use of information and communication technologies requires a fast and reliable Internet access in manufacturing. Hence, unreliable broadband connectivity or the lack of access to high-bandwidth connectivity for collaboration applications have been mentioned as one of the most important obstacles to be overcome (Thuy Duong & Teuteberg, 2016).

7.3 Economic Challenges

High implementation cost. As already mentioned, the high cost for technical equipment, for training and education and for external consultancy fees are a barrier to adoption. Unclear benefits and prediction of cost savings and a lack of consistent fiscal benchmarking to evaluate the business improvements and gains are other unsolved problems. In this context, the development of methods and tools for estimating and optimizing costs and benefits and the provision of industry association partnerships to work together can help to increase transparency and to reduce costs.

Organizational and process changes. The implementation of new technologies must take place at all levels of the organization and mostly requires the re-evaluation and re-engineering of business practices. For manufacturing companies, the main question to be answered is how to successfully handle the organizational and process changes within the organization and how to redesign the current business model (Thuy Duong & Teuteberg, 2016).

7.4 Political Challenges

Hesitation to adopt: Due to the high investment costs of new technologies, small and medium-scale manufacturing companies are hesitating to invest in them. Thus, one of the main challenges is to motivate manufacturing companies for the adoption of new technologies, e.g. by providing incentives for the adoption, through government mandates for BIM use and through funding programs for industry and research (Thuy Duong & Teuteberg, 2016).

7.5 Legal challenges

Regulatory compliance. The use of RFID technology for safety management and workforce management requires the automated capture and record of personal data. In many cases, there exist ethical and legal concerns about the tracking and monitoring of employees as well as the handling of the recorded information. For example, according to German data protection law, high restrictions must be considered in case of the outsourcing of corporate data containing personal information about employees to companies outside the European Union or European Economic Area. Prior to the implementation of these technologies, restrictions concerning to privacy and data protection must be checked by involving legal expert right from the earliest stages of the process (Thuy Duong & Teuteberg, 2016).

Legal and contractual uncertainty. Another obstacle is the legal and contractual uncertainty concerning to the use of BIM. For example, questions of the legal ownership of the model and the legal responsibility for errors and problems with the model must be answered (Thuy Duong & Teuteberg, 2016).

8. The Impact of Industry 4.0

The race to adopt elements of Industry 4.0 is already under way among companies in Europe, the U.S., and Asia. To provide a quantitative understanding of the potential worldwide impact of Industry 4.0, an outlook for manufacturing from German perspective was analyzed and it was found that the fourth wave of technological advancement will bring benefits in four areas (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015):

Productivity. During the next five to ten years, Industry 4.0 will be embraced by more companies, boosting productivity across all German manufacturing sectors by €90 billion to €150 billion. Productivity improvements on conversion costs, which exclude the cost of materials, will range from 15 to 25 percent. When the materials costs are factored in, productivity gains of 5 to 8 percent will be achieved. These improvements will vary by industry. Industrial-component manufacturers stand to achieve some of the biggest productivity improvements (20 to 30 percent), for example, and automotive companies can expect increases of 10 to 20 percent (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

Revenue Growth. Industry 4.0 will also drive revenue growth. Manufacturers' demand for enhanced equipment and new data applications, as well as consumer demand for a wider variety of increasingly customized products, will drive additional revenue growth of about €30 billion a year, or roughly 1 percent of Germany's GDP (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

Employment. Industry 4.0's impact on German manufacturing, was discovered that the growth it stimulates will lead to a 6 percent increase in employment during the next ten years. And demand for employees in the mechanical-engineering sector may rise even more—by as much as 10 percent during the same period. However, different skills will be required. In the short term, the trend toward greater automation will displace some of the often low-skilled laborers who perform simple, repetitive tasks. At the same time, the growing use of software, connectivity, and analytics will increase the demand for employees with competencies in software development and IT technologies, such as mechatronics experts with software skills. (Mechatronics is a field of engineering that comprises multiple engineering disciplines.) This competency transformation is one of the key challenges ahead (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

Investment. Adapting production processes to incorporate Industry 4.0 will require that German producers invest about an estimated sum of €250 billion during the next ten years (about 1 to 1.5 percent of manufacturers' revenues) (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015). The estimated benefits in Germany illustrate the potential impact of Industry 4.0 for manufacturing globally. Industry 4.0 will have a direct effect on producers and their labor force as well as on companies that supply manufacturing systems (Michael, Markus, Philipp, Manuela, & Jan Justus, 2015).

9. Conclusion

The adoption of Industry 4.0 technologies has far-reaching implications for the whole of manufacturing industry, the involved companies, the environment and for workers. Beside the economic benefits for improving productivity, efficiency, quality and collaboration, the adoption can help to enhance safety and sustainability. To fully reap these benefits, manifold political, economic, social, technological, environmental and legal challenges must be embraced. For example, companies must deal with organizational and process changes, with high implementation costs and the unclear prediction of cost savings or with the increasing need for data security and data protection. Industrial workers must handle with increasing job requirements and a higher level of mental stress due to the fear about job losses. From the technical point of view, there are several unsolved problems to be faced like the lack of standards for many technologies, the higher requirements for computing equipment or the increasing need for enhanced communication networks. Regulatory compliance, legal and contractual uncertainty are other issues to be considered. Considering these manifold challenges, it becomes clear that companies must be motivated for the adoption through government mandates, initiatives or funding programs. Nonetheless, the adoption of the Industry 4.0 concept can help the manufacturing industry to transform to a technology-driven industry, help with performance improvement in a bid to achieve improved global value chain.

References

Keliang, Z., Taigang, L., & Lifeng, Z. (2015). Industry 4.0: Towards future industrial opportunities and challenges. *2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD).* Zhangjiajie, China: IEEE.

Klaus, S. (2016). *The Fourth Industrial Revolution.* Crown Business New York.

Mario, H., Tobias, P., & Borris, O. (2016). Design principles for industry 4.0 scenarios. *49th Hawaii International Conference on Systems Science.*

Michael, R., Markus, L., Philipp, G., Manuela, W., & Jan Justus, P. (2015). Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries. *BCG Perspectives*.

Mohd Aiman Kamarul, B., Mohd Fauzi, O., Nor, H., Nor, A., & Muhamad, F. T. (2016). INDUSTRY 4.0: A REVIEW ON INDUSTRIAL AUTOMATION AND ROBOTIC. *Jurnal Teknologi* .

Nicholas, D., & Derek, O. (2018). The Fourth Industrial Revolution is driving Globalization 4.0. *World Economic Forum on the Middle East and North Africa.*

Nicholas, D., & Derek, O. (2018). The Fourth Industrial Revolution is driving Globalization 4.0. *World Economic Forum*.

Nino, P. (2018). INDUSTRY 4.0 AND ITS IMPACT ON THE INTERNATIONAL TRADE.

Robert, G. (2018). How industry 4.0 will change FDI - Companies . *fDiIntelligence.com*.

Stock, T., & Seliger, G. (2016). Opportunities of Sustainable Manufacturing in Industry 4.0. *13th Global Conference on Sustainable Manufacturing - Decoupling Growth from Resource use.*

Thuy Duong, O., & Teuteberg, F. (2016). Understanding the implications of digitisation and automation in the context of Industry 4.0: A triangulation approach and elements of a research agenda for the construction inudstry. *Computers in Industry*.

Torsten, O., & Gerrit, R. (2015). The digital transformation of industry - How important is it? Who are the. *ResearchGate*.

Wetmore, M. (2018). Industry 4.0: Total digitization . *PwC Canada*.