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Industrial Development 4.0 of the Federal Republic of Germany and experience for Vietnam

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Abstracts:

Industry 4.0 is now a vision beyond reality, but it is ready for change not only by the way we do business but also to engage our society in general. The progress of digitalization continues to drive increased activity in the manufacturing rooms of Detroit, Bochum, in China, Vietnam and Bangladesh. In the context of these developments, following policy issues raises questions: How can we accelerate the progress of new products, services and business models? And how can we ensure that as many people as possible benefit from this development and not just a small group? Social innovation, on the one side are new methods for solving social challenges, those affected, groups and organizations that accept and use. On the other hand, they also facilitate the dissemination and dissemination of many technical developments. This is especially true for industry 4.0. Vision: people, processes, services and data - everything will be networked, led by the Internet, the real world and the virtual world. This article will analyze the content of the investment process for industrial society 4.0 in Germany and suggest policies for planners in Vietnam in the current context

Keywords: **Industry 4.0; social investment; policy; Germany; Vietnam**

1. Introduction

As the world enters its fourth industrial revolution, a new manufacturing revolution is associated with unprecedented technological breakthroughs, related to Internet connectivity, cloud computing, 3D printing, sensor technology, virtual reality ... This new manufacturing revolution is expected to have a strong impact on every country, government, business and people around the globe, as

well as fundamentally change the way we live, work and produce. The essence of the Fourth Industrial Revolution is based on digital technology and integrating all smart technologies to optimize production processes and methods. The new era of investment, productivity and rising living standards are all thanks to human creativity and will have a profound impact on the political, social and economic systems of the world.

The INDUSTRIAL REVOLUTION 4.0 that we have just entered will create a world in which the virtual and physical systems of production chains around the globe can work together flexibly. IR 4.0 is not only about machines, intelligent and connected systems, but also has a much wider scope. At the same time, there are waves of further breakthroughs in areas from gene chain coding to nanotechnology, from renewables to electronic computing. It is promising to create enormous benefits and strongly impact the world economy as well as vietnam's economy.

IR 4.0 will first have a strong impact on production activities, creating a great change in production methods, the convergence between physical applications and digital applications that make up the internet of things (IoT) will change rapidly , extending the entire value chain from research and development to production, logistics to customer service, significantly reducing transaction and shipping costs, leading to miracles in production and productivity. In the process, IoT will transform all industries, from manufacturing to infrastructure to healthcare. By changing the way of production when there are modern technologies that can connect the real and virtual worlds, so that human production can control the process at its own home while covering all the activities of the factory through the superiority of the Internet.

For the commercial sector, this INDUSTRIAL REVOLUTION 4.0 firstly helps to significantly reduce the cost of trading and shipping. For the investment sector, with the nature of the fourth industrial revolution, technology

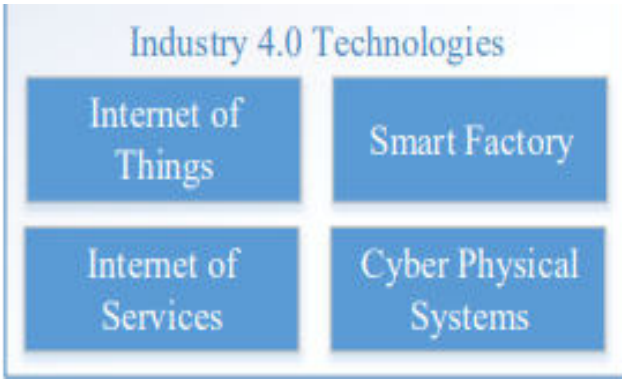
is the most attractive and potential investment segment of investors in the coming time, especially digital technology and the Internet. But this revolution can also create greater inequality, especially causing the risk of disrupting the labor market. When automation replaces people throughout the economy, workers are redundant and that exacerbates the gap between profit versus capital and profit versus labor. While technological innovation often leads to higher productivity and greater prosperity, the pace of change will also create a great pressure due to the shift of labor resources. Workers in factories during the Fourth Industrial Revolution will have new jobs with other requirements and in a working environment or organization that is no longer the same as it is today.

The term "Industry 4.0" was first introduced by the Alliance for Industrial and Scientific Research (Forschungsunion) in Germany in 2011. It refers to digitalization in industrial production. The concept of outlining the vision of a smart factory, which is characterized by a complete network of all production and process parts: real-time control through ITC and increased robotic use, self-control, are developments that should contribute to increasing productivity through resource efficiency. As a high-tech power, the policies of investment in industry 4.0 in Germany and the social consequences it brings are a valuable experience for developing countries such as Vietnam

2. Literature Review

The concept of i4.0 originated in Germany and has gained momentum in recent years building high expectations around its outcomes. It addresses the competition of low-cost labor resources faced by the companies in developed countries by reducing the overheads of low-skilled labor [8]. There have been several definitions of i4.0 and confusion related to the underlying concepts. Hermann et al. [11] and Roblek et al. [12] proposed i4.0 with four technology concepts as shown in Fig. 1 which has been followed and used extensively in several studies. This framework has been followed in this work and the underlying concepts are discussed as follows.

Figure 1: Technologies in i4.0



Source: A multi-case study on Industry 4.0 for SME's in Brandenburg, Germany

2.1. Internet of Things (IoT)

The IoT is an inter-networking of 'things' and 'objects', such as RFID, sensors, actuators, mobile phones that interact and co-operate with each other to reach common goals [13]. It enables the ability to combine physical and digital components (or software) in order to create new ones resulting in smart products [14] (for example smart transport, smart cities, smart factories and so forth). IoT for industrial purposes is different from the user based IoT due to demand for real time data availability and high reliability. Thus, IoT applied to industrial processes is referred as Industrial Internet of Things (IIoT). IIoT offers product traceability throughout the entire product lifecycle and enables flexibility and operational efficiencies, reshaping the supply chain and manufacturing process. Typical applications of IIoT in industry are predictive maintenance, remote asset management, improvement of worker productivity, safety and working conditions and differentiated customer experiences [15].

2.2. Internet of Services (IoS)

The manufacturing industry which has conventionally been product-oriented has shifted toservice-oriented manufacturing [16] as it enables gaining revenue from service transactions all along the life cycle of a product service system (PSS) [17]. The shift to service-oriented architecture enables high product quality and at the same time the value-added services give the companies an appropriate opportunity to differentiate themselves ensuring a strong competitive position. This has led to the development of IoS which is an infrastructure that uses the Internet as a medium for offering and selling services and making them tradable [18]. Through IoS the data of a product can be acquired even during

its operation and used for the development of new services and updates consequently increasing the perceived product quality. In this paper, the term Internet of Services is considered as the technology that monitors the product life cycle, taking decisions based on data gathered through the product life for predictive maintenance, seamless production flow and reliability of machines and products

2.3. Cyber Physical System (CPS)

are a fusion of cyber world and dynamic physical world with integrated computational and physical capabilities to interact with the environment through several modalities. They are characterized by a network of interacting elements where sensors (cyber objects) can be used to monitor the physical environments, and the actuators/controllers can be used to change the physical parameters [8]. When compared to the Internet which is based on the integration of network technology, applications and infrastructure; CPS's can be seen as the integration of embedded systems, sensors, and control systems [19]. Examples of CPS include biomedical and healthcare systems, smart grids, autonomous vehicles etc. There are several architectures proposed for CPS as detailed in [20] most of which are developed considering service-oriented architecture due to the shift to service-oriented manufacturing. The 5-level CPS structure proposed by Lee et al. [21] is adopted in this paper as it provides guidelines for developing and deploying a CPS for manufacturing applications.

2.4. Smart Factory

The development of IoT, IoS and CPS has led to the possibility of a smart factory which is highly flexible, reconfigurable, capable of producing customized products and small-lot products efficiently and profitably [22]. Just like humans live in two worlds i.e. physical world and cyber (internet) world, the factory will co-exist in two worlds: physical world and a digital twin in the cyberspace. The digital twin will take the data generated from sensor networks and manual inputs, process the data in cyberspace and take corrective actions in real time to effect the physical world [23]. The smart factory framework

for i4.0 proposed by Wang et al. [22] is adopted in this paper which consists of four tangible layers, namely, physical resource layer, industrial network layer, cloud layer, and supervision and control terminal layer. The evaluation of SME's based on the above four concepts is performed in the next section.

3. Overview results

3.1. Technology platform transformation support

Industry 4.0 arises in systems, in the interaction between networks and various technological fields: data security, protection and security (safety and security). It is the inclusion of operators, suppliers and users that accelerates the process of innovation, but also helps the standard to be developed. Some products and services of industry 4.0 will be developed into breakthrough new fields. This fact puts the challenge on many German companies, which traditionally tend to be more conservative. This is true for the manufacturing industry. Here companies usually take advantage of only the technical ideas and skills available within their own scope or in the integrated tight network, well-known partners.

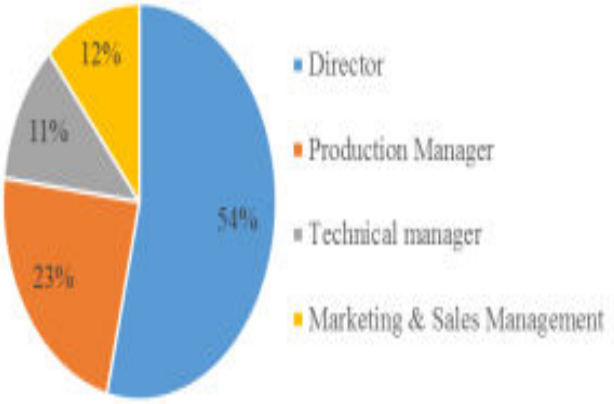
To survive in Industry World 4.0, companies and employees must enhance their "interactability" [25] referring to the skills and capabilities of an organization to successfully implement technological transformation. Due to the fact that these processes new products and services are increasingly marked by interdisciplinary technological integration, industry 4.0 development – requires cooperation between different network skill sets and memory knowledge. With increasing digitalization, the latter will likely become drafted and easily forwarded.From there, it is imperative that each party's own ability be combined with additional knowledge andthe behaviour of others' [26] The policy of supporting innovation technology must take this into account. The policy has powered to support this complex staging of views and discipline to adapt and learn from another better and faster. Policy can promote networking- working thinking, openness and exchange to enhance the absorption capacity of companies [17] in

schools and universities. Establish advanced education and training programs, it can promote the building of operational networks. It can stimulate the learning collective, also by integrating non-intensive studies to new technologies and new knowledge to be able to diffuse faster. Innovation policies can promote interdisciplinary project alliances and authority through initial contests or project sponsorships. It can assist in transferring basic research results to development applications

3.2. Focus on R&D

Industry 4.0 is more than just high-tech news. High-tech innovations are considered particularly attractive to the scientific and business community, policymakers and society. The Paul Romer model for endeerial growth provides the theory of explanation: the percentage of a workforce of the economy engaged in the fields of research, the growth of the economy. Since its in its ine establish, many analytical innovations and approaches to innovation policies have been followed by this principle around the world. The recipe then is: as much as possible. That means one can invest in research and development (R&D) and be re-released and see the positive effects on production and the blooming market. However, the processes of innovation are not linear and rarely develop under a waterfall model. Although innovation processes have met customer needs, based on practical knowledge or user experience. Therefore, along with the classic advertising of scientific and technological research, it is also necessary to focus more on social sciences. [28] called attention to advanced knowledge facilities for innovation in its research and set out the importance of knowledge practice in the development of industries and enterprises. In the context of his important considerations, he called it a departure from the state's innovation policy as "high-tech obsession", and for policymakers to focus on the specifics of innovation in areas other than in-depth research.

Figure 2: Role of the personnel in the discussions conducted on-site



Source: A multi-case study on Industry 4.0 for SME's in Brandenburg, Germany

Industry 4.0 needs both. This is what Industry 4.0 is specific about: application-based scientific innovation and customer-driven innovation. That is why we must timely consider how to design technical - social systems (e.g. polar organization versus swarm organization) and their framework conditions - including as much user potential as possible and scientific monitoring of those processes.

3.3. Industry 4.0 must be associated with social progress

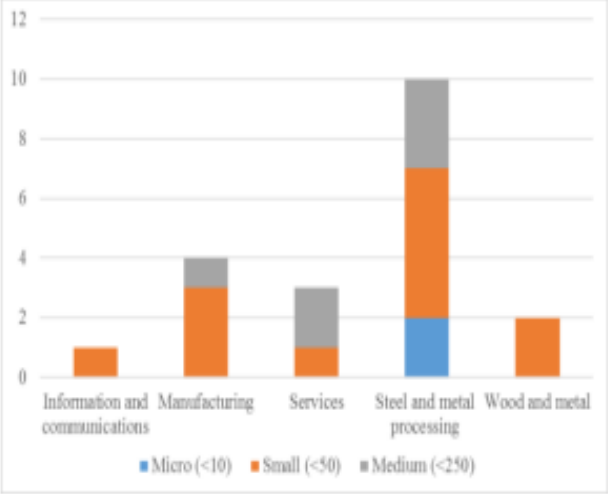
Industry 4.0 requires a lot, especially from the people. This is a lot of potential that has not been focused and exploited in the current context. It is impossible to understand machines that industry 4.0 is only for highly conditioneds. Policymakers have to rely heavily on society, not just on job distribution. Combining the use of technical support systems with social practices is key to promoting social progress: (such as social engagement and integration, comprehensive growth, improving compatibility with family needs , caring for the elderly and people with disabilities...) Social innovations can only happen in dialogue. Dialogue with society must be an organic part of research and

innovation; in turn, it can enhance technology and increase the level of social progress.

Those who innovate through serious participation must do more than framework conditions beyond technological development— their activities and integration into our real world: areas such as data protection, privacy, and security; copyright, competition regulations and intellectual property rights. However, measures and

consultations at an early stage in respect of the legal framework frameworks should be adjusted to suit technological development, social practices and business models. This dialogue must also be promoted between partners. The internal dialogue process must specifically cite the obligations of the company management level and the project to ensure an environment involving stakeholders

Figure 3: Industry sectors and classification of the surveyed companies



Source: A multi-case study on Industry 4.0 for SME's in Brandenburg, Germany

Social initiatives have an important influence on whether a reasonable technique-invention will become a widespread innovation (Schumpeter's distinction), on the channels it is diffused through and what effects are taking place in the process [30] A social innovation is to restructure the goal of social practice with the aim of better solving problems or meeting needs than is possible on the basis of establishing practice [31] and thus contributing to social progress. The problem is who is industry 4.0 better for? In this question there is a sub-content of the definition, namely its standard meaning. According to this understanding, innovation can only be social when it is socially acceptable, widespread in society or among certain social groups and eventually becomes an institutions oroften considered a new social activity [32] Industry 4.0 must still demonstrate its benefits and contribute to social progress. Only when developments in and around industry 4.0 actually bring social added value (e.g., leisurely work or create new labour quality), when social practice is "better for everyone" as a result of standard self-establishment – for both consumers and product suppliers. This can only happen if industry 4.0 combines technological

properties and factors that ensure social development

3.4. Industry 4.0 and market economy

For many years, Germany has been the prototype coordinating market economy. German companies have relied on long-term relationships, trusting employees, suppliers and development partners. German enterprises take advantage of "traditional customer capital" more than their foreign competitors and therefore have authority in industries that benefit from increased innovation (e.g., machinery and engineering). They coordinate activities in a closed network. This "culture of cooperation" is also supported by strong industry associations through pay negotiation, participation, dual skills training and reinforced learning opportunities. Policymakers should attend and strengthen a culture of cooperation, promote networks and partnerships, and above all provide framework conditions: infrastructure (e.g., expanding general access to high-speed broadband networks) and improving the quality of training in schools in technology and markets

So far, mainly larger companies are interested and engaged in industry 4.0. However, 99.6% of companies in Germany are SMEs (IFM 2014). Notably, small and medium-sized enterprises invest much less in research and development than large corporations. They also applied fewer patents and created fewer technologies [18] Their strength is cooperation and strong representation in industry, where they are above all engaged in modernization (innovations process). Small and medium-sized enterprises are suppliers, as well as consumers, and are critical to the dissemination of new technologies and practices in industry 4.0. As such, these companies may be leaders in social innovation and deserve the support of larger companies received under the asymes of " technology ".This beses the question: How do small and medium-sized enterprises adopt industry 4.0

A policy innovation can promote the use of information and communication technology (ICT)

through education and training. Industry 4.0 provides an opportunity here for small and medium-sized enterprises of different components. Areas where small and medium-sized enterprises have traditionally participated (manufacturing, automotive engineering, etc.) are turning toward the implementation of information and communication technology, small and medium-sized enterprises are in an important position with powerful associations and networks to transfer these strengths to other sectors (ICT and the service industry). This will be useful for setting standards

3.5. Industry 4.0 with information security and security issues

Digital data will be the most important material in the future [33]. Ensuring data privacy, security and security in a digital world is a central task for German research and innovation policy. However, it's not just about technology- industry 4.0 topics. Rather, they show a socio-political consciousness. This has broad implications across all areas of action [16] because data security and privacy begin with the behavior of others. This means acting thoughtfully and competently in relation to a person (his own) data and ensuring compliance with technical and legal issues. Therefore, security aspects must be taken into account during the process of planning new products, business models and modular training.

An example of this is the "firewall" problem. Industry 4.0 must impede data espionage through firewalls. The GermanFederal Information Security Office, the competent authority, can confirm the corresponding products and services

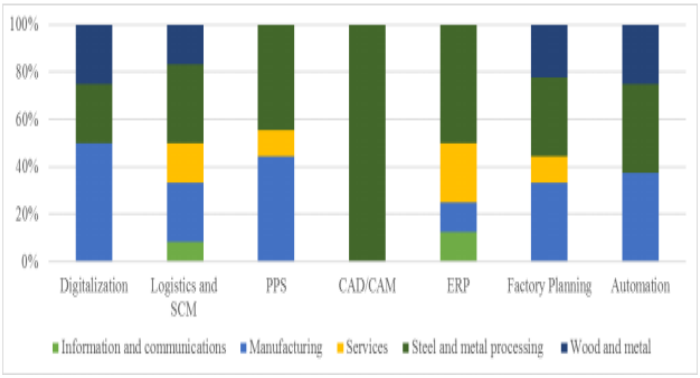
as there is no "firewall" - and therefore is likely to cause more than technical innovation problems. Common European standards and rules are necessary in these areas: data security in the industry, copyright, privacy protection, "the right to be forgotten" and more [29] Generally, policymakers can collaborate on data security, protection, and security development, maybe by introducing financial incentives for companies to develop or procurement of security solutions, or by establishing regulatory

regulations (e.g.,EU General Data Protection Regulation).

3.6. Industry 4.0 and policy coordination needs

System innovations, such as Industry 4.0, are characterized by the interaction between technological and social innovation. Therefore, technological and social aspects are coming together and allowing for a cohesive, comprehensive process of change. This comprehensive understanding of the need for coordination also requires a broader understanding of policy. Along with this question regarding research funding sources, the policy encourages modern and particular personnel policy, the effectiveness of science and the R&D system. organizing the future of the world of work and social acceptance for new technology (Figure 4).

Figure 4: Domain specific breakout of the problems faced by SMEs



Source: A multi-case study on Industry 4.0 for SME's in Brandenburg, Germany

Germany's innovation policy has focused on promoting technical innovation, relying primarily on supply (so-called technology promotion). It is a time when policymakers focus on the need side and promote development - social innovation. Industry 4.0 can only stand out in the daily lives of the population based on indicators of ensuring social progress (e.g., resource sustainability, more qualifications for those seeking training and "good work", and a better balance of life and work). A social policy that arises when technological innovation (industry 4.0 / digitalization) is accompanied by a systemated policy approach and

integrates important contributions from other policy areas. This requires more coordination - between ministries that exceed policy levels [24] However, efforts in industry 4.0 are not for all parties to be required to participate at the same time. Germany understands this and the policy system has created a level playing field. Coordination, cooperation and steps follow a premisted strategy. The strategy is associated with the goal of social development based on digitalization.

4. Discussion

Infact, in Vietnam, although there is no specific strategy to promote Industry 4.0, in each related field, there have been specific orientations and strategies. Accordingly, in the directives of Directive No. 50 of the Secretariat on promoting the development and application of biotechnology; strategies for development of Vietnam Information and Communication Technology; Science and Technology Development Strategy for the period 2011-2020 with the identification of priority areas including: ICT, biotechnology, new materials technology, machine building technology - automation; The Prime Minister's Directive No. 16/CT-TTg on strengthening access to the 4th Industrial Revolution... have contributed to the preparation of Infrastructure and Resources in Vietnam to take advantage of the opportunities of Industry 4.0, but the sidestill has a lot of work to do. The 4.0 IR will flourish as the need to find new, more sustainable production methods in the face of challenges such as climate change, population aging or other security issues is increasing. This revolution will bring many opportunities for development and integration, but at the same time also create many challenges for developing countries such as Vietnam.

In order to successfully access the opportunities of the 4th Industrial Revolution, from the development practices of the German Republic, some suggestions for Vietnamese policymakers are:

- The State needs to be more proactive in coordinating with enterprises, putting enterprises at the center in formulating policies. Especially

the policies towards industrial development 4.0, interest rate support policies for enterprises to digitalize, transfer and innovate technology.

- Enterprises need to be more active and proactive in coordinating with the Government, sharing with the Government about resources for infrastructure development, scientific and technological potential, national innovation.

- Drastically innovate the basics of education and training, especially vocational training. Develop a number of products that are strategically competitive at the national level.

- Have a specific cooperation strategy with leading countries in the region to develop their strengths together, taking advantage of the opportunities of the Fourth Industrial Revolution.

- It is necessary to join hands of a group of senior experts from enterprises, universities, research institutes and the Government to survey and re-evaluate the current status of Vietnam's industrial readiness 4.0, forecasting some scenarios of industrial impact 4.0 on Vietnam, thereby developing a clearer Industrial 4.0 approach strategy for Vietnam

5. Conclusion

The Industrial Revolution 4.0 has a strong impact on many fields, with the arrival of robots with artificial intelligence, intelligent working robots, the ability to memorly remember, learn infinitely, while that ability in humans is usually only available for a limited time. Therefore, the fact that high technologies and smart machines will create opportunities for people to work and do business more effectively by taking advantage of the advantages that the 4.0 technology revolution brings. Particularly in Vietnam, by going after and inheriting the achievements from the Industrial Revolution 4.0 left by the world also helps us save some research time. Instead, we can focus on developing those achievements accordingly and bringing the best effect to the country's economy.

However, in the Industrial Revolution 4.0, the factors that countries

like Viet Nam have been considering themselves as superior as the young, abundant manual workforce will no longer be strengths. In the future, people may have more difficulties finding jobs, because the craft sectors can now impact, even do better. Such a break in the labour market can cause socio-economic or even political uncertainty. This requires people to constantly improve themselves, make themselves in a higher position, be able to control machines intelligently and rationally to not be eliminated among many advanced technologies today. Besides, this industrial revolution 4.0 itself also has its limitations. We will now have to worry more about the security of personal information. This creates a challenge for our country in terms of the need to improve its own technology in order to create a solid "barrier" for this information.

The 4th Industrial Revolution is a trend that has an impact on the socio-economic development of many countries. In particular, one of the important technologies is Big Data. This is considered a core element for the use and development of the Internet of Things and artificial intelligence (AI). If we quickly grasp the opportunities that this industrial revolution brings, the country can create a buzz and move closer to the title of "power", on the contrary, it may be more tragic than the modern innovation from the elements of the 4.0 technology revolution.

REFERENCE

1. E. Westkämper, “Struktureller Wandel durch Megatrends,” Digitale Produktion, pp. 7–9.
2. World Bank. [Online] Available: https://data.worldbank.org.
3. C. J. Bartodziej, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics: Springer, 2016.
4. H. Kagermann, J. Helbig, A. Hellinger, and W. Wahlster, Recommendations for Implementing the strategic initiative INDUSTRIE 4.0: Securing the future of German manufacturing industry; final

report of the Industrie 4.0 working group: Forschungsunion, 2013.

5. R. Drath and A. Horch, "Industrie 4.0: Hit or hype?[industry forum]," IEEE industrial electronics magazine, vol. 8, no. 2, pp. 56–58, 2014.
6. European Commission, "2016 SBA Fact Sheet Germany," 2016. [Online] Available: http://ec.europa.eu/growth/smes/business-friendlyenvironment/performance-review-2016_en. Accessed on: Jun. 10 2017.
7. L. Sommer, "Industrial revolution-industry 4.0: Are German manufacturing SMEs the first victims of this revolution?," Journal of Industrial Engineering and Management, vol. 8, no. 5, p. 1512, 2015.
8. R. Masdefiol, M. del Mar, and F. Stävmo, Industry 4.0- Only designed to fit the German automotive industry: A multiple case study on the feasibility of Industry 4.0 to Swedish SMEs.
9. C. Faller and D. Feldmüller, "Industry 4.0 learning factory for regional SMEs," Procedia CIRP, vol. 32, pp. 88–91, 2015.
10. A. Decker, "Industry 4.0 and SMEs in the Northern Jutland Region," in Value Creation in International Business: Springer, 2017, pp. 309–335.
11. M. Hermann, T. Pentek, and B. Otto, "Design principles for industrie 4.0 scenarios," in System Sciences (HICSS), 2016 49th Hawaii International Conference on, 2016, pp. 3928–3937.
12. V. Roblek, M. Meško, and A. Krapež, "A Complex View of Industry 4.0," SAGE Open, vol. 6, no. 2, 2158244016653987, 2016.
13. D. Giusto, A. Iera, G. Morabito, and L. Atzori, The internet of things: 20th Tyrrhenian workshop on digital communications: Springer Science & Business Media, 2010.
14. F. Wortmann and K. Flüchter, "Internet of Things," Bus Inf Syst

Eng, vol. 57, no. 3, pp. 221–224, 2015.

15. D. O'Halloran and E. Kvochko, "Industrial Internet of Things: Unleashing the Potential of Connected Products and Services," in World Economic Forum, 2015, p. 40.
16. M. Brettel, N. Friederichsen, M. Keller, and M. Rosenberg, "How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective,"
17. J. Gao, Y. Yao, V. C. Y. Zhu, L. Sun, and L. Lin, "Service-oriented manufacturing: A new product pattern and manufacturing paradigm," J Intell Manuf, vol. 22, no. 3, pp. 435–446, 2011.
18. J. Cardoso, K. Voigt, and M. Winkler, "Service engineering for the internet of services," in International Conference on Enterprise Information Systems, 2008, pp. 15–27.
19. F. Hu et al., "Robust Cyber–Physical Systems: Concept, models, and implementation," Future Generation Computer Systems, vol. 56, pp. 449–475, 2016.
20. L. Hu, N. Xie, Z. Kuang, and K. Zhao, "Review of cyber-physical system architecture," in Object/Component/Service-Oriented Real-Time Distributed Computing Workshops (ISORCW), 2012 15th IEEE International Symposium on, 2012, pp. 25– 30.
21. Bornemann, Dagmar 2014: Industrie 4.0: Vermessen und funktional – aber nicht revolutionär, Impulse, Managerkreis der Friedrich-Ebert-Stiftung, Berlin.
22. Bundesverband Informationswirtschaft, Telekommunikation und neue Medien (); Fraunhofer BITKOMInstitut für Arbeitswirtschaft und Organisation (IAO) 2014: Industrie 4.0: Volkswirtschaftliches Potenzial für Deutschland, Berlin; Stuttgart.

23. Directive No. 50-CT/TW of the Secretariat on promoting the development and application of biotechnology for the cause of national industrialization and modernization
24. Directive No. 16/CT-TTg of May 4, 2017 of the Prime Minister on strengthening access to the 4th Industrial Revolution.
25. DZ Bank; GfK Enigma 2014: Umfrage in mittelständischen Unternehmen zum Thema Digitalisierung: Bedeutung für den Mittelstand, Frankfurt a. M.; Wiesbaden.
26. Enderlein, Hendrik; Pisani-Ferry, Jean 2014: Reformen, Investitionen und Wachstum: Eine Agenda für Frankreich, Deutschland und Europa, Berlin.
27. Forschungsunion; Acatech 2013: Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0: Abschlussbericht des Arbeitskreises Industrie 4.0, Essen; Frankfurt a. M.; Munich.
28. Franz, Hans-Werner 2010: Qualitäts-Management als soziale Innovation, in: Howaldt, Jürgen; Jacobsen, Heike (ed.): Soziale Innovation: Auf dem Weg zu einem postindustriellen Innovationsparadigma, Wiesbaden, pp. 335–354.
29. Fraunhofer Institut für Arbeitswirtschaft und Organisation (IAO) 2013: Produktionsarbeit der Zukunft: Industrie 4.0, Stuttgart.
30. Ganz, Walter; Fraunhofer IAO 2014: Welche Rolle spielen die Dienstleistungen in der Industrie 4.0? Präsentation anlässlich des FES-Fachgesprächs Industrie 4.0, 8.10.2014, Berlin..
31. Plattform Industrie 4.0 2014: Industrie 4.0: Whitepaper FuE-Themen,http://www.plattformi40.de/sites/default/files/Whitepaper_Forschung%20Stand%203.%20April%202014_0.pdf (12.3.2015).
32. PricewaterhouseCoopers (PwC) 2014: Industrie 4.0: Chancen und Herausforderungen der vierten industriellen Revolution, Munich; Frankfurt a. M.

33. Renn, Ortwin 2014: Das Risikoparadox: Warum wir uns vor dem Falschen fürchten, Frankfurt a. M. Roland Berger 2014: INDUSTRY 4.0: The New Industrial Revolution: How Europe Will Succeed, Munich.
34. Prime Minister: No. 418/QD-TTg: Decision approving the Science and Technology Development Strategy for the period 2011-2020
35. Stephan, Peter 2014: Industrie 4.0: Auswirkungen auf die Arbeitswelt aus Sicht eines Anwenders, Präsentation anlässlich des FES-Fachgesprächs Industrie 4.0, 12.11.2014, Berlin.
36. R. Masdefiol, M. del Mar, and F. Stävmo, Industry 4.0- Only designed to fit the German automotive industry: A multiple case study on the feasibility of Industry 4.0 to Swedish SMEs. [9] C. Faller and D. Feldmüller, "Industry 4.0 learning factory for regional SMEs," Procedia CIRP, vol. 32, pp. 88–91, 2015.