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Manufacturing 4.0: Perspectives from Developed and Developing Economies

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Abstract

Manufacturing 4.0 enables firms in terms of advanced and predictive analytics, integrated optimization, autonomous operations, and digital work. Though Manufacturing 4.0 has gained traction in the developed and developed economies alike, the ability to cope with this technical change is not evenly distributed geographically. There is need to put in perspective the spread of research and readiness of top manufacturing economies towards manufacturing 4.0 and portray a comparative profile regarding the response of emerging and developed economies regarding the adoption of Manufacturing 4.0. For doing the same a Systematic literature review was conducted for identifying and examining the articles in this domain in order to discuss (1) the geographical spread of research on manufacturing 4.0, (2) manufacturing 4.0 readiness of top manufacturing countries, and (3) comparison between developing and developed economies regarding the adoption of Manufacturing 4.0. Based on these findings, the present study brings together varied learnings from both developing as well as developed economies regarding the key facets of Manufacturing 4.0. This comprehensive analysis may be useful for policy makers and practitioners while they adapt and prepare for the age of digitalization and new manufacturing format.

Keywords: Manufacturing 4.0, Developed economies, Developing economies, Systematic literature review,

1. Introduction

Manufacturing 4.0 has not only been widely adopted by developed economies like Germany, the USA, France, the UK, and Japan (Luthra & Mangla, 2018); it has also got acceptability in developing economies like China and India, introducing programmes like 'Made in China 2025' and 'Make in India' (L. Li, 2018). Manufacturing 4.0 enables the transformation of manufacturing facilities into an interlinked digital plant, which facilitates the entities in the value chain to communicate, exchange information, and analyse the gathered data. Hence, in operational terms Manufacturing 4.0 enables firms in terms of (1) Visualization and alerts i.e., enabling firms to examine performance from C-suite to shop floor, providing a platform for Integrated alerting in time for the decision-maker (2) Advanced analytics i.e., enabling firms with Predictive insights for shifting from reacting to a proactive approach and linking analytics with dynamic plant scheduling for enabling agile operations (3) Active digital plant and best next action i.e., using real-time data and analytics and Artificial Intelligence with operations data for guiding decision-making (4) Predictive, integrated optimization i.e., Optimizing plant performance through integrated advanced analytics tools (5) Autonomous operations i.e., reducing risk and cost by employing Artificial Intelligence tools like deep learning (6) Digital work i.e., utilising automated workflow-driven mobile solutions to overlay real-time operational data, work history, asset conditions for managing plant operations.

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However, the ability to cope with this technical change is not evenly distributed geographically. Historically manufacturing has been considered a job creator in the economies. Developing economies have been adopting labour-intensive practices in manufacturing based on the rationale that low-cost labour would lead to manufacturing goods at a lower cost. Adding to this, labour unions also created opposition towards automation or the employment of technology for the perceived fear of losing jobs due to automation. While for developed economies, the critical issue has been reshoring manufacturing back to the developed world (Foerstl, Kirchoff, & Bals, 2016). Beyond the macro-economic context of the technological challenge as discussed above, studies also suggest a significant variation in the level and effectiveness of the integration of Manufacturing 4.0 with management philosophies like Lean manufacturing because of varying socio-economic contexts (Strange & Zucchella, 2017).

Although Manufacturing 4.0 has received traction from researchers and practitioners' communities, its actual impact (Závadská & Závadský, 2018), challenges, and critical success factors (Kamble, Gunasekaran, & Sharma, 2018) concerning its pervasive adoption need more exploration (Fettermann, Gobbo, Cavalcante, Almeida, & Tortorella, 2018). Though there seems to be a strong correlation between the adoption of Manufacturing 4.0 and backshoring of manufacturing facilities (Hannibal & Knight, 2018), it is still an important question for researchers and managers to explore if technology can drive backshoring of manufacturing. In this context, there exists a need to put in perspective the readiness of top manufacturing countries towards manufacturing 4.0 and develop a comparative profile regarding diversity of response towards this phenomenon in emerging and developed economies. By doing so, this article provides relevant analysis regarding the key facets of Manufacturing 4.0 that may help economies and firms decipher relevant approaches and strategies, which are based on their context to adapt and prepare for the age of digitalization and new manufacturing format.

The present study attempts to fill this gap by discussing (1) the geographical spread of research on manufacturing 4.0 (Section 3), (2) manufacturing 4.0 readiness analysis of top manufacturing countries (Section 4), and (3) portray a comparative profile regarding the response of emerging and developed economies regarding various aspects of the adoption of Manufacturing 4.0 (Section 5). The discussion in section 6 provides a comprehensive analysis of varied learnings both from developing as well as developed economies regarding the key facets of Manufacturing 4.0.

1. Methodology

In order to map and assess the existing literature in the area of Manufacturing 4.0, the present study employed a Systematic literature review (SLR) methodology for systematic extraction of relevant literature in the domain (Tranfield, Denyer, & Smart, 2003). SLR as a methodology is advantageous to traditional narrative reviews as it employs unambiguous and systematic procedures for minimizing the biases while searching, identifying, appraising, synthesizing, analyzing, and summarizing studies. The rigour involved in the systematic process ensures that the outcome has a minimum error, and the study leads to reliable findings and conclusions. The present study followed an overarching process spanning the following four distinct steps as prescribed by the prior literature (Alves & Mariano, 2018).

Step I. Specification of research objectives: The objectives were defined, and a search protocol was established.
Step II. Data collection: The material to be collected was defined, and appropriate keywords and databases were selected.
Step III. Article selection criteria: The criteria for selecting the documents were established. It was followed by loops of forward and backward citations from the selected papers.
Step IV. Content analysis: The key insights and pertinent issues were identified from the selected studies, and findings were elucidated.

To ensure the SLR process's robustness, an evaluation team comprising two professors well-versed with SLR methodology was established to guide the authors throughout the SLR process. We searched for the articles based on keywords from the Web of Science (WoS) database. The string of keywords used is illustrated below:

("Industry 4.0" OR "Manufacturing 4.0" OR "Digitization" OR "digital transformation" OR "digital servitization" OR "Smart manufacturing" OR "Block chain")
AND ("preparedness" OR "technical change" OR "adopt*")
AND ("Developed" OR "Developing" OR "Asia" OR "EU" OR "US" OR "China" OR "India" OR "Germany")

Following inclusion criteria were used for selecting the papers for the study: the predefined keywords exist as a whole or at least in the title, keywords, or abstract of the paper; the empirical studies published in a peer-reviewed journal; and the paper is in the English language. The articles, which fulfilled the inclusion criteria were selected for content assessment and analysis. The descriptive detail for the same is as below (see Table 1):

Insert Table 1 here

2. Geographical spread and focus of Manufacturing 4.0 research

By providing a descriptive analysis regarding the geographical spread of research on Manufacturing 4.0, this section helps in building an understanding of the focus of different economies concerning manufacturing 4.0. An attempt has been made to provide clarity regarding the adoption of Manufacturing 4.0 globally.

In an empirical study Nolting *et al.* (2019) performed an analysis of over 800 articles on the subject from Scopus and ScienceDirect databases. The result of the study illustrates the major centre of research in this domain along with their specific focus regarding manufacturing 4.0. Though the study observed 52 countries that significantly contribute to the field of Manufacturing 4.0 research globally, but the three key contributors in the development of Manufacturing 4.0 are the USA, Europe, and China. However, they observed a unique approach towards Manufacturing 4.0 in each region. Based on the analysis, they classified the identified research papers into (a) the region where research was conducted (b) the research focuses of manufacturing 4.0 research. The research focus was further classified into four approaches of smart manufacturing, namely (1) Cyber-physical systems (CPS), (2) information management, (3) human-machine interface, and (4) smart systems. Table 2 below illustrates the distribution of research papers into regions and research focus.

Insert Table 2 here

Summarizing the results of the study, we observed the following points:

- Different focus regarding the adoption of Manufacturing 4.0 in different regions, which can be attributed to different plans and strategies different regions adopted in their endeavour towards the Fourth Industrial Revolution.
- The USA based research primarily focuses on Cyber-physical systems (CPS), data management, while information management, human-machine interface, and intelligent systems were other areas of investigation.
- European institutions are leading research in human-machine interaction, and smart systems, followed by USA and China.
- China based research focuses more on data management with very little focus on human-machine interaction
- Concerning Europe, Germany, France, and the UK are three major players and Eastern European countries have minimal contribution in this field of research.
- Overall, Germany is a leader in Industry 4.0, contributing to over 40% of research in this domain globally.
- Non-uniformity in adopting terms like Industry 4.0 or Manufacturing 4.0 globally, as this is evident from the adoption of Made in China 2025 strategy in the Chinese context. Similarly, related terms are considered worldwide.

3. Manufacturing 4.0 readiness of top manufacturing countries

Digital readiness is a critical concern for the manufacturing industry. The CISCO, World Bank, Industrial Development 2018 report (Yoo, Wysocki, Cumberland, & Affairs, 2018) rated different countries in terms of their digital readiness score ranging 0 to 25. Table 3 presents the top 20 countries based on their contribution towards global manufacturing.

Insert Table 3 here

From the findings reported in Table 3, it becomes evident that only 30% of the top 20 manufacturing economies are under the category of developing economy. Though developing economies like China, India, and Brazil have become factories to support world's demand because of global offshore outsourcing followed by developed economies; their digital readiness is far below that of developed nations like the US, the UK, and Germany. Suggesting a significant gap and hence opportunities in this field.

Castelo-Branco, Cruz-Jesus, and Oliveira (2019) classified the countries in the European Union (EU) based on their level of readiness with reference to Manufacturing 4.0 by using Industry 4.0 Infrastructure, and Big Data Maturity as two dimensions (see Figure 1). The first-dimension measures infrastructure readiness, while the second dimension measures the capability concerning data processing. It is prudent to use a combination of these two dimensions to measure the digital readiness of a country as the convergence of infrastructure that produces data and analytical capabilities that processes data results in benefits from the digitization (Agarwal & Brem, 2015).

Insert Figure 1 here

The study suggests that Scandinavian economies are high on both dimensions, with Finland leading the group, followed by Netherlands and Luxembourg. However, a significant level of heterogeneity exists in the group. Extant research has also suggested that these economies are leaders at the EU level (Cruz-jesus, Oliveira, & Bacao, 2012), which may be the result of a high level of propensity from corporates towards higher digitization.

Concerning Germany, where the concept of Manufacturing 4.0 germinated, the study suggests further advancements in big data analytics in the manufacturing sector. A similar observation has also been made by OECD (OECD, 2017). In the case of the UK, the country is placed relatively high on big data analytics but low on the other dimension. Surprising results were observed for France and Italy; these economies are placed low in both dimensions. Various reasons can be cited for the observed variations in the preparedness of EU countries. Some of the reasons are listed below:

- Structural distribution of the Industrial sector
- Share of manufacturing in the overall economy
- Barriers to information and communication technologies interoperability and standards
- Lack of human resources with the required skillset
- Public policies can facilitate the diffusion of the correct information efficiently, specifically for SMEs, and provide resources in the best possible manner

4. Manufacturing 4.0: A comparison between emerging and developed economies

4.1. Integration of Manufacturing 4.0 and Lean Production

We chose to discuss the integration of Manufacturing 4.0 with Lean production (LP) for understanding the differences in the implementation level of Manufacturing 4.0 across developed and developing economies because the integration has been envisioned to create benefits for the manufacturing industry (Rafique, Nizam, Rahman, Saibani, & Arsad, 2019) in terms of mitigating some of the existing management challenges and leading towards higher performance standards (Sanders, Elangeswaran, & Wulfsberg, 2016; Sony, 2018). Moreover, research also suggests that integration varies significantly across various socio-economic contexts (Luthra & Mangla, 2018).

In a survey-based study with inputs from 249 managers from the manufacturing firms, which initiated the adoption of Manufacturing 4.0 in their respective firms, Tortorella et al. (2019) compared the organizations from Brazil (emerging economy) with Italy (developed economy). The results of the survey point to the following insights:

- The firm's socio-economic context and maturity level of Manufacturing 4.0 and lean principles significantly impact the integration between lean manufacturing and Manufacturing 4.0; the results are consistent with the findings of Tortorella and Fettermann (2018).
- The manufacturing industry profile is an important antecedent of the level of integration, which is evident from the fact that companies in the high-tech industry were more adaptive towards a high level of integration in the Brazilian context. Whereas in the Italian context, companies from low-tech industries were more adaptive.
- The key challenge lies in identifying a balance between the efforts for integrating Manufacturing 4.0 and LP in a firm and its impact on operational and financial performance.
- All companies should not go for adopting similar managerial approaches (Bhasin, 2012) and technologies (K. Zhou, Liu, & Zhou, 2015) for achieving similar results.

4.2. Manufacturing 4.0 and Made in China 2025

A survey-based study comparing the implementation of the Industrial Internet of Things (IIoT) in developed and developing economies was conducted by Müller and Voigt (2018), where data was collected from 329 SMEs, 222 from Germany and 107 from China for comparing “Manufacturing 4.0” and “Made in China 2025” concerning SMEs. The results of the survey suggest the following points:

- In the context of Germany, the Industry 4.0 might be more relevant for large firms compared to SMEs.
- German SMEs perceive benefits emerging from the operational perspective concerning "Industry 4.0". On the other hand, Chinese SMEs emphasize strategic as well as operational, economic benefits.
- German SMEs do not see Industry 4.0 as a tool for energy efficiency, whereas Chinese SMEs consider Made in China 2025 an effective tool for energy efficiency.
- Regarding the social challenges from IIoT, Chinese SMEs expect job losses, an observation in confirmation with Beier, Niehoff, Ziems, and Xue (2017). The lower digitization in the Chinese firms compared to Germany threaten more jobs because of more extensive plans regarding replacing workforce on account of automation in China in comparison with Germany.

In general, the study observed that the German SMEs expectation is that of lower impact on account of “Manufacturing 4.0”, seeing it as good for large firms. The study highlights that Chinese SMEs give higher priority to social benefits. Challenges regarding “Manufacturing 4.0” and various frame conditions were seen as more relevant by German SMEs than for “Made in China 2025” by the Chinese SMEs.

5. Discussion

5.1. Learnings from developing economies

Historically, the approach taken by developing economies has been the adoption of labour-intensive practices in the manufacturing sector. The primary rationale for the approach was that low-cost labour would lead to the manufacturing of goods at a lower cost. Adding to this labour unions were opposing automation or the introduction of technology for the perceived fear of losing jobs due to automation. Though it appears logical that labour intensive approach would generate more employment, but Indian manufacturing for long has stagnated at 15-16 percent of GDP, while for China, which is having higher economic development it is more than 26 percent. The manufacturing sector in developing economies needs to increase its competitiveness by developing a strategy for smart manufacturing and keeping quality, cost, and safety as key goals. Hence, in the subsequent subsection, we discuss driving factors, pathways of smart manufacturing, challenges, and strategic response to Manufacturing 4.0 in the developing economies.

5.1.1. Driving forces of Manufacturing 4.0 in developing economies: To understand the driving factors of Manufacturing 4.0 in developing economies, we take the case of the Chinese economy. We chose the Chinese context as (1) China is the largest manufacturing-based economy (K. Li & Lin, 2016). (2) Its collaboration with Germany for promoting Manufacturing 4.0 under the banner of “Shaping innovation together” (Tian & Pan, 2018).

For understanding the finer nuances of driving factors of Manufacturing 4.0 in developing economies, Lin, Wu, and Song (2019) analyzed 460 Chinese listed firms that promoted Manufacturing 4.0. While doing the same they examined the influence of company ownership, industry scenario, shareholding pattern, financial leverage, and firm size on the introduction of Manufacturing 4.0 and observed that:

- Subsidies from the government for promoting Manufacturing 4.0 have no significant impact on the organization's decisions concerning the adoption of Manufacturing 4.0
- Private firms were more adaptive towards the adoption of Manufacturing 4.0 as compared to state-owned firms.
- With a 1% increase in shareholdings of major shareholders, the firm's probability for implementing Manufacturing 4.0 increases by 0.48% as large shareholders may make decisions keeping in mind the long-term perspective.
- The capital market gives a positive premium to the companies implementing Manufacturing 4.0.

5.1.2. Path to smart manufacturing in emerging economies: In an empirical research (Y. Zhou, Zang, Miao, and Minshall (2019) employed a case study approach for understanding the path taken up by five Chinese companies for developing their traditional manufacturing facilities into smart factories and observed that developing economies may lose the leapfrogging opportunity the digital revolution provides if they follow the in-series upgrading pathway. Intelligent manufacturing upgrading of Chinese firms can be a good learning example in this regard. There is also a need to adopt digital up-gradation pathways based on the firm's operating model, resource availability, strategic fit, and industrial characteristics.

5.1.3. Challenges to Manufacturing 4.0 in emerging economies: Manufacturing 4.0 is relatively new to emerging economies. In this sub-section, we discuss the critical challenges to Manufacturing 4.0 in the emerging economies. We do so by taking the perspective of the Indian manufacturing industry as the Indian economy is one of the fastest-growing economies (Forbes, 2016), with manufacturing contributing to 16% of GDP and employing 12% of the workforce (IBEF, 2016). With the recent thrust on Smart City, Digital India, and Make in India, the Indian economy provides enormous opportunities in Manufacturing 4.0 (Abhishek, 2017; Thornton, 2017).

Luthra and Mangla (2018) in an empirical study classified the challenges for Manufacturing 4.0 in emerging economies as:

- *Organizational challenges:* Luthra and Mangla (2018) identified following organizational challenges: (1) limited availability of financial resources, (2) limited support from top management, (3) limited clarity on digital mission and vision of the firm, (4) behaviour towards technological change, (5) capabilities in the adoption of new business paradigm. Out of these, challenges due to the limited availability of financial resources were of the highest importance, followed by management support and limited clarity on the digital mission and vision of the firm. de Sousa Jabbour et al. (2018) also suggested that organizational factors like top management, leadership, and organizational culture significantly impact adaptation of manufacturing 4.0.
- *Technological challenges:* Luthra and Mangla (2018) identified four types of technical challenges: (1) lack of global standards and data sharing protocols, (2) the limited pervasiveness of

manufacturing 4.0 infrastructure, (3) challenges of integrating technology platform, and (4) Inferior quality of available data. Out of these, challenges due to the lack of global standards and data sharing protocols were of the highest importance. Jeschke, Brecher, Meisen, Özdemir, and Eschert (2017) have also pointed out the importance of these challenges in implementing manufacturing 4.0.

- *Strategic challenges:* Luthra and Mangla (2018) identified four types of strategic challenges, namely (1) limited government inputs and clarity on policies regarding digitization, (2) ambiguity on the benefits of such initiatives, (3) limited R&D on Manufacturing 4.0 adoption, and (4) novice nature of digital culture. Out of these, challenges due to limited government inputs and clarity on policies concerning digitization were of the highest importance. Müller et al. (2018) also pointed out the importance of government support in transforming existing manufacturing factories into future-ready ones.
- *Legal and ethical issues dimension:* Luthra and Mangla (2018) identified the following legal and ethical challenges, namely (1) challenges of data security, (2) Profiling and complexity issues, (3) challenges of coordination and collaborations, and (4) legal issues. The challenges of security issues were found to be of the highest priority. Challenges in this dimension are of great importance as firms have a responsibility towards their data security and their stakeholders (Müller et al., 2018).

5.2. Learnings from developed economies

5.2.1. Backshoring strategy and the adoption of Manufacturing 4.0: Business strategies have witnessed a shift from the offshoring of manufacturing activities towards the relocation of manufacturing in developed countries (Foerstl et al., 2016). With the advancement of Manufacturing 4.0, the idea of relocation of manufacturing has been further strengthened (Stentoft & Mikkelsen, 2014). Manufacturing 4.0 has enabled firms to reduce dependence on labour, reduce waste, improve productivity and quality (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014). Recent studies suggest the paradigm shift in manufacturing location strategy with the advancement of adoption of Manufacturing 4.0 by the firms (Hannibal & Knight, 2018). The research also suggests that firms will be inclined to upgrade to digital manufacturing with an increase in complexities of the supply chain (Foerstl et al., 2016), increased risk due to offshoring of manufacturing activities (Bals, Kirchoff, & Foerstl, 2016), and risk to intellectual property (Kaivo-oja, Knudsen, & Lauraéus, 2018) to name a few.

For a granular understanding, we analyzed the results of empirical examination by Ancarani, Di Mauro, and Mascali (2019) regarding backshoring of manufacturing activities by European firms, which highlighted the following two aspects:

- *Diffusion of Manufacturing 4.0 among backshoring firms:* The pervasiveness of manufacturing 4.0 is not widespread (14%) among the firms that chose to backshore manufacturing activities in Europe (Lorenz, Kuepper, Ruessmann, Heidemann, & Bause, 2016). This finding indicates that the drivers of the back shoring strategy were primarily due to challenges of product quality, productivity, and prototyping rather than inter and intra firm digital integration.
- *Competitive priorities and Manufacturing 4.0:* Exploring whether backshoring firms adopt Manufacturing 4.0 technologies after their relocation to Europe, Ancarani

et al. (2019) observed that two factors are predominant in their decision regarding backshoring (1) high cost of poor quality due to offshoring (2) product quality and performance. These firms believe that the back shoring of the manufacturing activity along with the adaptation of manufacturing 4.0 will enable them to mitigate the challenges mentioned above. These claims have also been supported by literature on technology adoption (Zahra & Covin, 1993) and backshoring (Bals et al., 2016). The literature on Manufacturing 4.0 has also proven the positive influence of manufacturing 4.0 adaptation by a firm on its performance related to cost of poor quality, product quality, process lead time for new product development (Brettel, Friederichsen, Keller, & Rosenberg,

- 2014).

6. Conclusion

The present study based on a Systematic literature review for the domain of Manufacturing 4.0 contributes to the existing literature first by highlighting the spread of research in the area in terms of focus and geographical regions. The findings suggest that there exists different focus regarding the adoption of Manufacturing 4.0 in different regions. This can be attributed to different plans and strategies different regions adopt in their endeavour towards the Fourth industrial revolution. This information can be useful for future scholars while planning and designing their research.

Secondly, though the developing economies have become factories to support world's demand, it was observed their digital readiness is far below that of developed nations. This not only point towards a significant gap but also opportunities in this field for developing economies, if they can overcome organizational, legal and ethical, strategic, and technological challenges. Thirdly, pertinent, and contextual learnings both from developed and developing economies, which have been developed after conducting a thorough comprehensive analysis can be useful for policy makers and practitioners to decipher relevant approaches and strategies, which are based on their context while they adapt and prepare their countries and firms for the age of digitalization and new manufacturing format.

Finally, this qualitative study can provide a foundation for future empirical studies. As majority of the research in the domain of Manufacturing 4.0 has been conducted in select countries only, this study makes a call for researchers to undertake research in this domain in the under-researched geographic and socio-economic contexts.

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Table 1: Descriptive analysis regarding article identification

Sr.	Inclusion criteria	Number of articles
1	Keyword search in WoS database	118
2	Language of publication (English)	110
3	Relevance to the topic	34
4	Forwards citation	5
5	Backward citation	7
	Total	**46**

Table 2: Distribution of research papers: Regions and research focus

Country	CPS	Data Management	Human–Machine Interaction	Smart Systems	Total
Western Europe	42	37	63	45	187
USA	50	39	29	24	142
China	14	25	7	11	57
Southeast Asia (Except China & Japan)	9	11	10	5	35
Australia and New Zealand	2	14	3	1	20
Canada	6	3	2	2	13
Japan	1	1	6	3	11
South Asia	3	11	1	0	15
West Asia	3	4	7	0	14
Eastern Europe	3	2	1	7	13
South America	1	1	1	2	5
Russia	0	0	0	4	4

Table 3: Contribution of the top 20 countries to global manufacturing

Rank	Country	Total GDP* (Global ranking)	Manufacturing Contribution (%)	Employment in manufacturing sector	Digital readiness	Economy Classification
1	China	2	39.50%	23.70%	13.64 (accelerate)	Developing
2	United States	1	18.90%	17.50%	20.1 (amplify)	Developed
3	Japan	3	29.70%	26.80%	17.33 (amplify)	Developed
4	Germany	4	30.10%	27.80%	17.68 (amplify)	Developed
5	France	7	28.90%	20.70%	16.98 (amplify)	Developed
6	South Korea	11	38.80%	25.10%	14.5 (accelerate)	Developed
7	United Kingdom	5	19.40%	18.70%	17.84 (amplify)	Developed
8	India	6	19.00%	24.20%	10.54 (accelerate)	Developing
9	Russia	12	32.40%	27.20%	13.33 (accelerate)	Developed
10	Italy	9	24.00%	27.20%	14.11 (accelerate)	Developed
11	Canada	10	28.10%	21.40%	17.11 (amplify)	Developed
12	Brazil	8	21.00%	21.60%	11.8 (accelerate)	Developing
13	Indonesia	16	40.30%	22.20%	11.73 (accelerate)	Developing
14	Australia	13	26.10%	21.80%	17.34 (amplify)	Developed
15	Mexico	15	31.60%	25.10%	13.11 (accelerate)	Developing
16	Spain	14	23.20%	19.70%	14.91 (amplify)	Developed
17	Saudi Arabia	20	44.20%	22.70%	13.35 (accelerate)	Developed
18	Turkey	17	31.80%	27.80%	12.58 (accelerate)	Developing
19	Taiwan	22	36.00%	23.60%	10.95 (accelerate)	Developed
20	Poland	24	40.20%	30.20%	13.89 (accelerate)	Developed

Source: CISCO, World Bank, Industrial Development Report (Yoo et al., 2018).

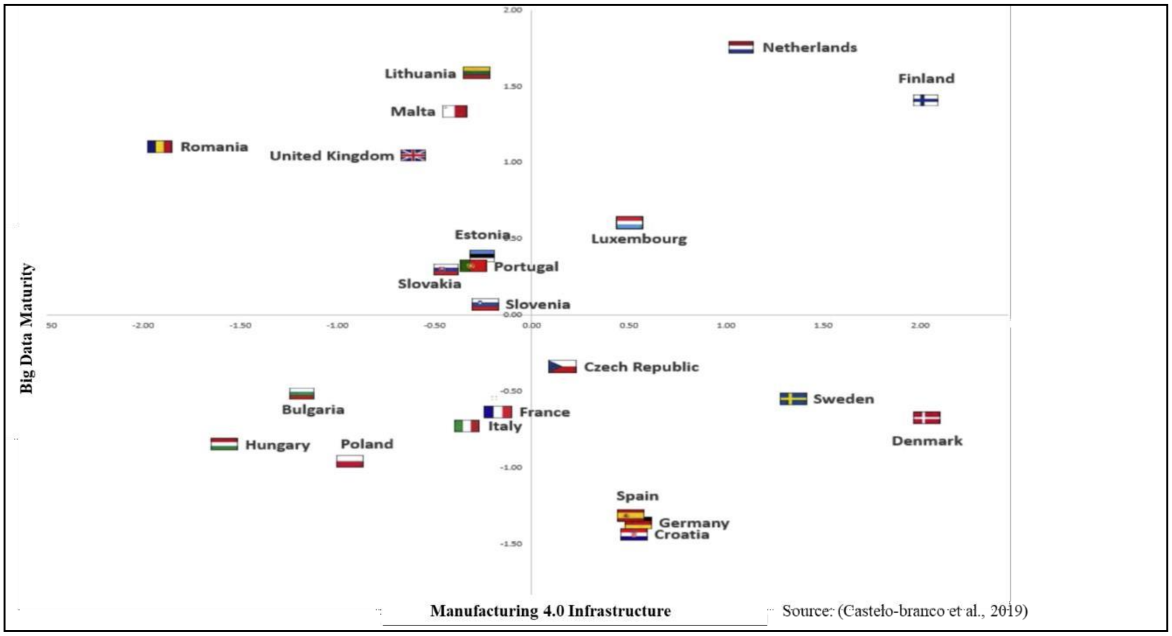

Figure 1: Factors scores of EU countries