TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

Industry Revolution 4.0: Implementing ideas from MNCs to SME units in Malaysia

Peter Yacob[1], Nurliyana Maludin[2], Suresh Nodeson[3], Sai Mei Ling[4], Adi Wira Mohd Zin[5]

[1] *Universiti Tunku, Abdul Rahman, Malaysia. Email: petery@utar.edu.my*

[2] *Universiti Tunku, Abdul Rahman, Malaysia. Email: nurliyana@utar.edu.my*

[3] *Universiti Tunku, Abdul Rahman, Malaysia. Email: suresh@utar.edu.my*

[4] *Universiti Tunku, Abdul Rahman, Malaysia. Email: saiml@utar.edu.my*

[5] *Universiti Tunku, Abdul Rahman, Malaysia. Email: adiw@utar.edu.my*

Article Info
Volume 81
Page Number: 1820 - 1825
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *10 December 2019*

Abstract

The creation of the industrial value in the early industrialized countries was initiated by the emergence of the Industry Revolution 4.0 (IR 4.0). This emergence has resulted in creating enormous opportunities for sustainable manufacturing. Hence, the main aim of this study is to analyze the recent developments and practices of IR 4.0 implemented in MNCs. It also aims at providing empirical information on the potential of implementing IR 4.0 in SME manufacturing units in Malaysia. The present study conducted in exploratory qualitative research design to examine the MNC in Malaysia who have successfully implemented the IR 4.0. This study is expected to help both researchers and practitioners of manufacturing and other industries who are serious towards the IR 4.0 implementation and are in search of an appropriate mechanism.

Keywords*: Industry 4.0, Small Medium Enterprise, Multinational Companies, Cyber Physical System, Smart Factory.*

I. INTRODUCTION

Small and medium-sized enterprises (SMEs) are considered as the backbone of most of the economical setups. Nevertheless, these enterprises are required to be implemented in both the production units as well as the commodities to affirm its position in this competition. The persistence in the miniature fashions, constant fall in the price of technologies in the field of sensors, information, and communication has led the path for the implementation of the vision of IR 4.0 and the idea of Smart Factories. On a second thought, such technological advances can aid in tackling the future challenges, but the idea of digitization of production process will alter the whole manufacturing scenario. Competencies are required on the technical level to develop Cyber Physical Systems (CPS) [1]. However, the challenges faced at the business and organizational levels are resulted from the new business models and employee training programs, which is utterly required for SMEs [2].

Hence, Industry Revolution 4.0 (IR 4.0) was formulated by German industrial associations, labor unions, politics and research with an effort to support this digitization transformation. Varied cases and instances of implemented and funded projects have been accumulated, which provide a base for the application of the IR 4.0 platform. Nevertheless, the success or failure of such approaches are totally dependable on the adoption and implementation of the IR 4.0 by the SMEs. Moreover, the barriers in terms of such adoptions are found to be high. It is quite problematic at times to find the suitable partner to conduct the research and aid in acquiring the desired knowledge for funding purpose from public research programs in comparison with Multinational Companies (MNCs) [3]. Hence, new policies, methodological tools and approaches are required to connect SMEs and MNCs to support the former in terms of development of both products and services.

II. LITERATURE REVIEW

There is a gradual increase in the competition globally in the sectors of manufacturing engineering sector. Both the US and Germany based industries have learnt the technique of implementing Internet of Things (IoT) as well as its services in their manufacturing sectors by using the Embedded System (ES). The US has taken initiative to battle against the deindustrialization through varied promotional programs for advancements in manufacturing [4]. The IR 4.0 terminology is used in Germany and Austria at varied industry-related fairs, conferences, and public founded projects [5]. The foremost aim of introducing IR 4.0 is to promote the internet associated

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

technologies into the industrial production as it is encountering serious obstacles due to upcoming information and communication technologies in the industrial sectors (IoT, CPS and ES) [6, 7].

IR 4.0 is a vision that focuses on the path led by the industries and its production. The journey of industrialization started during the later phase of the 18th century when the equipment for mechanical production was introduced. At the end of the 19th century, it was followed by the 2nd industrial revolution due to the introduction of the electrically powered machinery, which was meant for the mass production based on the division of work. The 3rd industrial revolution was initiated in 1970s, which was about the use of electronics and IT the automation of the production process. Embedded systems or the microcomputers aid in increasing the connection with each other as well as the internet. Hence, all these circumstances led to the transition from the physical world and the virtual world to the so-called cyber-physical systems. It is further considered as the 4th industrial revolution [8].

In order to make this IR 4.0 functional, two fundamental approaches should be undertaken, i.e. CPS and integration of computation and physical processes [9]. Embedded computing and networking system monitor the physical processes and control them.

The main ingredient of IR 4.0 is the smart factory that supports the complexity and efficiency growing at the first-pace in production [1]. In smart factories, there are people who communicate directly among them regarding machines, conveyance, and storage systems along with production facilities. IR 4.0 actively supports the production and documentation process [10, 11]. Hence, it demonstrates a change in the paradigm from "centralized" to "decentralized" production with the help of the technological progress that altered the traditional method of production [9]. Hence, the concept of smart factory is an important element of smart infrastructures in future. According to many researchers, it will refine the conventional mode of value chains and establish new business modules [12-15].

III. METHODOLOGY

An exploratory as well as a qualitative approach has been employed to device the research instrument [15] for this study. The lacunae of studies on IR 4.0 has persuaded to conduct the current study. The current research included the corporations who have already implemented the IR 4.0 within their work culture. Initial survey states that the manufacturers from German, Japan, and US are those countries who have untaken the smart factory technique [8]. The individuals in charge of operating this IR 4.0 are selected from two MNCs of each aforementioned countries. This selection was done on the basis of the purposive sampling technique. The potential participants were selected with their consent for the participation. The interview session was also conducted by using the interview method.

The interview mode was implemented to assess the influence of the IR 4.0 within their respective campuses. They were investigated to know about the things that motivated them to adopt the IR 4.0 in their organization irrespective of the hurdles they faced in the path. They were also asked about their strategies adopted to surpass the hurdles in their paths. The data collected from the interview sessions were analyzed using the NVivo software.

IV. FINDINGS

Data was collected from a senior management staff [MS] and a technical staff [TS] of two MNC. The primary qualitative data included semi-structured interviews with a given sample (N = 2) and an interview protocol was used to guide the semi-structured interviews. The qualitative data were then coded using a constant comparative method to obtain themes. In view of the topics, the focus of the interviews was to understand the underlying elements related to the implementation of IR 4.0 and the motivation behind the implementations. In addition, the interview also seeks the related challenges that the MNC faces during the initial stage of IR 4.0 implementation.

V. DISCUSSION

A. Technological system

Survey respondents stated that the investment done on the new technologies is uncertain and new technologies installed for this IR 4.0 may influence or increase the product's price. With the gradual increase in the electric and electronic, information and advanced manufacturing technologies, the mode of production is getting transferred to digital. The virtual reality technology combines with the new era of Cyber-Physical System (CPS), the challenges in its path has resulted in the decreasing the beneficiaries of the conventional form of manufacturing system [16]. Basically, industries pay more attention to the manufacturing units. These units focus more on providing machines having the qualities to see, detect, and communicate. They operate under supervision of production of the production systems, which allows for identification of any errors or failures to make the process more efficient. Hence, the implementation of the technology in this IR 4.0 system is one of its greatest obstacles. Innovation is termed as the major aspect in SMEs for which the investment are required in the automation sector. Hence, the in-depth idea about the digitization is a benefit for the better results of IR 4.0.

While not explicitly addressed in the interview protocol, during the qualitative phase, informant TS stated:

"The integration with ERP system and the use of cloud services to provide artificial intelligence and big data and the data analytic to optimise the production. So, to provide feedback by internet of things (IoT) and if you are having intelligence products, you can communicate with your customer and with your equipment and devices out there in the field. In connecting, a lot of data that you can used to other services and equipment, and to provide feedback to your

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

production and problem resolution, for better optimize your production, services and products".

On the other hand, informant MS argued that:

"*In the context of digital manufacturing, it is important to establish the technology system to achieve advanced manufacturing based on network technologies and manufacturing data. In addition, the implementation of IR 4.0 should take into account the status quo and manufacturing requirements. Due to the different characteristics of manufacturing field and information field, there are still many technical problems to be solved in order to accelerate the path of smart factory*".

While there are no easy or immediate solutions for the technological system application in SMEs, addressing this issues has proved to be a major leverage point at other area to garner support and action around technological system activities.

Similar findings have been stated by previous literature studies showing that companies' technology adoption depends on many determinants. For example, Costa et al. (2016) [17] stated the factors influencing adoption of enterprise resource planning (ERP) systems. In addition to this, Nguyen, Newby, and Macaulay (2015) [18] stated the factors determining the decisions of small business houses in order to implement technologies. vom Brocke et al. (2016) [19] presented the implementing factors of digital technologies. Arnold et al. (2016) [20] evaluated the adoption factors of embedded systems with respect to IR 4.0. Reyes et al. (2016) researched on the radio-frequency identification (RFID) adoption, and Oettmeier and Hofmann (2017) [21] on adoption of additive manufacturing technology. However, there has been limited no research at all based on the factors determining the adoption of Industry 4.0 as a concept.

B. Employees' commitment

Uncertainty were pervasive in the qualitative and quantitative results as to how employees' commitment in IR 4.0 adoption in SMEs. Changing the ways of functioning and expecting the same from the employees is not a preferable option [22]. The employees have to be convinced to implement the new technologies and techniques. Recruiting a new team with new individuals along with the experienced employees will show a positive influence on the proper execution of the new technology and the SMEs will definitely prosper after its execution. Before appointing, SMEs should select the change ambassadors on the basis of few features like excellent communication, empathy, and detailed idea about the digital working process [23]. In view of the employees' commitment, informant TS stated:

"*The biggest problem is helping people to understand what is even possible to think big enough. If you are not exposed to technologies, you have no ideas of what even possible, so you have no idea of what is the best practices. Unless you have seen the record. It's not a matter of acceptance of new technology because young people such from Gen Y and Gen Z or whatever they are, always over hand phone and over computer game, so acceptance of technology is a question mark for the organization*".

In supporting, informant MS argued that:

"*The image of the traditional production worker is changing in line with the rapid industrial development. Whereas tangible know-how of the operation of a certain type of plant used to be the most important competence of a production worker, Industry 4.0 puts much higher demands on the flexibility and adaptability of the workforce. A worker who is faced with new technology must be able to adopt it and quickly learn how to work with it. Consequently, these qualities are to be prioritized over technical diplomas when hiring new employees*".

The existing workplace surely has a deep connection and understanding about the products and production plant. Often SMEs find it difficult while implementing new technologies [24]. It is also troublesome in recruiting new employees with specific expertise. Hence, it is required to frequently upgrade the expertise of the organizational staffs by implementing the IR 4.0 techniques. It is therefore essential for organizations to invest both time and finance is equipping their man force to perform every form of work in the manufacturing sectors.

However, IR 4.0 cannot be implemented within a night but in the due process of its complete implementation the SMEs can garner the knowledge of its functioning and managing the whole production process. Hence, the data collected from this study will be totally from experience rather than any personal feelings [25]. The sampling data will also describe about the expertise of the current employees of the company. For this, they have to take up this new technology as a new challenge and not a threat.

Moreover, the employees will also feel a sense of responsibility towards their workplace along with a curiosity for the new work culture. The collected data will also provide them the insight of the need of changing a certain process for better results. The work environment will also be uplifted after implementing the results from the data assessment [26]. As mentioned earlier, employees have detailed knowledge of the production, they are working with and if they are up skilled on both a personal and professional level, and they will be able to contribute even more to the operation and optimization of the production. As the employees working in an organization have gained enormous knowledge about certain work style, SMEs are required to share their knowledge with the new recruits for the better results in the manufacturing industry [27].

C. Firm's resources

Corporations compete to remain engaged in seeking the leading positions in this immensely competitive market. IR 4.0 platform will certainly enable the corporations to excel in this field. They also have high access to experience human resource as a result of which they excel in this competition [28]. So, there is a need of highly experienced and qualified human resource for the proper functioning of this IR 4.0 system [29]. The SMEs who can acquire experience manpower can secure the top position in

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

this industry. In simple words, the success of this IR 4.0 system solely depends on the efficient human resource or manpower. According to informant TM:

"*The more acceptable and adaptable the top management teams are toward implementing emerging technological advances, the probability to succeed in accepting the change would greatly increase. Thus, the successful implementation of Industry 4.0 platform of technologies is not only highly dependent on the corporate strategy and evolving market dynamics but also on the cognitive and leadership capabilities of the top management. For example, Kodak was once a market leader but soon found that its leaders could not adopt the existing business towards the changing technological landscape. Subsequently, the board had to reconfigure the top management team from outside the group. The mélange of new culture brought by the new leadership and the existing work culture among the incumbent managers created tensions within the organization. Eventually, Kodak lost its market share and position*".

The corporations also are able to learn or garner knowledge from the market depending on its width and depth in certain sector. It also enable the company to evade any form of future risks. The weak ties of SMEs also show their ability to learn and adapt faster in comparison to the MNCs [30]. These ties aid the SMEs to identify the opportunities and resources along with managing the uncertainty and future risks. Similarly, IR 4.0 needs expertise from the sectors like IoT, Robotics, IT, manufacturing, and blockchain to excel here. Using similar logic, IR 4.0 requires knowledge and resources from various domains including IoT, robotics, IT, manufacturing and blockchain [31]. SMEs, which have the ability to identify the emerging technologies and opportunities early from the various discerning market sources, tend to learn faster and compete better.

On the other hand, while conducting a cost-benefit analysis, if the cost of incorporating the IR 4.0 technologies turns out to be more than the potential increase in overall benefits to the SMEs, then, the SME may engage with IR 4.0 service providers. Hence, it is best for the SMEs to observe, learn, and outsource their requirements than to develop in-house [32]. If the asset specificity of IR 4.0 technology is very high such that the capital expenditure and market risk outweigh the potential benefits, then the SME should engage with IR 4.0 service providers instead of buying and installing them within their own factory premises [33]. The cost and organizational dynamics of outsourcing the Industry 4.0 capabilities may have an entirely different effect on the corporate strategy. The risks of outsourcing the capabilities to industry 4.0 services providers may also be very high. While, the in-house development of industry 4.0 capabilities may significantly increase the costs, but, buying the industry 4.0 services may significantly weaken proprietary capabilities [34]. Therefore, firm's resources clearly provide a strong competitive edge to corporations engaging in IR 4.0 and greatly enhances the corporate performance.

D. External concern

IR 4.0 is probably the most disruptive concept for most industries, affecting not only revenue and cost structures but also shaking up the core business and operating models. In relation to the external concern, the arrival of the digital revolution on industry elicits another major goal being capable to obtain more and better data to support strategic decision making [35]. Strategic coherence is only possible through the analysis of results and environments. With perceived external support, previous studies have showed the relevance of perceived outside support for innovation and technology adoption. Grimsdottir and Edvardsson (2018) [35], for instance, analyzed motivators for implementing IR 4.0 in organizations came to the conclusion that expert consultations have a strong influence. Similarly Oettmeier and Hofmann (2017) [21] showed that external expertise in terms of consultations and vendor support has a significantly positive effect on the successful implementation of IR 4.0 in organizations. In view of the external concern, informant TS stated:

"*Aspect that is often neglected, but will have a major impact on the success of IR 4.0, are legal issues and how they will affect digital transformation. Companies think that legal risks, for example related to data protection, will hamper the digital transformation of their company, major deficits exist in the identification of relevant legal risks. The focus area expected that will be influenced by implementing IR 4.0 principles will be liability (product liability, contractual liability and distribution/assignment of risk), data protection and IT security, and intellectual property*".

It will be essential for any company that pursues the digital transformation of its business processes to carefully examine all of the legal challenges that it will face. This will include risks that stem from the integration of external partners (e.g. R&D partners, suppliers and customers) in the supply chain of the company, with regards to data protection, security and agreements on liability. The latter is extremely important since, with increased connectivity and integration, an agreement on who will be liable for faulty products will be crucial [36]. Liabilities towards customers are to be evaluated based on the impact that the planned implementation of I4.0 will have. It will become more important to have in place clear contracts between the partners to avoid and/or limit risks. The inclusion of respective insurances such as a cyber-insurance can avoid lengthy and costly law suits [37]. Cyber Insurances cover damages that will result from cyber-attacks or IT-system failures. In addition, the rework and/or adaptation of a company's general terms and conditions might also be necessary.

Data protection and IT security have to be the responsibility of a company's top management in the advent of I4.0. Apart from the organizational and technical impacts, the legal aspects of the digital transformation of processes and the introduction of new business models are to be taken into account from the

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

beginning. The fact that personal data is protected will generate new challenges since data analytics will deliver a relationship with the individual [38]. Hence each automotive OEM intending to collect data from their customers' cars will need their approval first. Complexity is also added by the fact that IT security and data protection laws differ from country to country [39]. Therefore, the task of adhering to the various laws being faced in their markets will be complicated. IR 4.0 will necessitate that companies pursuing digital transformation need to make substantial efforts to master legal changes in data protection, IT security, and liability. In general the effort for the companies to safeguard their business from a legal point of view will increase. In such scenario, the industry and policymakers need to work together to create human resources flexible for Industry 4.0 standards and requirements.

VI. CONCLUSION & RECOMMENDATIONS

IR 4.0 holds both great promise and significant challenges for industrial companies. To succeed, SMEs should implement only those technologies that are valuable for accelerating operational improvements, considering both quantitative and qualitative benefits. They must also integrate new capabilities and technologies into their ways of working and manage information architecture as an enabler of IR4.0 adoption. A transformation must be carefully structured, with special attention given to change management. SMEs can use proof-of-concept pilots to rapidly test IR 4.0 technologies and showcase the potential value. At the same time, the company should define a roadmap for deploying these initiatives at scale across the entire organization and articulate a bold vision for how it will deploy IR4.0 over the long term. In addition, a broader lesson about the digital future has also emerged. The most innovative MNCs regard IR 4.0 adoption as only the first phase of a full-scale digital transformation that extends beyond operations. These MNCs are investigating how they can use digital technologies to create new revenue streams such as by reinventing the customer journey, defining new business models, and developing new go-to-market approaches. A strategic analysis that identifies a comprehensive set of digital opportunities, touching all aspects of the business, is the first step companies should take to discover the next digital frontier.

REFERENCES

1. D. Schweer and J. C. Sahl, "The Digital Transformation of Industry–The Benefit for Germany," in *The Drivers of Digital Transformation*. US: Springer International Publishing, 2017, pp. 23-31.
2. Y. Xu and T. Koivumäki. Digital business model effectuation: An agile approach. *Comput. Hum. Behav*, vol. 95, 2019, pp. 307-314.
3. J. Bischoff, C. Taphorn, D. Wolter, N. Braun, M. Fellbaum, A. Goloverov and S. Ludwig. Erschließen der Potentiale der Anwendungen von Industrie 4.0 im Mittelstand: Langfassung der Studie: Berlin, zuletzt geprüft am 28. January 2016, 2016.
4. S. Lin, S. Cai, J. Sun, S. Wang, and D. Zhao, "Influencing mechanism and achievement of manufacturing transformation and upgrading: Empirical analysis based on PLS-SEM model," *J. Manuf. Technol. Manag.* Vol. 30, 2019, pp. 213-232.
5. K. Schuster, K. Grob, R. Vossen, A. Richert, and S. Jeschke, "Preparing for IR 4.0–collaborative virtual learning environments in engineering education," in *Automation, Communication and Cybernetics in Science and Engineering 2015/2016*. US: Springer International Publishing, 2016, pp. 417-427.
6. M. Hermann, T. Pentek, B. Otto, "Design principles for IR 4.0 scenarios," in *System Sciences (HICSS), 2016 49th Hawaii International Conference on* (3928-3937), IEEE, 2016.
7. A. Liebert, "IR 4.0–the intended impact of Cyber Physical Systems in a Smart Factory on the daily business processes: A Study on BMW (UK) Manufacturing Limited," 2016, pp. 40.
8. M. Breunig, R. Kelly, R. Mathis and D. Wee, "Getting most out of IR 4.0," 2016.
9. H. Kagermann, W. Lukas, and W. Wahlster, "IR 4.0: Mit dem Internet der Dinge auf dem Weg zur 4 industriellen Revolution," VDI nachrichten, vol. 13, 2011.
10. A. Skowron, "Tool Lifecycle Management in industrial practice," *Management Systems in Production Engineering.*, vol. 2, 2015, pp. 69-75.
11. T. Stock and Seliger, G., "Opportunities of sustainable manufacturing in IR 4.0," *Procedia CIRP*, vol. 40, 2016, 536-541.
12. W. Dorst and B. Ev, "Fabrik-und Produktionsprozesse der IR 4.0 im Jahr 2020," *IM Fachz. Für Inf. Manag. Consult. Nr*. 2012, 34-37.
13. M. Blanchet, T. Rinn, G. Thaden, and G. Thieulloy, "IR 4.0. The new industrial revolution. How Europe will succeed. Hg V Roland Berg. Strategy Consult," *GmbH Münch. Abgerufen Am.*, 2012, 1105.
14. A. Mahmood and Z. Hushairi, "ICT Convergence in Internet of Things–The Birth of Smart Factories," *Int. J. Comput. Sci. Inf. Secur.*, vol. 14, 2012, pp. 93-101.
15. J. W. Creswell and V. L. P. Clark, Designing and conducting mixed methods research, 2014.
16. L. Wang, M. Törngren and M. Onori, "Current status and advancement of cyber-physical systems in manufacturing," *J. Manuf. Sys.*, vol. 37, 2015, pp. 517-527.
17. C. J. Costa, E. Ferreira, F. Bento and M. Aparicio, "Enterprise resource planning adoption and satisfaction determinants," *Comput. Hum. Behav.*, vol. 63, 2016, pp. 659-671.
18. T. H. Nguyen, M. Newby and M. J. Macaulay, "Information technology adoption in small business: Confirmation of a proposed framework," *J. Small Bus. Manag.*, vol. 53, 2015, pp. 207-227.
19. J. vom Brocke, S. Zelt, and T. Schmiedel, "On the role of context in business process management," *Int. J. Inf. Manag.*, vol. 36, 2016, pp. 486-495.
20. C. Arnold, D. Kiel and K. I., "How the Industrial Internet of Things Changes Business Models in Different Manufacturing Industries. International Journal of Innovation Management," vol. 20, 2016, pp. 1640015-1-1640015-25.
21. K. Oettmeier and E. Hofmann, "Additive manufacturing technology adoption: an empirical analysis of general and supply chain-related determinants," *J. Bus. Econ.*, vol. 87, 2017, pp. 97-124.
22. W. E. Deming, *The new economics for industry, government, education*. Massachusetts: MIT press, 2018.
23. D. Jeske and C. M. Axtell, "Going global in small steps: E-internships in SMEs," *Organizational Dynamics*, vol. 45, 2016, pp. 55-63.

November-December 2019
ISSN: 0193-4120 Page No. 1820 - 1825

24. K. Schwab, *The fourth industrial revolution*. Crown Business, 2017.
25. M. Walker, "Workforce development through technologically enhanced learning experiences," *ELearning and Social Media: Education and Citizenship for the Digital 21st Century*, 2016, pp. 43-52.
26. M. K. Jena, S. R. Samantaray and B. K. Panigrahi, "A new adaptive dependability-security approach to enhance wide area back-up protection of transmission system," *IEEE Transactions on Smart Grid*, vol. 9, 2018, pp. 6378-6386.
27. M. A. Rasheed, K. Shahzad, C. Conroy, S. Nadeem and M. U. Siddique, "Exploring the role of employee voice between high-performance work system and organizational innovation in small and medium enterprises," *J. Small Bus. Enterprise. Dev.*, vol. 24, 2017, pp. 670-688.
28. J. Chatterjee, "Strategy, human capital investments, business- domain capabilities, and performance: a study in the global software services industry," *Strategic. Manag. J.*, vol. 38, 2017, pp. 588-608.
29. V. L. da Silva, J. L. Kovaleski and R. N. Pagani, "Technology transfer in the supply chain oriented to industry 4.0: a literature review." *Technol. Anal. Strateg. Manag.*, *31*(5), 2019, pp. 546-562.
30. P. Braunerhjelm and M. Henrekson, "An innovation policy framework: Bridging the gap between industrial dynamics and growth," in *Essays in Public Sector Entrepreneurship*. Cham: Springer, 2016, pp. 95-130.
31. J. Al-Jaroodi, N. Mohamed and I. Jawhar, "A service-oriented middleware framework for manufacturing industry 4.0," *ACM SIGBED Review*, vol. 15, 2018, pp. 29-36.
32. L. Xiao and M. Ramsden, "Founder Expertise, Strategic Choices, Formation, and Survival of High- Tech SMEs in C hina: A Resource- Substitution Approach," *J. Small Bus. Manag.*, vol. 54, 2016, pp. 892-911.
33. A. Rodríguez and M. J. Nieto, "Does R&D offshoring lead to SME growth? D ifferent governance modes and the mediating role of innovation," *Strategic Management Journal*, vol. 37, 2016, pp. 1734-1753.
34. Y. Charalabidis, A. Zuiderwijk, C. Alexopoulos, M. Janssen, T. Lampoltshammer and E. Ferro, "Open Data Value and Business Models," in *The World of Open Data*. Cham: Springer, 2019, pp. 115-136.
35. E. Grimsdottir and I. R. Edvardsson, "Knowledge Management, Knowledge Creation, and Open Innovation in Icelandic SMEs," *SAGE Open*, vol. 8, 2018, 2158244018807320.
36. J. F. Chang, *Business process management systems: strategy and implementation*. Florida: Auerbach Publications, 2016.
37. J. Chase, D. Niyato, P. Wang, S. Chaisiri and R. Ko, "A scalable approach to joint cyber insurance and security-as-a-service provisioning in cloud computing," *IEEE Transactions on Dependable and Secure Computing*, 2017.
38. C. Barreto, A. A. Cardenas and G. Schwartz, "Cyber-Insurance for Cyber-Physical Systems," in *2018 IEEE Conference on Control Technology and Applications (CCTA)*(pp. 1704-1711). IEEE, 2018.
39. D. Zhang, "Big data security and privacy protection," in *8th International Conference on Management and Computer Science (ICMCS 2018)*. France: Atlantis Press, 2018.