Proceedings of the First Australian International Conference on Industrial Engineering and Operations Management, Sydney, Australia, December 20-21, 2022

Decision Support for SME Entrepreneurs to Become SME4.0

Kenza Berrada
Faculty of Sciences and Techniques
Sidi Mohamed Ben Abdellah University
B.P. 2202 - Imouzzer Road, Fez, Morocco
Kenza.berrada0101@gmail.com

Brahim Herrou
Higher school of technology
B.P.2427 - Imouzzer Road, Fez, Morocco
Brahimherrou@yahoo.fr

Abstract

In order to remain competitive in the long term and push the efficiency of the company to its limits, entrepreneurs are increasingly open to the idea of implementing Industry 4.0 in SMEs to envision a connected SME4.0. As the biggest challenge encountered is to get started, this article aims to make it easier for SME entrepreneurs to decide on the implementation of new technologies, mentioning the latest technological trends, the advantages of being SME4.0 and specifically process 4.0, listing the last major barriers that hinder the implementation of Industry 4.0, and which mainly reside in the lack of skills of employees on new technologies and predictive maintenance, high costs of setting up new technologies and long process of return on investment.

Keywords
Industry 4.0, SME 4.0, Challenges and barriers, New technologies, Predictive maintenance

1. Introduction
The characterized parts of Industry 4.0 lead to general areas of activity, which are of particular interest to the discipline of business and information systems engineering (BISE) (Lasi et al. 2007).

For the discipline of BISE, interesting starting points arise particularly concerning the area of the integration of the basic physical system and the software system (Suchergebnisse 2022). New operations using real-time information via RFID, sensors, etc. allow advanced integration into various systems. To facilitate the exchange of information, a multitude of industrial communication networks have evolved over the years, starting in the 1980s. It is remarkable that these developments, in many cases, have replicated and welcomed new emerging technologies in other fields, mainly in the world of information and communication technologies (ICT). The latest trends influencing automation technology are IoT and CPS (Wollschlaeger et al. 2017). As a simple definition, IoT is considered as a computer link between physical objects within a system composed of several objects, while the CPS concept therefore expresses a physical coupling between objects (Valette et al. 2020). The CPS concept is often associated with the IOT concept.

IOT is a system, computer and digital, of related sensors distributed around the world on the Internet that can communicate with each other to share and transfer information using a unique identifier that is assigned to each device, as a UID (Unique Identifier). A mobile friendly web application connected to the Cloud IOT server is used here for real-time monitoring and control (Gupta and Johari, 2019). It is through these concepts that predictive maintenance was born, with the objective of monitoring the condition of a machine and applying predictive modeling techniques to predict the probability of machine failure and give a time estimate of its likely occurrence. Predictive maintenance in the age of the Internet of Things (IoT) can be summarized as a maintenance methodology that brings together the power of machine learning and sensor data streaming to maintain machines before they fail, optimize resources, and thus reduce unplanned downtime (Shetty 2018). Industry 4.0 becomes the goal of all industries that are increasingly

in deficit because of traditional maintenance operations that are very expensive and penalize in most cases the production process, this concerns both SMEs and large companies. The objective of this article is to help SME entrepreneurs to visualize the advantages of becoming SME4.0 and to list the latest barrier trends and challenges that these companies face. Therefore, this article will be structured to answer the following questions:

- What are the technologies of Industry 4.0?
- How can SMEs be connected to technology?
- What are the majority barriers and challenges to implementing Industry 4.0 in SMEs?

2. Research Methodology

To establish our literature review, we followed the following steps:

1. Once the subject was targeted, we chose numerous contents in order to better define it and to prepare the selection. In order to better manage the targeted references, we created a folder on the Mendeley software to keep track of each reading and then noted a few articles and scientific books browsed on the subject, in order to select the main sources. Our search is done especially on the databases science direct, scopus and IEExplore with the main word Industry 4.0 in SMEs, digitalization of SMEs, smart manufactury, new technologies and predictive maintenance.
2. Next, we conducted an analysis of the previously selected sources through note- taking, sorting to assist in the construction of the literature review plan, and analysis by asking the following questions:
   - For each study, what are the strengths, the elements that advance the research?
   - For each study selected, what are the limitations? Are there any points that are not clear?
   - Are there any points of debate?
3. After organizing the information, we began to pose a coherent structure to start writing our article, the objective of this structure is to sweep all the points necessary to establish a literature review, we cite:
   - The main (old and recent) studies carried out in the field studied,
   - Emerging research questions on the topic under analysis,
   - The main points discussed through the sources studied.
4. We were finally able to set up the target questions of our research

3. Industry 4.0 Technologies

Contrary to the industries that advance at different speeds according to their size, technologies are advancing every day and we find ourselves with new technologies more robust and efficient that allow the emergence towards the industry 4.0, with the appearance of web and mobile technologies in the late 1960s, the internet plays a very important role in everyday life both personal at home and professional in companies. The IoT (Internet of Things) is one of the examples of novelties made possible thanks to the evolution of web technologies and techniques that appeared in 1999, the technologies attributed to it allow to collect information in the heart of machines and to bring them up to the information system. This data is stored and processed by the complementary technologies Cloud and Big Data, which allow the management of very large data from various sources and formats in order to make sense of it and take better decisions, and thanks to the computer protocol based on cryptography, the blockChain is a system that appeared to raise and manage the problems of security and data protection, although the technology of cyber security relies on these protocols to take the increased security measures.

Industries are always looking to improve through the exploitation of data and information, artificial intelligence allows to predict the behavior of the data in time based on Deep Learning and participates directly in the decision making and promises to take over the control of the machines of the production process and thanks to cyber physical systems, it is possible to exchange information autonomously, to trigger actions and to control each other allowing with the help of sensors, actuators and software and communication elements to monitor and act in real time on the physical world.

A combination of the real, virtual and digital world can be observed thanks to the technology of augmented reality (AR) or virtual reality (VR) by directly visualizing objects or physical environments in an enhanced way with the help of a digital support (Glasses, Tablets, Smartphone, ...). This technology brings its fruit in the optimization of industrial maintenance.

And many more existing technology groups are shown in Figure 1:

Figure 1. Current industry 4.0 technologies

4. Connecting an SME to Industry 4.0

4.1 SME definition

In Morocco and according to the Directorate of Statistics, SMEs are present in all sectors of economic activity with a rate of 98%: industry, crafts and construction, trade and finally services, which include tourism, communications, transport and financial services. Moroccan SMEs constitute the major part of the country's economic fabric. According to the Moroccan definition, A small and medium-sized enterprise is any enterprise managed and/or administered directly by the natural persons who are its owners, co-owners or shareholders, and which is not held more than 25% of the capital or voting rights by an enterprise or jointly by several enterprises that do not correspond to the definition of a small and medium-sized enterprise (Dahir , 2022). The sub-commission in charge of the SME has recently retained the following criteria for the definition of the SME:

-Less than 200 people employed, and a turnover of less than 5 million DH in the creation phase, 20 million DH for the growth phase and 50 million DH for the maturity phase.

In other countries, according to the Organization for Economic Cooperation and Development, the criteria for classifying SMEs are different (Table 1):

Table 1. Organization for Economic Cooperation and Development criteria

Country	Small business	Medium-sized companies
Belgium	1 à 50	51 à 200
Denmark	1 à 50	51 à 200
United States	1 à 250	251 à 500
Finland	1 à 50	51 à 200
Great Britain	1 à 50	51 à 200

Japan	1 à 49	50 à 500
Switzerland	1 à 20	21 100

4.2 Becoming SME 4.0

SMEs are always faced with a diversity of products with low and variable volumes, which allows them to be less flexible in managing their machine park and seek to improve through digital transformation. In order to connect an SME to Industry 4.0, three essential steps are required: Make the product 4.0 through standardization and modular structure, make the process 4.0 by promoting linear physical flow and information flow and make the business model 4.0 by introducing online sales and after-sales service (Bouchard, 2021) Several studies focus mainly on the transformation of the process, three maturity models have been proposed by Christophe et al (2017). including technology maturity, deployment maturity and organizational digital maturity, which aims to address the state of available technologies, the assessment of the state of deployment of technology within the manufacturing process and the maturity of the organization to assume the digital transformation. In the same context, Marc-Antoine et al. defined three stages for the development of SME4.0 (Danjou 2017). including connecting machines and automating controls, interconnecting automated systems and work teams, and upgrading the intelligent system that processes data and provides predictive elements for decision making for a predictive maintenance application. In a literature review of 51 articles by Hermann et al. (2018), the authors identify the principles related to the application of Industry 4.0, hence interoperability, virtualization, decentralization, real-time capability, service orientation and modularity. This means that a human or a machine can perform several operations via a common computer language, visualize a virtual image of the production process, facilitate decision making for the employee as well as for the machine, control the process in real time, remake the business model with the new data available for new opportunities and finally separate the process for a better management of the system complexity thanks to its agility.

Through a survey conducted in Morocco on 20 SMEs, companies say they are ready to invest in the acquisition of new technologies and want to develop their know-how in this direction, via the digital transformation of the process that will allow the company to integrate new technologies and be automated and connected (Brahim, 2022),

4.3 Barriers and challenges for SMEs

In research studies, the circulating economy of industries is expected to score a profit of €1.8 trillion in 2030 just in Europe through the use of new technologies) (Ellen MacArthur Foundation 2013). But the measurement of the results of the investment returns is not yet declared as these technologies are still new and in their infancy which leaves their adoption long by the companies (Groves 2013). The use of these new technologies therefore recognizes a brake during its application for several reasons. Multiple researches have been initiated to trace the difficulties and barriers that delay the implementation of these new technologies in industries, three categories of challenges have been structured by the study of Gröger et al. (2018) conducted in the global company Bosch. The challenge of developing analytical solutions, where the major difficulty lies in the insufficient portability of analytical solutions in factories, processes and machines, which leads to significant implementation and maintenance costs

The challenge of employee empowerment, where its major difficulty lies in the mismanagement of analytics software by corporate staff with limited basic knowledge of data analytics tools and techniques, which creates a drag on data-driven decision making and therefore slows down the development of a corporate culture based on new technologies and data analytics.

The challenge related to governance, where its major difficulty lies in the lack of advanced protection of enterprise data and the absence of policies on data ownership, which leads to economically risky use.
In the study by Roda et al. carried out on 9 SMEs, several difficulties were noted in the same context but this time in smaller companies, which can slow down the process of digital transformation in the company (Roda et al. 2018).
In this study, a weighted vote was carried out by the managers to identify the major difficulties encountered by these SMEs, summarized in the Pareto of Figure 2:

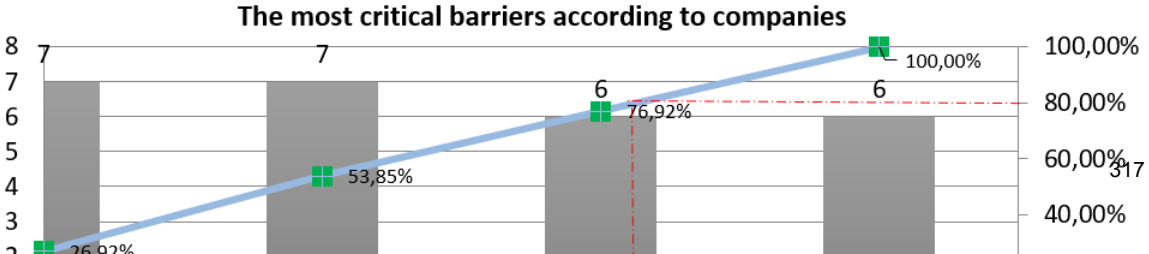

Figure 2. Pareto of identified barriers according to a weighted vote of 9 companies

Figure 2. Critical barrieres of company

According to the 20/80 law, where 80% of the effects are produced by 20% of the causes, it turns out that the challenge of making decisions through analytical data, the inability to perceive short-term benefits hence the long process of return on investment as well as the lack of employee skills currently form a barrier for the digital transformation of companies. This is a challenge faced by SMEs in particular. The ideas and applicability of Industry 4.0 for SMEs are partially feasible. SMEs run higher risks of not being repaid for their investments in digitalization in the short term (Matt et al. 2020).

They do not have a complete assessment of the current state with regard to their economy and technology, which creates another challenge that lies in the ignorance of the economic and technological benefits of digitization, giving the idea of starting over' (Jantunen et al. 2018).

5. Conclusion

Through research studies and literature review established in the context of Industry 4.0 application in SMEs, many SMEs are ready to make the digital transformation to an SME 4.0, but they are facing several barriers and obstacles that mainly come back to the lack of employee skills, high costs of implementing the new technologies and long payback process. This is usually due to the fact that SMEs have several production lines for different products and with different machines, the idea of implementing these new technologies in all operations is heavy for entrepreneurs because of the significant investment that it requires. In future studies, it will be necessary to think about applying the Lean manufacturing approach on a production line, by drawing the most critical operation which represents a bottleneck post for example, and whose productivity is reduced because of its high cycle time or that its availability is not in the objective because of the frequent stops, the goal is to introduce the new technologies only on this operation in a first time in order to visualize the benefits in term of productivity In predictive maintenance and decision support, rely on external expertise for a determined period of time to increase the competence of the employees, so that the entrepreneur will not have to make a large investment at the beginning, and will be able to introduce the culture of the new technologies gradually and will help in a safe and progressive increase in competence.

,

References

Brahim, B. La transformation digitale et industrie 4 . 0 : Quel impact sur les PME du secteur automobile au Maroc ?, no. May, 2022.

Bouchard, Stratégie D'implantation Du 4.0 Se Traduisant Par L'augmentation De L'agilité D'une Pme Manufacturière Québécoise, p. 6, 2021.

Danjou, C., L. Rivest, and R. Pellerin, Douze positionnements stratégiques pour l ' Industrie 4 . 0 : entre processus , produit et service , de la surveillance à l ' autonomie ., pp. 3–5, 2017, [Online]. Available: http://espace2.etsmtl.ca/id/eprint/16253/1/Rivest L 2017 16253.pdf.

Dahir n° 1-02-188 du 12joumada I 1423 (23 juillet 2002) portant promulgation de la loi n°53-00 formant charte de la petite et moyenne entreprise. https://adala.justice.gov.ma/production/html/fr/42106.htm (accessed Mar. 16, 2022.

Gupta and R. Johari, IOT based Electrical Device Surveillance and Control System, Proc. - 2019 4th Int. Conf. Internet Things Smart Innov. Usages, IoT-SIU 2019, Apr. 2019, doi: 10.1109/IOT-SIU.2019.8777342.

Jantunen, E., C. Emmanouilidis, A. Arnaiz, and • Eduardo Gilabert, Economical and technological prospects for e-maintenance, 2018. doi: 10.1007/s13198-011-0028-y.

Groves, P., B. Kayyali, D. Knott, and S. Van Kuiken, Accelerating value and innovation, 2013.

Gröger, C. Building an Industry 4.0 Analytics Platform Practical Challenges, Approaches and Future Research Directions, Datenbank-Spektrum, vol. 18, no. 1, pp. 5–14, 2018, [Online]. Available:

Shetty R. B., Predictive Maintenance in the IoT Era, Progn. Heal. Manag. Electron., pp. 589–612, Aug. 2018, doi: 10.1002/9781119515326.CH21.

Lasi, H.-G. Kemper, D.-I. T. Feld, and D.-H. M. Hoffmann, BISE-CATCHWORD The Authors,, 2007. doi: 10.1007/s12599-014-0334-4.

Matt, D. T., V. Modrák, and H. Zsifkovits, Industry 4.0 for smes: Challenges, opportunities and requirements. 2020Wollschlaeger, T. Sauter, and J. Jasperneite, Recent Trends in Automation Technology The Future of Industrial Communication Automation Networks in the Era of the Internet of Things and Industry 4.0, IEEE Ind. Electron. Mag., vol. 1932–4529, no. 17, p. 27, 2017, doi: 10.1109/MIE.2017.2649104.

Roda, M. Macchi, and L. Fumagalli, The Future of Maintenance Within Industry 4.0: An Empirical Research in Manufacturing, pp. 39–46, 2018, doi: 10.1007/978-3-319-99707.

Suchergebnisse.https://www.dfki.de/web/suchergebnisse?L=0&id=132&tx_solr%5Bq%5D=BISE (accessed Mar. 07, 2022).

Towards the Economy, Russ. Econ. Dev. in Russ., no. 8, pp. 26–29, 2013. https://doi.org/10.1007/s13222-018-0273-1.

Valette, B. El-Haouzi, G. Demesure, E. Valette, H. Bril El-Haouzi, and G. Demesure, L'humain dans les systèmes de production basés sur les paradigmes IoT et CPS : état des lieux et perspectives L'HUMAIN DANS LES SYSTEMES DE PRODUCTION BASES SUR LES PARADIGMES IOT ET CPS : ETAT DES LIEUX ET PERSPECTIVES, 13ème Conférence Internationale de Modélisation, Optimisation et Simulation, MOSIM'20, Nov 2020, Agadir, Maroc. hal-03025467.

Biographies

Kenza Berrada is a PhD student in the industrial technique's laboratory of the faculty of science and technology, Sidi Mohammed Ben Abdellah university, Fes Morocco. She has a state engineer degree in Mechatronics industrial engineering, she has experience in the automotive sector as a quality manager.

Brahim Herrou is a doctor engineer in industrial and mechanical engineering. He is professor in Sidi Mohammed Ben Abdellah university, Fes Morocco