Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI 10.46254/NA10.20250111
Published: June 17, 2025

The Main Challenges Lie in the Adoption of Industry 4.0 Technologies by Manufacturing Companies in Cameroon: An Exploratory Study

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Abstract

The rapid evolution of technology in recent decades requires companies to integrate technologies and their operations in order to compete globally. However, some developing countries like Cameroon are still having difficulty adapting to this new paradigm. The aim of this paper is to identify the main challenges encountered by Cameroonian manufacturing companies in the process of effort towards of the adoption of Industry 4.0 technologies. To this end, an exploratory study using a semi-structured interview guide was carried out with business executives in the cities of Douala and Yaoundé where most manufacturing companies are located. Over a two-month period, we conducted 16 interviews by use of phone and through face-to-face interactions. This study reveals that the main difficulties encountered are: costs linked to the acquisition, installation, maintenance of infrastructure and recruitment of qualified personnel (100%), power cuts (81%), internet quality (68%), political instability (75%) and subsidies (56%). At the end of this study, we formulated 5 hypotheses for future research, namely: H1: equipment costs have a negative and significant influence on the use of the tools of the fourth industrial revolution; H2: power outages negatively influence the adoption of industry 4.0 technologies; H3: Internet quality has a positive and significant influence on the adoption of Fourth Industrial Revolution technologies; H4: political instability negatively influences the adoption of industry 4.0 tools and H5: there is a positive and significant relationship between state subsidies and the adoption of new industrial technologies. These aim to address the identified gaps and will inform future research.

Keywords
Challenge, Adoption, Technology, Industry 4.0, manufacturing companies, Cameroon

1. Introduction

The industrial sector is becoming increasingly important in the global economy and in wealth creation. Africa in particular is endowed with natural resources whose exploitation is still in an embryonic stage. Manufacturing companies are still experiencing difficulties, particularly in the process of producing and processing raw materials and energy in terms of quality and quantity, which is an obstacle to the integration of the world economy. According to the International Monetary Fund, sub-Saharan Africa is the slowest growing region in the world. In addition, the United Nations Industrial Development Organization points out that Africa's share of global manufacturing value added is 1.6% (Kla and Diarra 2022). This is a result of the lack of infrastructure in the transport, lack of advanced technology, lack of telecommunications and poor energy sectors. Theses constitut a major obstacle to the strengthening of the African manufacturing and service industries. To this end, it is clear that there is a need to open up to new technologies.

In 2011, at the annual Hannover Fair, the Fraunhofer Institute highlighted a new German government policy to improve industrial practices across the country : the Fourth Industrial Revolution. Generally known as Industry 4.0, it is an industrial policy developed by the German government with the objective of gaining and maintaining a global competitive advantage at the level of manufacturing companies" (Blanchet 2016). Driven by a highly

competitive environment, the United States, the United Kingdom, Japan and many other countries worldwide have not hesitated to adopt and adapt to the new situation and technologies of the future mostly based on the fourth industrial revolution technologies.

Moreover, the fourth industrial revolution is affecting several functions in many different compagnies and organisations through the creation of recording, classification and synthesis systems generated by autonomous systems, sofware and in sone case robots. Now, physical devices can communicate via the internet, sharing and communicating information with each other devices and systems without human intervention (Camarinha-Matos et al. 2015). Industries are moving closer and closer to zero-stock production because they will no longer need to keep inventory due to the production being carried out at the desired time, thus leading to the significant reduction of production costs supply and many others.

Indeed, in a competition where Africa is and has been and was absent from the time of the first second and third industrial revolutions, Industry 4.0 is emerging as a response to the specificities of the economic ecosystems of Sub-Saharan Africa can make it possible to catch up in terms of industrialization. The adoption of Industry 4.0 can enable countries, compagnies, organisations, government and enterprises to improve their production and services systems, increase market share, improve results, have a more significant return, attract more investors to the African market, and contribute to GDP growth. In order to guarantee the sustainability of companies and their competitive advantage, managers are constantly finding strategic ways that allow them to increase not only productivity, but also improve economic and financial performance. Industry 4.0 technology allows manufacturing and services industries to increase their profitability on the capital employed by making maximum use of physical assets, models and systems reducing production time and strengthening their competitiveness and therefore their performance (Faure 2016; Dewa et al. 2018). In addition, the quantity and quality of manufacturing can increase in a short period of time, leading to more exports than imports (Adetunla and Madonsela 2022). However, the implementation of these new technologies also entails major infrastructure work that must be carried out to ensure the integration of professionals and a complete or partial overhaul of the production system.

1.1 Objective

This study is a contribution to the concept of Industry 4.0 and how it can be understood in developed, adopted, adapted and optimally utilised in developing countries. The objective is to identify the main challenges faced by manufacturing companies in the adoption of Industry 4.0 technologies focusing on Cameroon. In other words, what are the difficulties faced by Cameroonian manufacturing companies in adopting Industry 4.0 tools? Following a qualitative exploratory study, we have identified some difficulties encountered by practitioners in this sector when it comes to the implementation of the industrie 4.0 usefully and productively. In the rest of this study, we will present the literature review, the methodology, the results and the discussion followed by a brief literature, and we will conclude with the conclusion.

2. Literature Review

Industry 4.0 refers to the shift to intelligent and connected production systems (UN 2020). It changes the way the economy and society work, including the way people interact with others and with their environment. The goal of Industry 4.0 is to provide individualized, intelligent and environmentally sustainable goods and services (Shadravan and Parsaei 2023). New technologies increase production, improve energy efficiency and make production more sustainable. Smart industry also makes it possible to accurately predict product requirements and quickly identify defects leading to the best possible results (Kusiak 2018). Digital transformation involves fundamental changes that are essential for the survival of organizations in order to achieve better results, taking into account the internal, external and global dimensions of the company (Henriette et al. 2015; Ismaïl et al. 2018). According to the United Nations Industrial Development Organization (UN 2020), countries where Industry 4.0 technologies are widespread have faster growth in manufacturing value added than others, creating new jobs.

The digital industry uses several elements such as: Artificial intelligence to ensure the maintenance of the production line and to identify equipment and product defects. It allows systems to make their own decisions, improving manufacturing performance, regulating product costs, and increasing efficiency in the process. This can be further supported by for example. the Industrial Internet of Things/Internet of Things, which highlights human-machine interaction through sensors in order to achieve better production planning. We can also have cyber-physical systems that use information and communication technologies to control physical processes and systems. In addition, physical worlds interact with Internet of Things (Lee and Seshia 2016).

Originality of Industry 4.0 lies in the connection of products, machines and people with the environment by grouping production, information technology and the internet (Kargermann et al. 2013). It highlights analytics technologies, the cloud, big data and the Internet of Things (Kane et al. 2015; Sébastien et al. 2017). According to Manhart (2017), industries should adopt these smart manufacturing strategies to maintain current competitiveness

and have a long-term competitive advantage in the global market. However, several countries such as Cameroon are still on the sidelines of these new technologies. Indeed, the theory of the diffusion of innovation developed by Rogers (1995) integrates many factors at different levels to explain adoption decisions. Rogers' classic model recognizes that the specifics of innovative technology affect adoption rates. Moreover, some organisations and business leaders prefer to keep their customs and are not yet ready for any change (Tremblay 2003). Based on this approach of Rogers and the literature mentioned above, we will identify the difficulties to integrate new technologies in manufacturing companies.

3. Methodology

This study followed a qualitative exploratory approach, the target population of which is made up of manufacturing companies established in Cameroon. Following a semi-structured interview guide, questions were asked about the difficulties encountered, and the main challenges that would be a hindrance to the implementation of these new technologies. At the beginning of the data collection, we contacted 10 managers or executives from different companies, going to their premises, via the assistant or the secretary to make an appointment. As the interviews progressed, we continued to make appointments with other respondents. After going through 16 intensive interviews We noticed that after the sixteenth interview, we noticed the redundancy of the responses. To this end, we limited our study to a sample of 16 companies in order to respect the saturation effect. The first theme of our interview guide focused on the knowledge of the tools of Industry 4.0 (for example: have you ever heard of industry 4.0 tools such as the Internet of Things, cyber-physical systems cloud, big data?), and the second was focused on the difficulties hindering the adoption of these new technologies (for example: What prevents you from integrating these new tools into your production and management system?). It should be noted that certain questions were asked based on the answers in order to have clarity on the information provided. The information collected was analyzed meticulously by repairing sentences and/or terms that appeared several times in the different contents. The analysis of the content of the responses allowed us to identify the main challenges encountered by practitioners in this sector of activity. The following table shows the characteristics of the sample.

Table 1. Sample characteristics

Frames	Branch	Post	Experience in years	Maintenance Means
I1	Agri-Food	Chief Financial Officer	14	Telephone
I2	Agri-Food	Chief Financial Officer	10	Face-to-face
I3	Wood	Managing director	22	Face-to-face
I4	Agri-Food	Production Manager	16	Telephone
I5	Drink	Marketing Director	10	Face-to-face
I6	Agri-Food	Production Manager	12	Face-to-face
I7	Textile	Production Manager	7	Face-to-face
I8	Furniture	Deputy Director	15	Face-to-face
I9	Metal	Production Manager	8	Telephone
I10	Metal	Chief Financial Officer	17	Face-to-face
I11	Agri-Food	Chief Financial Officer	12	Telephone
I12	Chemical	Production Manager	9	Telephone
I13	Agri-Food	Deputy Director	20	Face-to-face
I14	Agri-Food	Production Manager	8	Face-to-face
I15	Drink	Production Manager	13	Face-to-face
I16	Drink	Sales Manager	10	Telephone

Source: authors, I= Interviewee

50% of the sample was made up of agri-food companies, beverages 18.75%, metals 12.5%, wood, textiles, chemicals and furniture each representing 6.5% of the sample. It is also noted that most of these interviewees are financial directors or production managers and average experience is about 15 years.

4. Results and Discussion

4.1 Key results

The analysis of the responses collected during the interviews allowed us to obtain key ideas regarding the challenges encountered by the practitioners. The table 2 highlights the different key ideas.

Table 2. Presentation of Key Ideas by Interviewee

Key Ideas	Interviewee Reference	Percentage of interviewees
The use of Industry 4.0 technologies requires large investments at high costs	All interviewees	100%
The lack of energy due to untimely power cuts is an obstacle to the adoption of new technologies	I1, I2,I4,I5,I6,I7,I9,I10,I11,I12, I14,I15 et I16	81%
Quality network coverage hinders the adoption of new technologies	I1, I2, I3, I4, I5, I6, I9, I11, I12, I15 et I16	68%
Political instability discourages potential investors	I1, I2, I3, I4, I5, I6, I7, I8, I9, I11, I12 et I13	75%
The lack of state subsidies does not encourage economic agents to adopt Industry 4.0 technologies	I3, I5, I6, I7, I8, I9, I11, I13 et I14	56%

Source: authors , I= Interviewee

This table allowed us to extract some variables driving the adoption of Industry 4.0 tools. These are: equipment costs, power cuts, internet quality, political instability and subsidies. These variables are summarized in the figure below:

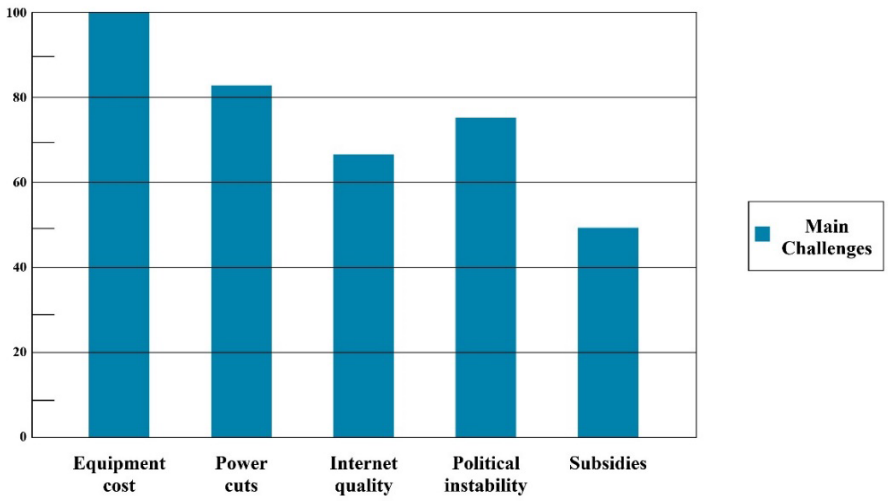

Figure 1. distribution of the main challenges by percentage of interviewees

The figure above shows the main challenges related to the adoption of new technologies as a percentage of interviewees. It appears that all the respondents in our sample have the cost of equipment as their main challenge. 81% of respondents believe that power cuts are an obstacle to digitlization, 68% mention a problem related to the quality of the internet, 75% mention political instability and 56% deplore the lack of subsidies.

4.2 Discussion

The following is a highlight of the different challenges extracted from the responses by the interviewees.

4.2.1 Equipment Cost

The cost of installing infrastructure was mentioned by all the interviewees in our sample. The I2 interviewee, for example, specifies this in his remarks: « ... This is all well and good, but it is an exorbitantly expensive investment, we do not have enough resources to take ownership of it because we not only need quality infrastructure, but we will also have to retrain staff or recruit new ones... ». Indeed, the implementation of Industry 4.0 requires large investments and therefore a significant amount of financial resources. Manufacturing companies need to source digital equipment and use the expertise of engineers in digitalization. Studies by Decker (2017) show that several companies are still evaluating the need to invest in the data and system architecture required for the introduction

of Industry 4.0 because they are not yet certain of the return on investment. In the same vein, a later study by Aheleroff et al. (2020) points out that many companies are unclear about the benefits of using digital industry technologies.

In addition, the thorny problem of finding skilled labour has always been at the centre of many industries' concerns. Indeed, one of the direct consequences of this revolution is the increase in the unemployment rate due to the disappearance of certain professions in favor of new professions adapted to Industry 4.0 such as edge computing, expert edge computing, 3D printer engineer, cybersecurity engineer, machine learning engineer, IT/IOT/Cloud solutions architect (Grassi et al. 2020). This natural implies that people whose skills will become redundant will oppose the changes that come with the acquisition of new technologies that replace them. Changing working conditions can also lead to conflicts within the organization because it is difficult to change workers' habits (Liu et al. 2020). The adoption of Industry 4.0 therefore requires a gradual and carefully managed change.

4.2.2 Power Cuts

81% of the respondents in our sample mentioned the lack of energy. Some of them deplore the lack of organization or even the inefficiency of the company in charge of electricity. The I8 interviewee underlines in his words « ... Do we even have electricity first? We face load shedding here almost every day and you can't imagine the costs that this generates in the production process... Fix this basic problem first and we'll see later... ».
Indeed, the lack of energy is a major problem in several countries in sub-Saharan Africa, several regions are still facing problems of reliable electricity supply despite the resources deployed by the government. Nzepang et al. (2024), after conducting a study on the impact of load shedding on the efficiency of manufacturing firms, concludes that the number of load shedding, the duration, the total cost of electricity and losses negatively and significantly affect the efficiency scores of firms. However, as highlighted by the work of UN et al. (2023) the adoption of Industry 4.0 requires large investments in terms of capital and therefore, some economic agents will only be able to commit if they are certain of the return on investment. The discussion can be richer by indication the percentatge electrification of Cameroon, the power production capacity versus the peak demand. Also providing the population of Cameroon helps to indicate level or power deficit.

4.2.3 Internet Quality

The quality of the internet was mentioned by 68% of the respondents in our sample. According to them, the network coverage problem remains a major challenge for the adoption of Industry 4.0 tools. The I1 interviewee expresses himself « ... We still have a network problem in this country... We are talking about large investments that require a good internet connection to run the machines, we cannot make such commitments under such conditions... » Indeed, the digital shift in manufacturing companies is leading to a partial or total transformation of the production system however. Internet connectivity and telecommunication networks are necessary for the adoption of high technology. The Internet of Things for example, require wireless network coverage. In addition, the technological transformation includes a machine automation system through sensors that monitor the maintenance status of the machines and transmit production data for better analysis (Aaron 2023). However, the lack of telecommunications infrastructure in developing countries remains a major problem (UN 2018). Not only is the cost of access high, but the quality of the internet does not improve the productivity of companies. According to Niebel (2018), mastering the internet service is an important driver of growth and a lever for economic development. It is also necessary to consider the energy needs and environmental impacts of the network devices and systems in order to scientifically examine their pros and cons.

4.2.4 Political instability and subsidies

It is clear that 75% of the interviewees mentioned the problem of political instability. They spoke of the war that has been going on in two parts of the country for several years now. I5 emphasizes this « ... With this war that doesn't stop, we are no longer sure of anything in this country... the economy in the North West and South West is bad, we are afraid to invest because nothing is stable... »
Indeed, political instability is a barrier and pauses brakes on the country's economic growth, it romoves the bridge between potential investors and economic agents. This can be severely affect the retrun on investment and the health of enterprises and businesses.

In addition, it was noted in our interviews that 56% of respondents mentioned the lack of subsidies. Some interviewees would like the state to be more involved in this type of project, for example by reducing customs fees when importing high-tech machinery and industry 4.0 technologies. The I14 interviewee emphasizes in his words that: « ... what does the State propose tous to invest in this kind of project? This is high technology and the State should make our task easier by starting by reducing customs fees for example... ask the State what it is proposing to facilitate the use of new technologies… »

In view of this discussion, we see that there are basic problems that need to be solved before thinking about integrating new fourth industriel revolution technologies into the production system. The researchers then highlighted five research hypotheses from this preliminary study, namely:

H1: Equipment costs have a significant negative influence on the use of the tools of the Fourth Industrial Revolution
H2: Power cuts negatively influence the adoption of Industry 4.0 technologies
H3: Internet quality has a positive and significant influence on the adoption of Fourth Industrial Revolution technologies
H4: Political instability negatively influences the adoption of Industry 4.0 tools
H5: There is a positive and significant relationship between state subsidies and the adoption of new industrial technologies.

4.3 Proposal for Improvement

This study is based on a qualitative exploratory approach. A quantitative approach to this problem with statistical tests may be the subject of future research as mentioned above. The conducted our interviews were only in the cities of Douala and Yaoundé where most of the industries in Cameroon are located. A future study will extend coverage throughout the national territory of Cameroon and can even extend the study further into the Central African sub-region in research of regional solution, which can be more viable.

5. Conclusion

This research aimed to identify the main challenges related to the adoption of Industry 4.0 technologies in manufacturing companies in Cameroon. Following a qualitative exploratory approach through semi-structured interviews with the managers of 16 manufacturing companies, the summarized the main challenges mentioned by respondents are groupe into five variables, namely: equipment cost (100%), power cuts (81%), internet quality (68%), political instability (75%) and subsidy (56%). These variables will be the cornestones of the hypothesis that have been developed and will be tested in future research. Indeed, it is important to emphasize that the use of Industry 4.0 technologies in developing countries such as Cameroon requires a review of basic infrastructure such as the supply of reliable energy sources and the implementation of high-quality network coverage. These main factors remain paramount for the use of new technologies in the production systems of manufacturing companies. In addition, the State should further promote digitalization in order to integrate into the international system and boost the national GDP through incentive, rebates and duty exemptions.

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